ONCOVIE® CANCER EXERCISE SPECIALIST

HANDBOOK

By Andrea Leonard
MS, CES, PES, CPT



Module One

15th Edition

CETI
Cancer Exercise Training Institute

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The research findings in this document include recent updates through 2026. The statistics quoted are based on data sources used by cancer.org and other international sources where the most recent source statistics are from 2022.

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As new scientific information becomes available through basic and clinical research, recommended treatments and drug therapies undergo change. The author and publisher have done everything possible to make this book accurate, up to date, and in accord with accepted standards at the time of publication. The author and publisher are not responsible for errors or omissions or for consequences from application of the book, and make no warranty, expressed or implied, regarding the contents of this book. Any practice described in this book should be applied by the reader in accordance with professional standards of care used regarding the unique circumstances that may apply in each situation.

His unconditional love and support inspired me to do great things.



Morton Beres
1935-2014

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General Information

This OncoVie® Cancer Exercise Specialist (CES) series of handbooks are designed to help qualified individuals prepare for an OncoVie® CES workshop or home study. The program is designed for ***medical and fitness professionals who have a strong working knowledge of anatomy and physiology and carry a national certification and/or degree in an exercise or health related field of study.*** This qualification process is designed to evaluate competence in the participants' knowledge, skills, and abilities found in the OncoVie® CES handbook and accompanying videos.

Workshop Information

OncoVie® Cancer Exercise Specialist workshops are designed to develop and enhance the knowledge base and skills of the participants. The curriculum has been developed so that instructive material and its practical application are scheduled together. This allows the participant to better assimilate both theory and practice. In addition to the recommended prerequisites, participants should have adequate knowledge and background in the health or fitness profession. The workshops are not intended to provide the full experience and knowledge necessary for the CES.

Qualification Information

OncoVie® CES qualifications encompass cognitive and practical competencies and are evaluated by multiple choice exams at the end of each section and a 125-question final exam. The candidate must score an 80% or better on the final exam and hold a current CPR (Cardio Pulmonary Resuscitation) certification to receive an OncoVie® CES Qualification. Questions on all exams are drawn from the module and video content. The formal certification will be available for print after successful completion of the final exam. You will have two chances to take the exam (there will be a re-test fee of $50 thereafter). A certificate of completion for CEU's will be emailed to you within 24 hours.

Qualification Renewal

In an attempt to ensure ongoing competency and to maintain a high standard for qualified professionals, CES qualifications must be renewed every two years. You will be given a two-month grace period after your qualification expires, in which to take the examination. You can purchase the re-qualification at: CETI.teachable.com, or write to us at: Andrea@thecancerspecialist.com.

Get Listed

Add your contact information to the International OncoVie® Cancer Exercise Specialist Online Directory by emailing CETI with contact information and credentials that you would like listed.

Course Format and Components

- Modular, Self-Paced Online Curriculum featuring expert-led video instruction, digital manuals, and evidence summaries.
- Interactive Case Studies addressing a spectrum of cancers and treatment pathways.
- OncoVie® Exercise Flowcharts and Programming Templates for direct application in clinical and fitness settings.
- Knowledge and Competency Assessment to ensure mastery of theoretical and applied content.

Certification Outcome

Graduates of the OncoVie® Cancer Exercise Specialist Course earn a globally recognized credential demonstrating advanced expertise in oncology-specific exercise prescription, rehabilitation integration, and survivorship care.

This certification empowers professionals to serve as essential members of the oncology care continuum bridging science and compassion to help survivors move beyond recovery and reclaim strength, confidence, and vitality.

Cancellation Policy

Home Study/Self-Paced:

- **14 days** to request a refund provided you have not moved beyond Module One.

Live Workshops/Webinars:

- **NO Refunds** issued after registration or attendance.

CETI reserves the right to cancel a workshop or webinar due to low attendance. **No Refunds** will be given and we are not responsible for any travel expenses incurred. We will make every attempt to reschedule and you have the option to switch to home study.

COURSE DESCRIPTION

The OncoVie® Cancer Exercise Specialist (CES) Course was created to equip health and fitness professionals with the knowledge and tools to design safe, effective, and personalized exercise programs for individuals affected by cancer.

Grounded in the most current 2025-2026 evidence in exercise oncology, survivorship science, and functional restoration, this comprehensive course synthesizes the latest clinical research on how movement impacts tumor biology, inflammation, immune modulation, hormone balance, fatigue, and quality of life. Participants explore the physiological and psychosocial effects of cancer treatments – including surgery, chemotherapy, radiation, immunotherapy, and hormonal therapy – and learn to mitigate their impact through targeted, progressive movement strategies.

The curriculum blends scientific theory with hands-on application, using detailed case studies, postural and functional assessments, corrective exercise methods, and individualized, evidence-based programming for over 25 cancer types. Graduates emerge confident in their ability to bridge the gap between medical care and fitness, working collaboratively with healthcare teams to optimize recovery, resilience, and long-term survivorship outcomes.

Learning Objectives:

- Understand the biological mechanisms through which exercise influences cancer risk reduction, treatment tolerance, and recurrence outcomes.
- Understand how various cancer treatments alter musculoskeletal, cardiovascular, endocrine, and lymphatic function, and how targeted exercise supports physiological repair and adaptation.
- Perform detailed pre-exercise evaluations for clients with a history of cancer, identifying contraindications, surgical limitations, and treatment-related side effects.
- Utilize movement and postural assessments to identify compensations, asymmetries, and functional deficits caused by surgery, radiation fibrosis, or disuse.
- Design and progress individualized exercise programs that restore functional movement, balance, and muscular strength while addressing fatigue, neuropathy, and bone loss.
- Integrate cardiovascular, resistance, flexibility, and neuromuscular training principles to enhance cellular resilience, metabolic efficiency, and quality of life.
- Adapt programs safely across all stages of survivorship, from active treatment through long-term recovery, using progressive overload and patient-specific variables.
- Implement targeted interventions for common cancer-related impairments, including:
    - Lymphedema prevention and management
    - Chemotherapy-induced peripheral neuropathy (CIPN)
    - Osteopenia and osteoporosis
    - Postural dysfunction and muscular imbalance
    - Cancer-related fatigue and cardiotoxicity
- Employ gentle corrective and restorative movement patterns to restore lymphatic flow, mobility, and joint integrity.
- Recognize the psychosocial and emotional dimensions of survivorship and apply motivational strategies to foster adherence and self-efficacy.
- Incorporate mindfulness, breathwork, and recovery strategies that complement physiological healing and reduce systemic inflammation.
- Collaborate effectively with oncologists, surgeons, and rehabilitation professionals while maintaining scope-of-practice boundaries.
- Apply critical thinking and ethical reasoning to create exercise programs aligned with current survivorship standards of care.

An OncoVie® Cancer Exercise Specialist Must:

- Always obtain medical clearance before initiating exercise with any client currently in treatment or with ongoing medical supervision.
- Follow all physician-imposed restrictions and contraindications to ensure client safety.
- Maintain communication and documentation with the medical team, providing updates on exercise progress, tolerance, and outcomes.
- Ensure their work enhances safety and efficacy in the fitness setting for clients with a history of cancer, ensuring exercise programming is restorative rather than harmful.

Scope of Practice

The OncoVie® Cancer Exercise Specialist operates within a non-clinical yet medically informed scope. They do not diagnose, treat, or prescribe medical interventions, but rather use movement science to complement oncology and rehabilitation care. Their work enhances safety and efficacy in the fitness setting for clients with a history of cancer, ensuring exercise programming is restorative rather than harmful.

Core Responsibilities of an OncoVie® Cancer Exercise Specialist

1 Comprehensive Assessment

- Conduct detailed health histories and pre-exercise screenings to identify medical limitations, surgical history, and treatment side effects.
- Evaluate posture, balance, mobility, flexibility, and functional strength to establish baselines and identify compensations or movement restrictions.
- Recognize red flags requiring medical clearance or referral to healthcare providers.

2 Individualized Exercise Prescription

- Design safe, personalized exercise programs based on cancer type, treatment phase, and individual recovery goals.
- Integrate cardiorespiratory, resistance, flexibility, balance, and neuromuscular training to address muscular imbalances, scar tissue adhesions, lymphatic flow, and fatigue.
- Modify programs in real-time to accommodate pain, fatigue, neuropathy, or lymphedema risk.

3 Functional and Corrective Movement Integration

- Employ corrective exercise strategies to restore joint alignment, posture, and movement efficiency post-surgery or radiation.
- Utilize evidence-based progressions to rebuild foundational strength, coordination, and core stability.
- Address long-term survivorship issues such as osteoporosis, cardiotoxicity, and metabolic dysfunction through progressive overload and functional movement re-education.

4 Education and Empowerment

- Educate clients about the benefits of movement during and after cancer treatment - including its role in improving circulation, immune function, and mental well-being.
- Empower survivors to participate actively in their recovery, using exercise as a tool for autonomy, confidence, and long-term resilience.
- Provide evidence-based lifestyle guidance on recovery, stress reduction, and self-care within scope of practice.

5 Monitoring and Progress Evaluation

- Track progress through measurable outcomes such as improved range of motion, strength, balance, and fatigue levels.
- Adjust programs according to treatment changes, disease status, or evolving side effects.
- Document sessions and progress accurately to support continuity of care and professional accountability.

Sample Questions & Answers

The following sample questions will help the student assess his or her knowledge base in preparation for the multiple choice CES examinations. The questions reflect the type of question asked and the depth of knowledge expected. The answers follow the last question. The student is encouraged to review in detail, those topics for which his/her answers were incorrect.

1. The function(s) of the lymphatic system is/are:

a) aiding the immune system in protecting the body from disease
b) returning fluids to the blood in the circulatory system
c) transporting fat from the digestive tract to the blood
d) filtering bacteria, viruses, tissue debris, and other foreign substances from body fluids
e) all of the above

2. After an Abdominal TRAM procedure, particular attention must be paid to strengthening which of the following muscle groups in order to stabilize the torso?

a) obliques and intercostals
b) latissimus dorsi
c) erector spinae
d) both a and c
e) all of the above

3. A potential client forwards their medical release form to their doctor. The doctor will not give their approval for the client to participate at this time. However, the client still wants to participate. You should:

a) give them the proper paperwork and get them enrolled before they change their minds
b) suggest they be reevaluated by their doctor and check back with you later
c) allow them to enroll, but let them know that they will only be allowed to do stretching and range of motion exercises until you have their doctor's permission
d) give them some stretches to work on and suggest they do them for a few weeks before they go back to their doctor for reevaluation
e) both a and c

4. We currently know that lymphedema may be caused by:

a) radiation treatment to the lymph nodes
b) lifting weights in excess of 12 lbs.
c) antidepressant use
d) drinking more than 8 glasses of water daily
e) none of the above

5. Clients undergoing chemotherapy/radiation will reap the same physiological training results as those not undergoing treatment.

a) true
b) false

6. Which of the following is not a sign of cancer fatigue?

a) lack of interest in normal day-to-day activity
b) increased appetite
c) increased time spent lying in bed or sleeping
d) not having enough energy to do normal activities
e) all of the above

7. The fingertip wall walk will help to do which of the following?

a) increase ROM in shoulder abduction and flexion
b) increase ability to externally rotate
c) improve shoulder extension
d) prevent lymphedema
e) none of the above

8. With radiation therapy, pain is often associated with which of the following?

a) breakdown of mucous membranes
b) scarring of the nerves (fibrosis)
c) swelling
d) skin sores
e) all of the above

9. You are scheduled to begin training a woman with a slight case of lymphedema. Prior to your first workout you should do which of the following?

a) contact their doctor for permission
b) contact their physical therapist or lymphedema specialist
c) instruct them to wear their sleeves or wraps as prescribed by their doctor or therapist
d) both a and b
e) all of the above

10. Osteosarcoma is the most common kind of

a) breast cancer
b) osteoarthritis
c) osteoporosis
d) bone cancer
e) none of the above

11. To help to prevent the onset of lymphedema, a patient should practice which of the following precautions?

a) use moderation when working the affected body part
b) always get blood drawn or shots given in the unaffected arm or leg
c) elevate the affected arm or leg whenever possible
d) both b and c
e) all of the above

12. All of the following are road blocks to pain control except:

a) nausea
b) sedation
c) hallucinations
d) premature ventricular contractions
e) allergic reactions

13. When performing a postural assessment, it is important to have your client stand still and maintain perfect posture while you conduct the assessment.

a) true
b) false

14. Prior to beginning or resuming a strength training routine after a mastectomy, your client should have 90% or better range of motion in her affected arm.

a) true
b) false

15. What precautions must be taken with a client who has undergone an extensive cervical lymph-node dissection for medullary thyroid cancer?

a) do not let client overheat
b) make sure that they stay well hydrated
c) use moderation for all upper back and neck strength training
d) emphasize stretching of the neck area
e) all of the above

16. Somatic pain can be described by which of the following:

a) sharp pain
b) aching
c) throbbing pain
d) b and c only
e) all of the above

17. At which stage is lymphedema still potentially reversible?

a) stage I
b) stage II
c) stage III
d) stage IV
e) none of the above

18. The five sub-classes of cancer, that are not carcinomas, include all the following except:

a) sarcomas
b) melanomas
c) leukemias
d) lymphomas
e) blastomas

19. The term "hidden cells" is used when referring to which of the following?

a) cancer cells not detected at the time of surgery
b) cancer cells that are found in the ducts or lobules of the breast
c) cancer cells that have found their way into the lymph nodes
d) cells that move through the blood stream, making them almost impossible to find
e) none of the above

20. Which cancer is the leading cause of cancer-related death worldwide, according to GLOBOCAN data?

a) breast
b) colorectal
c) lung
d) liver

Answers to Sample Test Questions
1. E / 2. D / 3. B / 4. A / 5. B / 6. B / 7. A / 8. E / 9. E / 10. D / 11. E / 12. D / 13. B / 14. A / 15. E / 16. E / 17. A / 18. E / 19. A / 20. C

FOREWORD
By Stacey Mann, CES, CPT



Fifteen years ago, my understanding of strength, resilience, and movement was forever changed.

When my youngest son was diagnosed with T-Cell Acute Lymphoblastic Leukemia at just three and a half years old, he was already a child in constant motion - curious, energetic, and full of life. Cancer could have taken that from him. Instead, in his own determined way, he chose to keep moving.

I can still picture him riding an old red tricycle through the hospital halls, weaving between IV poles and nurses' stations, refusing to let treatment define his spirit. At the time, I was working as a running coach and personal trainer, as well as managing a nonprofit for Parkinson's Disease. Even in the early, overwhelming days of his diagnosis and treatment, I couldn't help but notice something remarkable: his activity - however simple, however small - seemed to matter. It supported him through lengthy hospital stays. It strengthened him through chemotherapy and total body radiation. It helped him endure through an allogenic cord blood transplant. Years later, exercise sustained him throughout a papillary thyroid cancer diagnosis. I truly believe that his desire to stay active played a meaningful role in his ability to withstand treatment and ultimately thrive. Today, he is not just a survivor - he is living well in survivorship.

That experience changed the course of my life.

Once his treatment for Leukemia ended, I went searching for answers. I wanted to understand what I had witnessed as both a mother and a fitness professional. That search led me to the Cancer Exercise Training Institute, where I became an OncoVie® Cancer Exercise Specialist.

The education I received gave language, structure, and science to what I had seen firsthand. It equipped me with the knowledge to safely and effectively support individuals navigating multiple types of cancer—meeting them where they are, understanding the complexities of treatment, and helping them rebuild strength and confidence through movement.

Because of the OncoVie® Cancer Exercise Specialist course, I was able to create something I once didn't even know was possible: a live, virtual oncology exercise program serving women with a history of cancer as well as those living with metastatic disease. The 2Unstoppable Strong program, offered by the nonprofit 2Unstoppable; has become a space where individuals, no matter where they are in the world, can reconnect with their bodies, regain a sense of control, and rediscover what movement means to them after diagnosis.

Without the in-depth education I received from the Cancer Exercise Training Institute and Andrea Leonard, I would not feel equipped to work with cancer survivors and thrivers. I would not be able to help others return to movement safely or guide them toward improved outcomes and a better quality of life.

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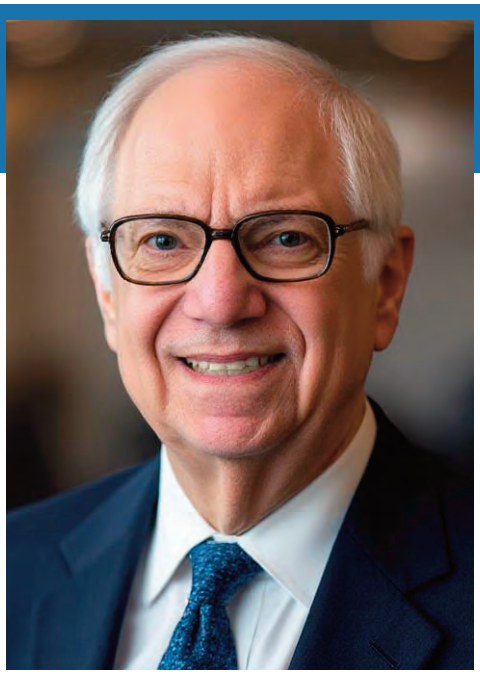
This course represents more than evidence-based practice - it represents possibility. It reflects the growing understanding that exercise is not just safe for individuals with cancer, but essential. It is a powerful tool for healing, resilience, and hope.

Becoming an OncoVie® Cancer Exercise Specialist will not only empower you with the knowledge and confidence to assist clients on their journey with cancer but will also allow your clients to trust their bodies again with you by their side.

I have seen that truth in the hospital hallways, through the determination of a small child on a red tricycle. And I continue to see it every day in the lives of those who choose to keep moving forward, no matter where they are in their journey.

My hope is that this course will equip and inspire you to do the same for yourself, for your clients, and for the countless individuals whose lives and cancer outcomes can be positively transformed through the incredible power of movement.

FOREWORD
By Dr. Robert L. Bard, MD, DABR, FAIUM, FASLMS



Cancer survivorship is no longer measured simply by years lived after diagnosis. Today, the conversation has rightfully evolved toward how well individuals live after treatment - how they recover strength, restore confidence, regain mobility, reclaim intimacy, and rebuild quality of life. In this new era of restorative care, exercise is no longer considered optional. It is essential medicine.

It is my profound honor to write this foreword in recognition of the extraordinary work of Andrea Leonard and the Cancer Exercise Training Institute (CETI). Andrea has dedicated her career to advancing one of the most important yet historically underserved areas of modern healthcare: cancer rehabilitation through exercise science. Her leadership, vision, and commitment to education have helped establish a new standard for survivorship support worldwide. As a physician specializing in diagnostic imaging and cancer care for decades, I have had the privilege of witnessing both the triumphs and limitations of modern oncology. We have made remarkable progress in detecting and treating disease. Yet many survivors continue to face debilitating consequences long after treatment ends - fatigue, muscle loss, reduced mobility, chronic pain, emotional distress, lymphatic compromise, cardiovascular decline, and profound deconditioning. Too often, patients complete treatment only to discover that surviving cancer is merely the beginning of another difficult journey. This is precisely why the work presented in this handbook is so critically important.

The CETI curriculum recognizes that recovery requires more than medical intervention alone. It requires movement, education, structure, compassion, and informed guidance from trained professionals who understand the unique physiological and emotional challenges cancer survivors face. Exercise, when properly designed and supervised, has the power to transform outcomes. It improves cardiovascular health, muscular function, metabolic resilience, balance, mobility, posture, and endurance. Just as importantly, it restores hope, confidence, independence, and emotional well-being. What Andrea Leonard has created is not simply a fitness program. It is a sophisticated educational framework that empowers professionals to become active participants in survivorship medicine. The OncoVie® CES is uniquely trained to understand the cancer continuum - from diagnosis and treatment through recovery and long-term restorative care. This level of specialized education is desperately needed in healthcare today. The handbook itself reflects that mission beautifully. Its comprehensive structure provides an essential foundation in oncology, treatment effects, physiology, contraindications, rehabilitation principles, functional assessment, and individualized exercise programming. It bridges the gap between medical science and practical implementation. It also reinforces the reality that no two cancer patients are alike, and therefore no two rehabilitation strategies should ever be identical.

I particularly admire CETI's emphasis on competency, clinical understanding, and ongoing education. The program recognizes that exercise professionals working with cancer survivors carry an important responsibility - one that requires advanced knowledge, sensitivity, and interdisciplinary awareness. This certification helps ensure that survivors receive safer, more informed, and more effective support during one of the most vulnerable periods of their lives.

Continued on next page.

In many ways, cancer rehabilitation represents the future of integrative healthcare. We are entering an era where restorative medicine, exercise oncology, functional recovery, and quality-of-life metrics are becoming central to patient care. Survivors are seeking solutions that go beyond symptom management. They are seeking restoration. They want to return to work, return to family roles, return to intimacy, return to movement, and return to living fully.

This handbook helps make that possible. From my perspective as an imaging specialist, I have also seen how exercise positively influences vascular health, inflammatory response, musculoskeletal recovery, lymphatic function, and overall physiological resilience. The body was designed to move, heal, adapt, and strengthen. When survivors are guided properly, exercise becomes one of the most powerful tools available to support recovery and long-term wellness.

Andrea Leonard deserves tremendous recognition for championing this field long before it gained widespread attention. Her tireless advocacy has helped educate thousands of professionals while bringing dignity and visibility to the needs of cancer survivors everywhere. She has built more than a certification program - she has helped build a movement. To every professional pursuing this education, I commend your commitment. Your willingness to expand your knowledge and serve this population reflects a deeper understanding of healthcare itself: that healing is not only about treating disease, but about restoring the human being behind the diagnosis.

The future of survivorship care depends upon collaborative, educated, and compassionate professionals who recognize the value of rehabilitation and restorative care. This handbook is an important contribution toward that future.

I congratulate Andrea Leonard and CETI for their exceptional leadership, and I encourage every reader to approach this material not only as a course of study, but as an opportunity to profoundly impact lives.

Cancer survivors deserve more than survival alone.

They deserve the opportunity to recover strength, function, confidence, and hope.



BIOGRAPHY

Andrea Leonard is the founder and president of the Cancer Exercise Training Institute (CETI) and the most influential figure in the development of oncology exercise as a recognized clinical discipline. A 42-year cancer survivor who was first diagnosed with thyroid cancer at eighteen, her life and her life's work are inseparable. She has experienced cancer from every dimension - as survivor, as daughter who lost her father and other family members to the disease, and as an advocate currently supporting her mother through metastatic breast cancer. That depth of personal experience is not incidental to her professional authority. It is the source of it.

Her formal work began in 1992 at the National Capital YMCA in Washington, D.C., where she rose to Director of Personal Training and developed the EMPOWER program - designed to restore physical function following surgery. Her mission sharpened in 1996 when her mother was diagnosed with breast cancer for the second time. In response, Andrea assembled a medical advisory team from Georgetown, George Washington, and Johns Hopkins University Medical Centers to advise on "Essential Exercises for Breast Cancer Survivors," published by Harvard Common Press in 2000 - the first evidence-based exercise resource for cancer survivors ever produced. That same year, she founded the Breast Cancer Survivors Foundation, an Oregon 501(c)(3) nonprofit, dedicated to supporting women navigating breast cancer recovery. But watching her father and grandfather battle cancer - and witnessing the profound unmet needs of patients with all cancer types - made clear that her mission had to be broader. She dissolved the Foundation and in 2004 founded the Cancer Exercise Training Institute, expanding her vision to serve every cancer survivor, regardless of diagnosis.

From that foundation, Andrea developed the OncoVie® Cancer Exercise Specialist certification - the most comprehensive oncology exercise credential in existence, covering 26 cancer types, pediatric oncology, surgical interventions, lymphedema management, and individualized exercise prescription. All credentialed specialists must recertify every two years, ensuring clinical currency and an unwavering standard of patient safety.

The results speak to the scale of her vision. CETI has trained over 20,000 OncoVie® Cancer Exercise Specialists across 60 countries - more than any other organization in the world. Andrea holds a BA from the University of Maryland and an MS in Functional Nutrition from Rocky Mountain University of Health Professions. An education partner with the American Council on Exercise (ACE), she also holds credentials as a Certified Personal Trainer, Corrective Exercise Specialist, and Performance Enhancement Specialist through the National Academy of Sports Medicine (NASM). She is the author of 25 books on oncology exercise, a keynote speaker on five continents, and was named the 2019 PFP/Club Industry Personal Trainer of the Year.

Her work has inspired organizations, universities, and medical fitness programs worldwide to model their survivorship initiatives after CETI's evidence-based framework, redefining how oncology recovery is approached in both clinical and community settings. Andrea Leonard did not enter an established field and rise within it. She built the field - from personal experience, clinical collaboration, and an uncompromising belief that movement is medicine. This book is the latest expression of that conviction, and of a career devoted entirely to ensuring that no cancer survivor faces recovery without the guidance they deserve.

CHAPTER ONE

THE "C" WORD

OBJECTIVE: to understand cancer and the deviation from normal cell growth and to gain an understanding of:

- Causes
- Categories
- Genetics

GOAL: to have a general understanding of cancer as a disease.

Cancer is a major public health challenge. In 2022, an estimated 20 million people around the world were diagnosed with cancer, and 9.7 million deaths occurred from the disease. By 2050, the number of new cancer cases is predicted to reach 35 million - a 77% increase. The proportional rise will be most striking in low- and middle-income countries, where cancer mortality is projected to nearly double, as those with the fewest resources will bear the greatest burden. Cancer is the cause of about 30% of all premature deaths from noncommunicable diseases among adults aged 30-69, and one third to one half of cancer cases could be prevented by reducing exposure to known risk factors (Bray et al., CA: A Cancer Journal for Clinicians).

The most frequently diagnosed cancer is lung cancer (12.4% of total cases), followed by breast (11.6%), colorectal (9.6%), prostate (7.3%), and stomach (4.9%). Lung cancer is also the leading cause of cancer death (18.7% of total cancer deaths), followed by colorectal (9.3%) and liver cancers (7.8%). The most common cancer types vary among countries, with certain cancers, such as cervical cancer and Kaposi sarcoma, much more common in countries at the lower end of the human development index (HDI) than in high-HDI countries (Bray et al., CA: A Cancer Journal for Clinicians). Cancer occurs in approximately 400,000 children every year worldwide, and the rate is expected to increase (AACR, Pediatric Cancer Progress Report, 2025).

For both sexes combined, roughly one half of cases and over one half of cancer deaths worldwide occurred in Asia in 2022, in part because close to 60% of the global population resides there (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Europe accounts for 22.4% of total cancer cases and 20.4% of cancer deaths despite representing only 9.6% of the global population, followed by North America's 13.3% of incidence and Latin America and the Caribbean's 7.2% of mortality worldwide (Bray et al., CA: A Cancer Journal for Clinicians). In contrast to other regions, the shares of cancer deaths in Asia (58.3%) and Africa (7.1%) are higher than the shares of incidence (49.3% and 5.7%, respectively) because of the different distribution of cancer types and higher case fatality rates in these regions (Bray et al., CA: A Cancer Journal for Clinicians).

WHAT IS CANCER?

The term “cancer” refers to a group of diseases in which abnormal (malignant) cells divide and form additional abnormal cells without any order or control. There are more than 100 types of cancer. Types of cancer are usually named for the organs or tissues where the cancers form. For example, breast cancer starts in cells of the breast, and prostate cancer starts in cells of the prostate. Cancers also may be described by the type of cell that formed them, such as an epithelial cell or a squamous cell. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. In normal tissues, the rates of new cell growth and old cell death are kept in balance. In cancer this balance is disrupted.

Cancer cells differ from normal cells in many ways that allow them to grow out of control and become invasive. One important difference is that cancer cells are less specialized than normal cells. Normal healthy cells mature into specific cell types with distinct functions, cancer cells do not. Cancer cells continue to divide without stopping. Cancer cells also can ignore signals that would normally tell cells to stop dividing (programmed cell death, or apoptosis), which the body uses to get rid of unneeded cells.

Angiogenesis, the growth of new capillary blood vessels in the body, is a natural process used by the body for healing and reproduction. The body controls angiogenesis by producing a precise balance of growth and inhibitory factors in healthy tissues. Abnormal blood vessel growth, either excessive or insufficient, is now recognized as an underlying factor in many conditions, including cancer, skin diseases, age-related macular degeneration, diabetic ulcers, cardiovascular disease, stroke, and many others. Cancerous tumors release angiogenic growth factor proteins that stimulate blood vessels to grow into the tumor, providing it with oxygen and nutrients. Cancer cells may be able to influence the normal cells, molecules, and blood vessels that surround and feed a tumor. They can induce nearby normal cells to form blood vessels that will supply the tumor(s) with oxygen and nutrients, that are required for growth.

Cancer cells are also often able to circumvent the immune system by “hiding” from the immune system. Tumors can also use the immune system to stay alive and grow by keeping the immune system from killing cancer cells. Angiogenesis inhibitors, also called anti-angiogenics, are drugs that block angiogenesis. Blocking nutrients and oxygen from a tumor “starves” it. These drugs are an important part of treatment for some types of cancer.

EXAMPLES OF ANGIOGENESIS INHIBITORS ARE:

- **Inlyta® (Axitinib)** – treatment option for kidney cancer
- **Avastin® (Bevacizumab)** – treatment option for colorectal, kidney, and lung cancers
- **Cometriq® (Cabozantinib)** – treatment option for medullary thyroid cancer and kidney cancer
- **Everolimus® (Afinitor, Zortress)** – treatment option for kidney cancer, advanced breast cancer, pancreatic neuroendocrine tumors (PNETs), and subependymal giant cell astrocytoma, which is a rare type of noncancerous brain tumor
- **Revlimid® (Lenalidomide)** – treatment option for multiple myeloma, tumors involving cells that normally produce antibodies, and mantle cell lymphoma, which is a type of non-Hodgkin lymphoma
- **Lenvima® (Lenvatinib)** – treatment option for endometrial carcinoma, hepatocellular carcinoma, renal cell carcinoma, and thyroid cancer
- **Votrient® (Pazopanib)** – treatment option for kidney cancer and advanced soft tissue sarcoma
- **Cyramza® (Ramucirumab)** – treatment option for advanced stomach cancer; gastroesophageal junction adenocarcinoma, a cancer located where the stomach joins the esophagus; colorectal cancers; and non-small cell lung cancers
- **Stivarga® (Regorafenib)** – treatment option for colorectal cancer and gastrointestinal stromal tumors (GIST)
- **Nexavar® (Sorafenib)** – treatment option for kidney, liver, and thyroid cancers
- **Sutent® (Sunitinib Malate)** – treatment option for kidney cancer, PNETs, and GIST
- **Thalomid®/Synovir® (Thalidomide)** – treatment option for multiple myeloma. Women who are pregnant should not take this drug because it is prove to harm fetuses.
- **Caprelsa® (Vandetanib)** – treatment option for medullary thyroid cancer
- **Zaltrap® (Ziv-aflibercept)** – treatment option for colorectal cancer

Because many of the body's normal functions depend on angiogenesis, angiogenesis inhibitors can cause a wide range of side effects including:

- High blood pressure
- Biochemical hypothyroidism
- Hand-foot syndrome - this causes tender, thickened areas on the palms and soles. Sometimes, it causes blisters.
- Diarrhea
- Fatigue
- Low blood counts
- Problems with wound healing or cuts reopening

Although common, these side effects do not happen with every drug or every person, and medicines are available to help manage these side effects. Rare side effects are:

- Serious bleeding
- Clots in the arteries with resultant heart attack or stroke
- Heart failure
- Blood clots
- Holes in the intestines (bowel perforations)

DEVIATION FROM NORMAL CELL GROWTH

Cancer tissue has a distinctive appearance when viewed under a microscope. Pathologists will look for a large number of dividing cells, variation in nuclear size and shape, variation in cell size and shape, loss of normal tissue organization, and a poorly defined tumor boundary. Sometimes pathologists will detect a condition known as "hyperplasia." This refers to tissue growth based on an excessive rate of cell division, leading to a larger than usual number of cells. Everything else in the cells' structure seems to remain normal and potentially reversible. Hyperplasia can be a normal tissue response to an irritating stimulus; for example, a callus that forms on your hand when you begin playing tennis on a regular basis.

Another non-cancerous condition is called "dysplasia." This, too, is an abnormal type of cell proliferation characterized by loss of normal tissue arrangement and cell structure. Often these cells will revert to normal behavior but occasionally they become malignant over time.

These areas are usually closely monitored by a professional in case they need treatment. The most severe cases of dysplasia are sometimes referred to as "carcinoma in situ." This term refers to an uncontrolled growth of cells that remains in its original location. It does, however, have the potential to develop into an invasive malignancy and, is therefore, usually removed surgically when possible. Lastly, there is invasive cancer. Unlike carcinoma in situ, this cancer has spread beyond its original location and has begun to infiltrate into other, previously healthy, tissue. These tumors tend to grow more quickly, spread to other organs more frequently, and be less responsive to therapy. These cancers are surgically removed when possible and often accompanied by radiation and/or chemotherapy to kill any cancerous cells that have spread outside of the tumor.

Cancers are divided into several categories with carcinomas making up 80-90% of all cancers (NCI, What Is Cancer?, 2023)

Carcinomas – cancers that arise in the epithelium, the membranous tissue that forms the inner lining and outer covering of organs, glands, and vessels, as well as the surface layer of the skin. Carcinomas include lung, breast, cervical, prostate, and colon cancer.

Carcinomas that begin in different epithelial cell types have specific names:

- **Adenocarcinoma –** is a cancer that forms in epithelial cells that produce fluids or mucus. Tissues with this type of epithelial cell are sometimes called glandular tissues. Most cancers of the breast, colon, and prostate are adenocarcinomas.
- **Basal Cell Carcinoma –** is a cancer that begins in the lower or basal (base) layer of the epidermis, which is a person's outer layer of skin.
- **Squamous Cell Carcinoma –** is a cancer that forms in squamous cells, which are epithelial cells that lie just beneath the outer surface of the skin. Squamous cells also line many other organs, including the stomach, intestines, lungs, bladder, and kidneys. Squamous cell carcinomas are sometimes called epidermoid carcinomas.
- **Transitional Cell Carcinoma –** is a cancer that forms in a type of epithelial tissue called transitional epithelium, or urothelium. This tissue, which is made up of many layers of epithelial cells that can get bigger and smaller, is found in the linings of the bladder, ureters, and part of the kidneys (renal pelvis), and a few other organs. Some cancers of the bladder, ureters, and kidneys are transitional cell carcinomas.

The following five categories make up the remaining (NCI, What Is Cancer?, 2023)

- **Sarcomas –** cancers in the bone, cartilage, tendons, ligaments, fat, muscle, and blood & lymph vessels. Osteosarcoma is the most common cancer of bone.

- **Leukemias –** cancers that begin in the blood-forming tissue of the bone. These cancers do not form solid tumors. Large numbers of abnormal white blood cells (leukemia cells and leukemic blast cells) build up in the blood and bone marrow and "crowd-out" normal blood cells. Due to the low level of normal blood cells, it can make it harder for the body to get oxygen to its tissues, control bleeding, or fight infections.

  Examples include:

  - Myelogenous or granulocytic leukemia (malignancy of the myeloid and granulocytic white blood cell series)
  - Lymphatic, lymphocytic, or lymphoblastic leukemia (malignancy of the lymphoid and lymphocytic blood cell series)
  - Polycythemia vera or erythremia (malignancy of various blood cell products, but with red cells predominating)

- **Lymphomas (including multiple myeloma) –** cancers that begin in lymphocytes (T cells or B cells). These are disease-fighting white blood cells that are part of the immune system. In lymphoma, abnormal lymphocytes build up in lymph nodes and lymph vessels, as well as in other organs of the body.

  There are two main types of lymphomas.

  - **Hodgkin Lymphoma –** people with this disease have abnormal lymphocytes that are called Reed-Sternberg cells. These cells usually form from B cells.
  - **Non-Hodgkin Lymphoma –** this is a large group of cancers that start in lymphocytes. The cancers can grow quickly or slowly and can form from B cells or T cells.

- **Melanomas –** cancer that forms in the skin cells that produce pigment responsible for skin color

- **Gliomas –** these cancers form in the brain and spinal cord. They are named based on the type of cell in which they formed and where the tumor first formed in the central nervous system. For example, an astrocytic tumor begins in star-shaped brain cells called astrocytes, which help keep nerve cells healthy.

What Causes Cancer?

Cancer is a genetic disease caused by changes to genes that control the way our cells function; particularly how they grow and divide. Genetic changes may be inherited from our parents - only 5-10% of all cases - (Schröck and Siebert, Medizinische Genetik, 2025). They can also arise during a person's lifetime as a result of errors that occur as cells divide or because of damage to DNA caused by certain environmental exposures (acquired changes). Cancer-causing environmental exposure that leads to oxidative stress includes chemicals in tobacco smoke, radiation, pesticides, viruses, food additives and coloring, and more.

Chemicals and radiation that can cause cancer are known as "carcinogens." Carcinogens initiate a series of genetic alterations or mutations and encourage cell proliferation. This usually doesn't happen overnight. Sometimes several decades can pass between exposure to a carcinogen and the onset of cancer. Since exposure to carcinogens is responsible for triggering most cancers, we can reduce our risk by taking steps to avoid such agents whenever possible. The use of tobacco products has been implicated in one out of every three cancer deaths. Despite the Surgeon Generals' repeated warnings, as well as the fact that smoking is the largest single cause of death from cancer, the tobacco industry continues to thrive. Avoiding tobacco products, cigarettes, cigars, and chewing tobacco is the single most effective lifestyle decision you can make to prevent cancer.

Although it is usually not life-threatening, skin cancer caused by exposure to sunlight is the most frequently observed type of cancer. Most of us do not take skin cancer very seriously because it is often easy to cure. Melanoma, a more serious form of skin cancer, also associated with sun exposure, is potentially lethal. Once again, we choose to ignore the repeated and ever-present warnings to stay out of the sun and continue to bask in the sun's glory for hours on end. Risk of skin cancer can be greatly reduced by wearing clothing to shield the skin from ultraviolet radiation, wearing protective sunscreen or by avoiding direct sun exposure altogether.

Actions can also be taken to avoid exposure to some of the viruses that are associated with cancers. The most common of which is the human papillomavirus (HPV) which is involved in the transmission of cervical cancer. "Safe sex," including limiting exposure to multiple sex partners, is the best way to prevent this virus which is sexually transmitted. Many carcinogens have become "occupational" hazards to those who encounter them on a regular basis. These include arsenic, asbestos, benzene, chromium, leather dust, naphthylamine, radon, soot's, tars, oils, vinyl chloride, and wood dust. Workers who are exposed to these chemicals have a higher incidence of cancer.

The increase in identifiable cancer cases is due largely in part to increased life span because cancer is more prevalent among older people. Obesity (being extremely overweight) raises the risk of type II diabetes, high blood pressure, heart disease, and cancer. The connection between type 2 diabetes and cancer is complex, involving both genetic and lifestyle factors. The two diseases - diabetes and cancer - share several key risk factors, including obesity and lack of physical activity. Excess body fat can lead to insulin resistance, a risk factor for type 2 diabetes. It also can trigger chronic inflammation, and increased estrogen production which, along with insulin resistance, are key contributing factors in the development of tumorous cells.

An increasing number of studies now suggest that a significant proportion of cancer patients harbor an underlying predisposition to malignancy, and it is likely that this proportion will only increase as sequencing technology becomes more widely deployed. A second AACR-convened workshop held in 2023 updated surveillance recommendations and added newly described syndromes not addressed in the prior 2016 workshop - reflecting how actively the field continues to expand (Brodeur et al., Clinical Cancer Research, 2025).

Recent advances in molecular biology and genetic technologies - particularly large-scale genome sequencing - have significantly improved the biological and molecular understanding of cancer predisposition syndromes, but many gray areas remain, including the interpretation of variants of uncertain significance whose role in cancer pathogenesis is not yet fully characterized (Carta et al., Frontiers in Oncology, 2025).

New research published in October 2025 revealed that up to 5% of Americans - approximately 17 million people - carry genetic mutations or variants linked to increased cancer susceptibility, regardless of personal or family cancer history, based on analysis of over 70 common cancer-related genes identifying more than 3,400 unique mutations (Idumah et al., JAMA, 2025).



Cancer cells come in all different shapes and sizes and are classified by their aggressiveness and from the tissue where they originate. Cancer cells that essentially resemble their non-cancerous counterparts and can still perform some of their normal functions are described as well *differentiated*. On the flip side, the cells that are identified by their disorganized structure and their ability to divide rapidly and chaotically are known as *poorly differentiated* cells. A tumor that remains confined to its original, or primary location, is referred to as *localized*. There are two ways that a cancer can spread; it can grow straight through the primary organ and directly into adjacent tissue (referred to as a *local extension or regional disease*), or in metastatic cancer, a colony of malignant cells can break away and ride the circulatory system to nearby lymph nodes or a distant organ where it forms a *secondary cancer*. Sometimes, despite batteries of tests, a metastatic tumor is diagnosed, but no primary tumor is found. When this happens, the cancer is declared a *cancer of unknown primary origin*.



We are born with two copies of most genes - one from our mother and one from our father. When we inherit an abnormal copy of a gene, our cells already start out with one mutation. If the other copy of the gene stops working (because of an acquired mutation, for example), the gene can stop functioning altogether. When the gene that stops working is a *cancer susceptibility gene*, cancer may develop. Some cancer susceptibility genes function as *tumor suppressor genes* (normal genes that slow down cell division, repair DNA mistakes, or tell cells when to die - a process known as *apoptosis* or programmed cell death). When tumor suppressor genes do not work properly, cells can grow out of control, which can lead to cancer. Many family cancer syndromes are caused by inherited defects of tumor suppressor genes. Cancers that are caused by inherited genes tend to occur earlier in life than those that are acquired.

When many people in one family have cancer, the assumption is that it is inherited however, it is more likely that it is due to chance or exposure to a common toxin. Less often, these cancers may be caused by an inherited gene mutation causing a family cancer syndrome.

The following list (provided by the Canadian Cancer Society) are cancers that are more likely to occur from an inherited gene:

- Family members were diagnosed with cancer at a younger age
- Many family members have the same or a related type of cancer
- More than one type of cancer in a single person (like a woman with both breast and ovarian cancer)
- Cancers occurring in both of a pair of organs (both eyes, both kidneys, both breasts)
- Family members have an uncommon or rare type of cancer
- There is more than one case of childhood cancer in siblings (brothers and sisters)

Cancer in a parent, brother, or sister is more cause for concern than cancer in a more distant relative. Even if a gene mutation is present, the chance of you becoming diagnosed is reduced with more distant relatives, as the amount of shared DNA decreases with each degree of relation. Having two relatives with cancer is more concerning if the people are related to each other - for example, if both relatives are your father's sisters it carries more weight than if one was your father's sister and the other was your mother's sister, since both affected relatives sharing the same genetic lineage provides stronger evidence of an inherited variant being present in that family line (Cleveland Clinic, Genetic Testing for Cancer Risk, 2024; ACS, Family Cancer Syndromes, 2025).

FAMILY CANCER SYNDROMES

Having several different kinds of cancer among family members is not as concerning as many family members having the same type of cancer. There are, however, some family cancer syndromes in which a few types of cancer seem to go hand-in-hand - breast cancer and ovarian cancer run together in families with hereditary breast and ovarian cancer syndrome, and colon and endometrial cancers tend to go together in a syndrome called hereditary non-polyposis colorectal cancer, also known as Lynch syndrome (ACS, Family Cancer Syndromes, 2025).

The age at which someone is diagnosed is also important. Colon cancer is rare in people under forty, and having two or more cases in close relatives under forty years of age could be a sign of an inherited cancer syndrome such as Lynch syndrome or familial adenomatous polyposis (CDC, About Lynch Syndrome, 2026; Mayo Clinic, Colon Cancer, 2025). On the other hand, breast cancer is very common in menopausal women. If both your mother and her sister were found to have breast cancer when they were in their 50s, it is less likely to be due to an inherited gene change, as a BRCA gene mutation is more strongly indicated when breast cancer occurs before age 50 (ACS, Hereditary Breast and Ovarian Cancer Syndrome, 2025; CDC, About Lynch Syndrome, 2026).

1. **Ataxia-Telangiectasia –** affects the nervous system, immune system and other body systems. It can cause a loss of balance, poor coordination (ataxia), frequent infections, red eyes (due to widening of blood vessels) and abnormal eye movements. Ataxia-telangiectasia increases the risk of leukemia, lymphoma and breast cancer. It is caused by a mutation of the ATM gene, which normally repairs damage to DNA.

2. **Basal Cell Nevus Syndrome –** is also called Gorlin syndrome or nevoid basal cell carcinoma syndrome. It is usually caused by a mutation in PTCH1, a tumor suppressor gene. This syndrome causes different problems with the skin, eyes, nervous system, endocrine glands and jawbone. People may also have a larger head size than average (called macrocephaly). Basal cell nevus syndrome increases the risk of non-melanoma skin cancer, brain and spinal cord cancer and soft tissue sarcoma.

3. **Beckwith-Wiedemann Syndrome –** causes the body to grow more than it should or asymmetrically during development and into childhood. Newborns may have hypoglycemia. Children with Beckwith- Wiedemann syndrome have an increased risk of developing Wilms tumor (a type of kidney cancer that affects children), hepatoblastoma (a rare type of liver cancer that affects children), neuroblastoma, rhabdomyosarcoma, and adrenal gland cancer.

4. **Bloom Syndrome –** is caused by a BLM gene mutation that changes the way chromosomes interact with each other. People with Bloom syndrome are usually smaller than average, have a high-pitched voice and easily develop skin rashes (especially over the nose and cheeks) after being in the sun. Having Bloom syndrome increases the risk of acute leukemia, lymphoma, breast cancer, colon cancer, bone cancer and Wilms tumor (NIH GARD, Bloom Syndrome, 2025).

5. **Carney Complex –** causes changes in the color of the skin, blue moles (nevi) and growth of a specific type of tumor called a myxoma in the skin, breast, or heart. It increases the risk of endocrine gland tumors like thyroid and adrenal gland cancers and nerve sheath tumors. Carney complex is caused by a mutation in the PRKAR1A gene (NORD, Carney Complex, 2025).

6. **CHEK2 –** the CHEK2 gene gives the body instructions for making a protein called CHK2, which acts as a tumor suppressor; it keeps cells from growing and dividing too quickly. When DNA becomes damaged, or DNA strands break, the CHK2 protein works with other proteins to thwart cell division, preventing cells with bad DNA from dividing. When it's mutated, it fails to perform this function and potentially cancerous cells are able to divide and reproduce themselves more readily (Memorial Sloan Kettering Cancer Center, 2023). Anyone with a family history of a CHEK2 mutation may also be at risk for having one. If you have a mutation, there's a 50/50 chance that you may pass it on to your son or daughter.

   CHEK2 mutations are found in a variety of cancer types, including breast, kidney, thyroid, and other cancers (Memorial Sloan Kettering Cancer Center, 2023.) The risk of breast cancer in women with a CHEK2 mutation is estimated to be approximately 1.5-3 times higher than in women without such a mutation, with risk greatest among those who also have a family history of breast cancer (ASCO, CHEK2 and Breast Cancer Risk, 2024). CHEK2 mutations have been found in up to 1.6% of the general population and in 2-3% of women diagnosed with breast cancer (Breastcancer.org, CHEK2, 2024).

7. **Cowden Syndrome (CS) –** is characterized by the development of multiple benign hamartomatous growths, most commonly on the skin, oral mucosa, and gastrointestinal tract, along with macrocephaly and other systemic features (American Cancer Society, 2024). However, individuals with Cowden syndrome carry a markedly elevated risk for several malignancies. The lifetime risk of breast cancer reaches approximately 85%, with an average age of diagnosis between 38-46 years - significantly earlier than in the general population. Additional elevated cancer risks include thyroid cancer (approximately 35%), renal cell carcinoma (34%), and endometrial cancer (up to 28%), as well as colorectal cancer and melanoma. (Eng C, GeneReviews, updated August 2025).

8. **ERCC3 –** a gene that makes a protein involved in the first step of making proteins and in repairing damaged DNA. Mutations (changes) in the ERCC3 gene may cause cells to lose their ability to repair damaged DNA, which may lead to abnormal cell growth. ERCC3 gene mutations have been found in several inherited syndromes, including a condition called xeroderma pigmentosum. People with this condition have a very high risk of developing skin cancer and other types of cancer (NCI, What Is Cancer?, 2023).

9. **Familial Adenomatous Polyposis (FAP) –** accounts for approximately 0.5 to 1% of all colorectal cancer cases. It is an autosomal dominant condition marked by the development of hundreds to thousands of colorectal adenomatous polyps from early adolescence through the third decade of life, resulting in near-certain colorectal cancer development by age 50 in the absence of prophylactic surgery (Patel & Ahnen, 2024). The prevalence of FAP is estimated at 2.2-3.2 cases per 100,000 individuals, with an incidence ranging between 1 in 5,000 to 10,000, affecting men and women equally (NORD, Familial Adenomatous Polyposis, 2023). Although 10-30% of patients diagnosed with FAP lack a detectable APC gene mutation, family members of these individuals should undergo the same surveillance as those with a confirmed mutation (Patel & Ahnen, 2024).

10. **Familial Atypical Multiple Mole Melanoma (FAMMM) Syndrome –** people with FAMMM syndrome have many moles (50 more moles than the average person). FAMMM is caused by a mutation in one of several genes including the p16 tumor suppressor gene. People with FAMMM have a very high risk of developing melanoma, as well as ocular melanoma and pancreatic cancer - with a cumulative pancreatic cancer risk of approximately 17% by age 75 in CDKN2A (p16) carriers. FAMM is also called dysplastic nevus syndrome (Siddiqui, Puckett, and Dunn, StatPearls, 2025).

11. **Familial Colorectal Cancer (FCC) –** approximately 25-30% of all colorectal cancer cases occur in families without evidence of a known inherited syndrome such as familial adenomatous polyposis (FAP) or hereditary nonpolyposis colorectal cancer (HNPCC/Lynch syndrome); this non-syndromic clustering is thought to result from a combination of unidentified genetic variants and shared environmental or lifestyle factors (National Cancer Institute, 2024). The risk of colorectal cancer is approximately twice as high in individuals with an affected first-degree relative compared to those without such a history, and risk increases further with the number of relatives affected and the age at which they were diagnosed (Keum and Giovannucci, StatPearls, updated 2025; NCI, Genetics of Colorectal Cancer PDQ, 2024).

12. **Familial Retinoblastoma –** is passed from parents to children in an autosomal dominant pattern, which means only one parent needs a single copy of the mutated gene to pass the increased risk of retinoblastoma on to the children. If one parent carries a mutated gene, each child has a 50% chance of inheriting that gene (Kamihara et al., Clinical Cancer Research, 2025).

13. **Fanconi Anemia –** is a rare disease passed down through families (inherited) that mainly affects the bone marrow. It results in decreased production of all types of blood cells. This is the most common inherited form of aplastic anemia, and is distinct from Fanconi syndrome, a rare kidney disorder. Beyond bone marrow failure, Fanconi anemia significantly increases the risk of developing acute myeloid leukemia, myelodysplastic syndromes, and squamous cell carcinomas of the head, neck and gastrointestinal tract (Mehta and Tolar, GeneReviews, updated 2022; Canadian Cancer Society, Family Cancer Syndromes, 2025).

14. **Gardner Syndrome –** is related to familial adenomatous polyposis (FAP). People with Gardner syndrome develop many polyps in the colon but also have tumors outside of the colon. Like FAP, Gardner syndrome is caused by a mutation in the APC gene. People with Gardner syndrome have an increased risk of colorectal cancer, soft tissue sarcoma and thyroid cancers (Canadian Cancer Society, Family Cancer Syndromes, 2025).

15. **Hereditary Breast and Ovarian Cancer Syndrome –** for many years, doctors have studied families in which many of the women developed breast and/or ovarian cancer. Often the cancers were found at younger than usual ages, and some of the women had multiple cancers. Some had bilateral breast cancer while some had breast and ovarian cancer. Through the study of these families, scientists discovered the tumor suppressor genes BRCA1 and BRCA2 (NCI, BRCA Gene Mutations: Cancer Risk and Genetic Testing, 2024). Hereditary breast and ovarian cancer syndrome (HBOC) due to BRCA1 and BRCA2 gene mutations is inherited in an autosomal dominant fashion and accounts for roughly half of all cancer cases related to inherited genetic risk (Sapre & Park, StatPearls, 2023). Because some women and families present with a cancer history consistent with HBOC but test negative for mutations in these two genes, scientists believe additional genes contribute to hereditary risk. Beyond BRCA1 and BRCA2, other implicated genes now include PALB2, ATM, CHEK2, RAD51, and BRIP1, among others, and research to identify further susceptibility genes continues (Petrucelli, Daly, and Pal, GeneReviews, updated 2024).

    Mutations in either BRCA1 or BRCA2 confer a significantly elevated cancer risk. More than 60% of women who inherit a harmful change in BRCA1 or BRCA2 will develop breast cancer during their lifetime, compared to approximately 13% of women in the general population, and approximately 39-58% of women with BRCA1 variants and 13-29% with BRCA2 variants will develop ovarian cancer, compared to just 1.1% of the general population (National Cancer Institute, 2024). Along with breast and ovarian cancer, HBOC is also associated with fallopian tube cancer, primary peritoneal cancer, male breast cancer, pancreatic cancer, and prostate cancer, with the latter three being more prevalent among BRCA2 carriers (NCI, BRCA Gene Mutations: Cancer Risk and Genetic Testing, 2024).

    BRCA mutations occur in an estimated 1 in 300-400 individuals in the general population but are approximately ten times more prevalent among people of Ashkenazi Jewish descent, affecting roughly 1 in 40 (Dana-Farber Cancer Institute, BRCA and Ashkenazi Jewish Ancestry, 2023). Women with a strong family history of breast and/or ovarian cancer may choose to undergo genetic counseling to assess their personal risk and, if a mutation is confirmed, may pursue intensified surveillance or risk-reducing interventions such as prophylactic mastectomy and salpingo-oophorectomy.

If a BRCA mutation is identified in a family member, each close relative - parent, sibling, or child - has a 50% chance of carrying the same mutation (NCI, BRCA Gene Mutations: Cancer Risk and Genetic Testing, 2024).

Men who carry a BRCA mutation also face elevated cancer risks. The lifetime risk of breast cancer in men with a BRCA1 mutation is approximately 0.2-1.2% by age 70, and approximately 1.8-7.1% in men with a BRCA2 mutation, compared to a general population risk of approximately 0.1% (NCI, BRCA Gene Mutations: Cancer Risk and Genetic Testing, 2024).

16. **Hereditary Diffuse Gastric Cancer –** is a rare autosomal dominant cancer susceptibility syndrome characterized by an elevated risk of diffuse gastric cancer and lobular breast cancer. The prevalence of HDGC in the general population is estimated at less than 1 in 100,000, and the syndrome accounts for less than 1% of all gastric cancer cases (NCI, Hereditary Diffuse Gastric Cancer PDQ, 2024). The majority of confirmed cases are caused by inactivating germline mutations in the CDH1 tumor suppressor gene, which encodes the cell adhesion protein E-cadherin. (NCI, Hereditary Diffuse Gastric Cancer PDQ, 2024). First-degree relatives of affected individuals each carry a 50% risk of inheriting the causative mutation.

    The lifetime risk of diffuse gastric cancer ranges from 21-42% in men and 14-33% in women carrying the CDH1 pathogenic variants, with an average age of diagnosis at 49 years, and the earliest reported diagnosis occurring at age 14 (Ryan et al., JAMA, 2024; NCCN, Gastric Cancer Clinical Practice Guidelines, Version 2.2024). The lifetime risk of lobular breast cancer for women with a CDH1 pathogenic variant is 37-55% by age 80, making breast cancer surveillance an essential component of management (Ryan et al., JAMA, 2024). For individuals who carry a CTNNA1 mutation, studies have reported a lifetime gastric cancer risk of up to 57% in families from European hereditary cancer registries (NCI, Hereditary Diffuse Gastric Cancer PDQ, 2024).

17. **Hereditary Leukemia and Hematologic Malignancies Syndromes –** multiple inherited genetic mutations have been identified that can lead to conditions including myelodysplastic syndrome (MDS), acute myeloid leukemia (AML), and aplastic anemia. A germline predisposition is estimated to underlie approximately 10-20% of hematologic malignancy cases across the lifespan, with higher rates of 10-30% observed in pediatric cases; recent studies suggest that approximately 10-20% of familial myeloid malignancies such as AML and MDS have an inherited cause (NCI, Genetics of Hereditary Hematologic Malignancies PDQ, updated 2024).

18. **Hereditary Non-Polyposis Colorectal Cancer (HNPCC), or Lynch Syndrome –** also known as hereditary nonpolyposis colorectal cancer (HNPCC), is the most commonly inherited cancer syndrome that increases a person's risk for colorectal cancer, accounting for approximately 2-4% of all colorectal cancer cases. It's an autosomal dominant disorder caused by germline mutations in one of four DNA mismatch repair (MMR) genes - MLH1, MSH2, MSH6, or PMS2 - or, less commonly, by a deletion in the EPCAM gene, which affects the function of MSH2. When these MMR genes are mutated, the proteins they encode can no longer repair damaged DNA during cell replication, which can eventually lead to cancer (NCI, Genetics of Hereditary Hematologic Malignancies PDQ, updated 2024).

    The lifetime risk of colorectal cancer in people with Lynch syndrome can range from 10-80% depending on which gene mutation is present, and cancers are far more likely to develop before the age of 50 compared to the general population (Frontiers in Oncology Reviews, 2025).

    Beyond colorectal cancer, Lynch syndrome is also associated with significantly elevated risks for endometrial cancer (25-60% lifetime risk, with the highest risks in MLH1/MSH2 carriers) as well as cancers of the ovary, stomach, small bowel, urinary tract, pancreas, and brain (MSK, Lynch Syndrome, 2024). Cancer risk and age of onset can vary considerably even among members of the same family, depending on the specific gene involved.

19. **Hereditary Retinoblastoma –** retinoblastoma is a rare malignant tumor of the retina, most commonly diagnosed in early childhood, with an incidence of approximately 1 in 17,000 live births and roughly 8,000 new cases diagnosed globally each year (StatPearls, Retinoblastoma, updated 2025). Approximately 45% of all retinoblastoma cases are hereditary, caused by a germline pathogenic variant in the RB1 tumor suppressor gene, which normally regulates cell cycle progression (StatPearls, Retinoblastoma, updated 2025). When both copies of the RB1 gene are inactivated, retinal cells grow out of control, resulting in cancer (American Cancer Society, 2024). Beyond the eye, children with hereditary retinoblastoma carry a significantly elevated lifetime risk of subsequent malignancies, particularly bone and soft tissue sarcomas and melanoma (Kamihara et al., Clinical Cancer Research, 2025).

20. **Juvenile Polyposis Coli –** is a rare autosomal dominant hereditary disorder characterized by multiple hamartomatous polyps throughout the gastrointestinal tract, with an estimated incidence of approximately 1 in 100,000 individuals (Patel and Ahnen, GeneReviews, updated 2022). The term "juvenile" refers to the type of polyp rather than the age of onset; most individuals develop polyps by age 20, and while most polyps are benign, malignant transformation can occur if left untreated (Patel and Ahnen, GeneReviews, updated 2022). The lifetime risk of gastrointestinal cancer ranges from 11 to 86%, with colorectal cancer being the most common malignancy, followed by gastric cancer (NCCN, Genetic/Familial High-Risk Assessment, Version 1.2025). Individuals with SMAD4 variants carry a higher risk of gastric cancer and most also present with features of hereditary hemorrhagic telangiectasia, requiring additional cardiovascular surveillance (Mak et al., Hereditary Cancer in Clinical Practice, 2023).

21. **Li-Fraumeni Syndrome –** is a rare hereditary cancer predisposition syndrome estimated to affect approximately 1 in 5,000-1 in 20,000 individuals, most often caused by an inherited germline mutation in the TP53 tumor suppressor gene. When mutated, TP53 loses its ability to prevent abnormal cells from dividing uncontrollably, and the syndrome is inherited in an autosomal dominant pattern. The core tumor types associated with LFS include soft tissue sarcoma, breast cancer, brain cancer, leukemia, and adrenocortical carcinoma, and these cancers often develop in children and young adults (ACS, Li-Fraumeni Syndrome, 2024; Villani et al., StatPearls, updated December 2025).

    The lifetime cancer risk is exceptionally high, approaching nearly 90% in women and 75% in men - with 50% of cancers occurring before age 40 (Villani, Malkin, and Tabori, StatPearls, 2025; Khincha and Savage, GeneReviews, updated May 2025). Women with LFS face a lifetime breast cancer risk of 80-90%, which is higher than the risk associated with BRCA1 and BRCA2 mutations, and nearly all LFS-related breast cancers occur prior to menopause (Khincha and Savage, GeneReviews, updated May 2025). Among women diagnosed with unilateral breast cancer who did not elect risk-reducing mastectomy, the risk of contralateral breast cancer is significantly elevated (Khincha and Savage, GeneReviews, updated May 2025).

22. **Multiple Endocrine Neoplasia (MEN) Syndromes –** is a group of hereditary syndromes characterized by tumors affecting two or more endocrine glands. Both primary forms, MEN1 and MEN2, are inherited in an autosomal dominant pattern and are caused by distinct gene mutations (NCI, Multiple Endocrine Neoplasia PDQ, 2024). MEN Type 1 is caused by inactivating germline mutations in the MEN1 tumor suppressor gene and has an estimated prevalence of approximately 2-20 per 100,000 individuals. It is primarily characterized by tumors of the parathyroid glands, duodenopancreatic neuroendocrine system, and anterior pituitary, with parathyroid tumors occurring in approximately 95% of affected individuals (Bartsch et al., PMC, 2024)

    MEN Type 2 is caused by activating germline mutations in the RET proto-oncogene, with an estimated prevalence of approximately 1 in 30,000 individuals (NCI, Genetics of Endocrine and Neuroendocrine Neoplasias PDQ, 2024). MEN2A accounts for more than 80% of all cases and is characterized by medullary thyroid cancer (MTC), which develops in virtually all affected individuals and is the primary cause of mortality, along with pheochromocytoma in more than 50% of cases (NCI, Genetics of Endocrine and Neuroendocrine Neoplasias PDQ, 2024; Pasternak et al., PMC, 2022). MEN2B presents a more aggressive clinical course and carries the highest risk of early-onset MTC, for which prophylactic thyroidectomy in infancy is recommended for the highest-risk genotypes (NCI, Genetics of Endocrine and Neuroendocrine Neoplasias PDQ, 2024; NCCN, Thyroid Carcinoma Clinical Practice Guidelines, Version 2.2025).

23. **MUTYH-Associated Polyposis (MAP) –** is a rare, hereditary condition - affecting approximately 1 in 20,000 - 40,000 individuals (ACS, MUTYH-Associated Polyposis, 2024) - in which a person has numerous adenomatous polyps (abnormal tissue growths) in their colon and rectum. People with harmful mutations in the MUTYH gene can develop several different types of polyps in their large intestine, including adenomas, sessile serrated polyps, and hyperplasic polyps. Most people who have MAP usually develop between 10 and 100 polyps. In rare cases, some people who have MAP can have colorectal cancer without any polyps, while others have more than 1,000 polyps. The colorectal polyps are often found in people in their 40s (Nielsen et al., GeneReviews, updated 2021; ACS, MUTYH-Associated Polyposis, 2024).

24. **Neurofibromatosis Type 1 –** is caused by a mutation in the NF1 gene. People with neurofibromatosis type 1 have patches of skin that have a different color from the rest. The patches of skin are called café-au-lait spots that can be smooth or raised and from beige to dark brown. People with neurofibromatosis type 1 also develop neurofibromas along the nerves. Most tumors are benign, but some can become malignant over time. Neurofibromatosis type 1 increases the risk of brain cancer, adrenal gland cancer, rhabdomyosarcoma, neuroblastoma, neuroendocrine tumors, soft tissue sarcoma, and leukemia (Friedman JM, GeneReviews, updated 2022; Uusitalo et al., Journal of Clinical Oncology, 2016).

25. **PalB2 –** is now firmly recognized as a major breast cancer susceptibility gene comparable in significance to BRCA2. When a pathogenic variant is present, the gene's ability to repair damaged DNA through homologous re combination is impaired, significantly elevating cancer risk across multiple sites (NCI, PALB2 and Associated Cancer Risks PDQ, updated 2025). A 2024 Bayesian meta-analy- estimated a cumulative breast cancer risk of approximately 12.8% by age 50 and 48.5% by age 80 with risk further modified by family history and birth cohort (Ruberu et al., Genetic Epidemiology, 2024). The overall lifetime risk of 35-50% compares to approximately 12% in the general population, 55-72% in BRCA1 carriers, and 45-69% in BRCA2 carriers (BCRF, PALB2 Mutations and Breast Cancer Risk, 2026). Beyond breast cancer, PALB2 carriers face a 5% lifetime risk of ovarian cancer, a 2-3% risk of pancreatic cancer, and an elevated risk of male breast cancer, with a disproportionate excess of triple-negative breast cancer and a nearly twofold increased hazard ratio for mortality (NCI, PALB2 and Associated Cancer Risks PDQ, updated 2025).

26. **Peutz-Jeghers Syndrome –** is caused by a germline pathogenic variant in the STK11 (LKB1) tumor suppressor gene, which regulates cell growth and proliferation. The syndrome is characterized by two hallmark features: hamartomatous polyps throughout the gastrointestinal tract, most commonly in the small intestine, and distinctive mucocutaneous pigmentation appearing as dark spots around the lips, mouth, fingers, and other mucosal surfaces, typically present by age 5 (StatPearls, Peutz-Jeghers Syndrome, updated February 2025)). The overall lifetime cancer risk has been reported as high as 93%, with gastrointestinal cancers, including colorectal, gastric, pan- creatic, and small bowel, representing the most common malignancies (Amos CI, GeneReviews, updated 2021).

27. **POT1 –** is a hereditary cancer predisposition condition caused by germline pathogenic variants in the POT1 (Protection of Telomeres 1) gene, an essential component of the shelterin - complex that regulates telomere length and protects chromosome ends. When POT1 is mutated, telomere elongation and genomic instability result, increasing susceptibility to multiple cancer types. POT1-TPD is inherited in an autosomal dominant pattern, though penetrance is not yet fully characterized. The syndrome is primarily associated with an elevated risk of cutaneous melanoma, chronic lymphocytic leukemia (CLL), cardiac and soft tissue angiosarcoma, and gliomas, with the age of onset for first primary melanoma ranging from 15-80 years (Baptista Freitas et al., European Journal of Human Ge- netics, 2024). Individuals with POT1 pathogenic variants are significantly more likely to develop multiple primary tumors than the general population, with a sevenfold increased risk of melanoma and a 6.6-fold increased risk of sarcoma compared to individuals without the variant (Richardson et al., Ambry Genetics, 2023).

28. **Rb1 –** encodes a tumor suppressor protein that regulates cell cycle control and prevents cells from dividing uncontrollably. When both copies of RB1 are inactivated, retinal cells can proliferate unchecked, leading to retinoblastoma, with approximately 8,000 new cases diagnosed globally each year, or roughly 1 in 17,000 live births (StatPearls, Retinoblastoma, updated 2025). Survi- vors carry a substantially elevated risk of subsequent pri- mary malignancies, with the cumulative incidence of a first - subsequent malignancy estimated at 33% by 50 years after diagnosis (Schonfeld et al., British Journal of Cancer, 2021). The most common subsequent cancers include os- teosarcoma, soft tissue sarcomas, and melanoma, with risk further increased in those who received radiation therapy (Kamihara et al., Clinical Cancer Research, 2025).

29. **Turcot Syndrome –** is a rare hereditary disorder defined by the concurrent development of primary central nervous system tumors and multiple colorectal adenomas and/or colorectal cancer (Cleveland Clinic, Turcot Syndrome, updated December 2025). Current evidence indicates that Turcot syndrome is not a distinct genetic disease in itself, but rather a clinical presentation arising from two well-established hereditary colorectal cancer syndromes, FAP and Lynch syndrome, distinguished by the underlying gene mutation (Khattab and Monga, StatPearls, updated 2024; NCI, Turcot Syndrome, 2025).

30. **Von Hippel-Lindau Disease (VHL) –** is a multi-system disorder characterized by abnormal growth of blood vessels (hemangioblastomas) of the brain, spinal cord, and retina; clear cell renal cell carcinoma; pheochromocytoma and paraganglioma; pancreatic cysts and neuroendocrine tumors; and endolymphatic sac tumors. Renal cell carcinoma occurs in approximately 70% of individuals with VHL and is the leading cause of mortality in this syndrome (Maher ER, GeneReviews, updated May 2025).

31. **Werner Syndrome –** is characterized by the premature onset of multiple age-related conditions beginning in the second to third decade of life, including bilateral cataracts, short stature,scleroderma-like skin changes, type 2 diabetes mellitus, osteoporosis, and severe atherosclerosis. Heart attack and cancer are the most common causes of death, with a median age of death of approximately 54 years.The overall elevated risk of neoplasms in Werner syndrome ranges from 2 to 60-fold higher than population controls depending on cancer type (Oshima, Martin, and Hisama, GeneReviews, updated March 2026).

32. **Wiskott-Aldrich Syndrome –** is a rare X-linked recessive primary immunodeficiency disorder caused by mutations in the WAS gene, affecting almost exclusively males with an estimated incidence of approximately 1 in 100,000 live births (Patil et al., PMC, 2024; StatPearls, Wiskott-Aldrich Syndrome, 2026). The syndrome is characterized by a clinical triad of microthrombocytopenia, eczema, and combined immunodeficiency, with autoimmune disorders occurring in up to 40-70% of patients (Ochs et al., GeneReviews, updated February 2026). Approximately 15% of individuals develop lymphoma at an average age of 30 years, with B-cell lymphomas predominating, frequently Epstein-Barr virus-positive, and often arising in extranodal sites including the brain and gastrointestinal tract (Ochs et al., GeneReviews, updated February 2026).

33. **Xeroderma Pigmentosum (XP) –** individuals with XP face an approximately 10,000-fold higher risk of non-melanoma skin cancers and a 2,000-fold increased risk of melanoma compared to the general population, with skin cancers typically appearing in the first decade of life (National Cancer Institute, 2024). XP is also associated with a significantly elevated risk hematologic malignancies, particularly in patients with XPC gene mutations (Sarasin, 2023). Neurological degeneration, occurring in approximately 25% of patients, represents an additional serious complication independent of UV exposure (GeneReviews, 2022).

CHAPTER TWO

CANCER STAGING

OBJECTIVE: to understand how cancers are graded and what it means to a patient's treatment and prognosis. You will gain an understanding of:

- Psychological implications
- The 5 stages of grief
- Different types of cancer staging

GOAL: to understand the variables associated with cancer staging and how they will affect our programming, as well as the mental state of the patient.

Staging helps to describe where in the body the cancer is located, if or where it has spread, and whether it is affecting other parts of the body. Doctors often use diagnostic tests to determine a cancer's stage. Staging may not be complete until all tests are finished.

Knowing the stage helps the doctor:

- Plan treatment, including the type of surgery and/or whether chemotherapy or radiation therapy are needed
- Predict the chance that the cancer will return after the original treatment
- Predict the chance of recovery
- Talk about the diagnosis in a clear, common language with the entire health care team
- Determine how well the treatment worked
- Compare how well new treatments work among large groups of people with the same diagnosis

TNM Staging System (Tumor, Node, Metastasis)

Developed by the American Joint Committee on Cancer (AJCC) and the Union for International Cancer Control (UICC), the TNM system is the most widely used method for describing the anatomic extent of solid tumors. Each component - Tumor (T), Node (N), and Metastasis (M) - is assessed to determine the overall cancer stage.

Component	Description	Key Details
T (Tumor)	Describes the size and local extent of the primary tumor	Ranges from T0 (no tumor evidence) to T4 (large or invading nearby structures) Subcategories (e.g., T1a, T1b) refine depth specific organ involvement
N (Nodes)	Indicates whether regional lymph nodes contain cancer cells	N0+ no lymph node involvement; N1-N3 = increasing number or proximity of involved nodes
M (Metastasis)	Identifies distant spread of the cancer to other organs	M0 = no distant metastasis; M1 = distant metastasis confirmed

After assessing T, N, and M, they are combined to form an overall stage grouping ranging from Stage 0 (in situ) to Stage IV (metastatic disease). For example, breast cancer described as T2N1M0 indicates a moderately sized tumor (T2), one lymph node involved (N1), and no metastasis (M0), which corresponds approximately to Stage IIB.

Stage Grouping (I-IV System)

This simplified version categorizes cancers into four major stages for easier clinical communication. Stage grouping helps clinicians describe disease extent, guide treatment planning, and predict prognosis.

Stage	Description	General Prognosis
Stage 0	Carcinoma in situ (CIS) - abnormal cells present but have not invaded nearby tissue	Often curable with local excision
Stage I	Localized cancer confined to the organ of origin	High cure rate; surgery often curative
Stage II	Locally advanced cancer, larger or with limited regional spread.	Requires multimodal therapy (surgery ± chemo/radiation)
Stage III	Further regional spread, often to nearby lymph nodes or structure	Aggressive treatment needed; prognosis depends on tumor biology
Stage IV	Metastatic cancer - spread to distant organs (e.g., liver, lung, bone)	Incurable in most cases; focus on disease control and quality of life

Anatomic vs. Prognostic Staging

In recent AJCC editions (especially for breast, colon, prostate, and melanoma), cancer staging now incorporates biologic and molecular markers in addition to traditional anatomic criteria. This approach provides a more accurate prediction of prognosis and guides precision therapy decisions.

Type	Basis	Example
Anatomic Stage	Traditional TNM criteria	Tumor size, lymph node involvement, and metastases
Prognostic Stage	Integrates tumor grade, molecular markers, and receptor status (ER, PR, HER2, Ki-67)	Combines biologic and clinical factors to refine prognosis and treatment selection

Other Specialized Staging Systems

Some cancers require tailored systems because the TNM classification alone does not fully capture clinical complexity. These specialized staging systems consider unique biological, anatomical, and molecular characteristics re levant to specific cancers.

Cancer Type	Staging System	Key Elements
Leukemias	No TNM system (since there's no solid tumor)	Use prognostic scoring systems such as Rai or Binet for chronic lymphocytic leukemia
Lymphomas	Ann Arbor / Lugano staging	I-IV system based on number of nodal regions and extranodal involvement
Multiple Myeloma	Revised International Staging System (R-ISS)	Based on β2-microglobulin, albumin, LDH, and cytogenetic abnormalities
Ovarian Cancer	FIGO system (International Federation of Gynecology and Obstetrics)	Considers peritoneal spread, lymph node involvement, and distant metastasis
Cervical & Endometrial Cancer	FIGO system, using clinical and surgical findings	Stage I (confined to uterus/cervix) → Stage IV (distant spread)
Brain Tumors	WHO Grading (I-IV).	Based on histologic and molecular features rather than anatomical extent
Hepatocellular Carcinoma	Barcelona Clinic Liver Cancer (BCLC) staging	Integrates liver function (Child-Pugh score), performance status, and tumor burden

Restaging and Clinical vs. Pathologic Staging

Staging can occur at different points in a patient's cancer journey. Clinical staging is performed before treatment, pathologic staging is determined after surgery, and restaging is used if the disease recurs or progresses. Each type provides unique insights that guide management and prognosis.

Type	Description
Clinical Stage (cTNM)	Determined before treatment, using physical examination, imaging, and biopsies. Guides initial therapy decisions
Pathologic Stage (pTNM)	Determined after surgical removal and microscopic examination of the tumor; provides the most accurate prognosis
Restaging (rTNM)	Used after recurrence, progression, or new therapy to reassess the extent of disease

Tumor Grade: Assessing Cellular Abnormality

Tumor grade reflects how much cancer cells differ from normal, healthy cells under the microscope. Pathologists determine grade based on cellular differentiation, nuclear appearance, and mitotic activity.

Grade	Description	Behavior
Grade 1 (Low grade / Well-differentiated)	Cells look similar to normal tissue and tend to grow slowly	Least aggressive; better prognosis
Grade 2 (Intermediate / Moderately-differentiated)	Cells show more abnormalities; moderate growth rate	Intermediate prognosis
Grade 3 (High grade / Poorly-differentiated)	Cells appear very abnormal; rapid growth and spread	More aggressive; higher recurrence risk
Grade 4 (Undifferentiated / Anaplastic)	Cells lack identifiable structure or origin	Very aggressive; poorest prognosis

Specific cancers use specialized grading systems:

- **Breast Cancer:** Nottingham histologic score (Elston-Ellis) evaluates gland formation, nuclear pleomorphism, and mitotic rate.
- **Prostate Cancer:** Gleason scoring system (2-10 scale) assesses glandular patterns; combined scores classify into Grade Groups 1-5.
- **Brain tumors:** WHO Grading (I-IV) integrates histologic and molecular markers (e.g., IDH mutation, 1p/19q codeletion).

These references can be cited for all staging and grading:

- Amin MB, Edge SB, Greene FL, et al., eds. AJCC Cancer Staging Manual. 9th ed. Springer; 2024.
- Brierley JD, Gospodarowicz MK, Wittekind C, eds. TNM Classification of Malignant Tumours. 9th ed. Wiley-Blackwell; 2024.



5 STAGES OF GRIEF

Throughout our lifetime we experience many instances of grief. Grief can be caused by certain situations, relationships or even substance abuse and addiction. Children may grieve the divorce of their parents, a husband may grieve the death of his wife, one might grieve the ending of a relationship, or someone may have received a terminal medical diagnosis and they are grieving their impending death.

In 1969, psychiatrist Elisabeth Kübler-Ross described five popular stages of grief that are referred to as DABDA. This theory suggests that we go through five distinct stages of grief after the loss of a loved one: denial, anger, bargaining, depression, and finally acceptance. These, of course, can be applied to all other situations of grief and loss as well.

DENIAL

Denial is the stage that initially helps us to survive the "loss." An individual might think that life makes no sense, is too overwhelming, and that they just can't handle this change. They start to deny the news and essentially become "numb." It's common to wonder how life will go on under these different circumstances - they are in a state of shock because life as they once knew it, has changed in a blink of an eye. If they were diagnosed with cancer, they might think that the diagnosis is incorrect. If they receive news that a loved one has died, perhaps they cling to a false hope that there must be a mistake. In the denial stage, individuals are living in 'altered reality,' rather than dealing with what is true.

Shock and denial actually help individuals to cope and survive extreme grief. Instead of allowing oneself to become overwhelmed with grief, we deny it, do not accept it, minimizing its "full" impact at one time. It may, in fact, be our body's own natural defense mechanism. As the initial shock and ensuing denial begin to fade, the healing process begins. Individuals may be overwhelmed with the feelings that they were suppressing as they begin to surface.

ANGER

Once an individual starts to live in 'actual' reality again and not in 'altered' reality, anger might kick in. It is common in this stage to ask, "why me?" and think "life's not fair!" They might lash-out and blame others for their grief, redirecting their anger on friends and family. Most find it incomprehensible as to how something like this could happen to them. If someone is of strong faith, they might start to question their belief in God.

Many researchers and mental health professionals agree that this anger is a necessary stage of grief and encourage individuals to allow themselves to feel the anger. It is a known fact that suppressing feelings of anger and resentment is not healthy. Many will feel that their life has been shattered and there's nothing for them to hold on to anymore. Anger may help individuals to "get back' to reality. It in a natural and necessary step in the healing process.

BARGAINING

You can probably remember a time when something bad happened and you made a deal with God. "Please God, if you let my father live, I will do ANYTHING!". This is bargaining. This could also be called the stage of false hope. Individuals might falsely make themselves believe that they can avoid the impending grief through "negotiation." Many are so desperate to get their life back to how it was before the event, that they are willing to do just about anything. Guilt commonly accompanies the act of bargaining. This is when people find themselves constantly saying "what if" statements. What if I had let someone else drive me home - the accident would have never happened. What if I encouraged her to see the doctor when she first started complaining about the pain in her chest - the cancer could have been found sooner and she could have been saved.

DEPRESSION

Grief and depression have similar symptoms, so it can be hard to tell the difference. Dr. Michael Miller, the editor of the Harvard Mental Health Letter and Assistant Professor of Psychiatry at Harvard Medical School, said that with both grief and depression: "People cry. They feel depressed. They're having trouble sleeping. They may not have an appetite. They may not feel like doing anything. They may not take pleasure in anything."

Depression represents the emptiness someone feels when we they are living in reality and realize the person or situation is gone or over; this may be abandonment, a relationship ending, death, or one's health. In this stage, they may withdraw from life, feel numb, live in a fog, and not want to get out of bed. They don't want to be around others, don't feel like talking, and experience feelings of hopelessness.

Some may experience suicidal thoughts - thinking "what's the point of going on?" There is no timeline for grief. In addition, cultural and circumstantial factors contribute to how people express and cope with it.

During a prolonged battle with a terminal illness such as cancer, as well as after the death of a loved one, a community of family, friends, and co-workers often unite to provide ongoing support to those who are grieving. People suffering from major depression continue to isolate themselves and keep themselves disconnected from others and may resist support and assistance. Those who don't get the support that they need may be at a higher risk for slipping into clinical depression during the grieving process.

ACCEPTANCE

The last stage of grief identified by Kübler-Ross is acceptance. This does not mean that people are okay with their situation or loss, but in this stage their emotions may begin to stabilize. Individuals begin to come to terms with their "new" reality and they're okay with it. It's not a "good" thing, it's certainly not what they wanted or expected, but it's something they can live with. It is a time of adjustment and fluctuating emotions. They will have ups and downs, good days and bad days, and then more good days. there will still be grief and sadness, but the good days start to outnumber the bad days. In this stage, people usually begin to feel the fog start to lift and start engaging with friends and family again. They may even join a support group with others who have shared similar experiences. This is the time to evolve into one's new reality.



What to Say To A Friend or Loved One Who Has Just Been Diagnosed with Cancer

Studies show that people do better emotionally in a crisis when they have strong support from family members and friends. If you have a friend or loved one that has just been diagnosed, you may find yourself not knowing what to say or do. Maybe you are afraid of saying the wrong thing. Here are some tips:

1) Listen first - talk second. This may be your biggest challenge when your loved one faces a life-threatening diagnosis. Try to listen without passing judgement and without "cheerleading." You can't possibly know exactly what they are feeling, or what is going through their mind. As well-intended as you might be, your excessive optimism may have a negative effect. Your ability to sit with them and listen as they share their feelings is probably the single best thing that you can do for them right now.

2) Give advice only when you are asked. Friends and loved ones often take on the task of researching the diagnosis, treatment options or clinical trials. This can be very helpful, as the information is often daunting at best. Whatever you do, do not say, "You ought to try this" or "You should do that." Instead, let them know that you've done your research and allow them to decide if they want to hear what you have to say.

3) Learn as much as you can about their cancer.
American Cancer Society (cancer.org) and other reputable organizations have helpful literature and user-friendly websites that provide detailed information about cancer treatments, side effects and other related concerns.

4) Support your loved one's treatment decisions. It is their body and their life. While you may be able to share decision-making, ultimately it is your loved one's body and spirit that bear the impact of the cancer.

5) Remember the caregiver; the spouse, partner, parent or adult child of the person with cancer. Caregivers take on necessary tasks such as driving to treatment, arranging medical appointments, and providing much-needed care and emotional support. Often they also take on many of the roles formerly handled by the person who has been diagnosed. The caregiver can also benefit from additional help with these tasks.

6) Don't become invisible. Cancer treatment can be lengthy, and the cancer journey continues long after the last day of treatment. Cancer patients often note that calls become infrequent from friends and family after the initial crisis of diagnosis. I know firsthand that checking in regularly to see how they are doing or offering to come by for a visit is both helpful and incredibly meaningful for them.

7) Don't "baby" them. You may try to make life easier for the person going through treatment by “doing things” for them. It is more about US, than it is them. It's a way that we make ourselves feel useful at a time we may otherwise feel helpless. Performing their normal activities of daily living may keep them from focusing on the fact that they have cancer and prevent the disease from taking control of their lives. Being able to do things for themselves may make them feel less helpless. Try not to make their cancer the topic of every conversation.

8) No two people will have the same response to treatment. Everyone will have their own needs, reactions, and responses to the impact cancer has had on their lives. After treatment is over, it is a time where your loved one will need to determine what their new "norm" is. The safety net of medical providers and doctors' appointments has been ripped out from beneath them. While they are relieved that treatment is over, they may also feel scared and alone. This is often the time when people begin to process the enormity of what they have been through. Prior to this, they were deeply involved in, and distracted by, all the medical issues such as getting to treatment, maintaining some semblance of normalcy, and coping with side effects.

Palliative Care and the Role of the OncoVie® CANCER EXERCISE SPECIALIST

Palliative care in oncology has undergone a profound and necessary shift in how we understand it, and for those of us who have walked this road personally, that shift could not have come soon enough. For far too long, the word “palliative” carried with it a kind of quiet surrender - a signal that the fight was winding down and comfort was all that remained. But that framing has always been incomplete, and the science has now caught up to what many patients and caregivers have known intuitively for years: that quality of life is not a consolation prize. It is the point. It deserves the same focused, skilled attention as any other dimension of cancer care, and it deserves it from the very beginning of the journey, not just at the end. What the research has made increasingly clear - and what I have witnessed firsthand - is that movement matters in this season of life more than most people realize. The idea that a palliative cancer patient should simply rest and wait has been steadily and convincingly dismantled by evidence showing that structured, appropriately guided physical exercise can meaningfully improve strength, reduce fatigue, support emotional wellbeing, and protect the quality of daily life even for patients living with advanced or metastatic disease. Patients want to move. They want to feel capable and present in their own bodies. They want to contribute to their own care in some tangible way. What they too often lack is someone who truly understands their situation and can guide them safely.

That is the gap an OncoVie® Cancer Exercise Specialist is uniquely positioned to fill. This is not general fitness instruction applied to a sick person.

This is a specialized, deeply informed approach to movement that accounts for everything cancer and its treatment do to the body - the fatigue that feels nothing like ordinary tiredness, the bone density changes, the neuropathy, the cardiovascular strain of chemotherapy, the hormonal disruptions, the shifts in balance and coordination, the psychological weight of it all. In a palliative care context, where the goal is not performance but presence - not endurance records but the ability to walk to the kitchen, embrace a grandchild, or simply feel less like a patient and more like a person - that level of specialized knowledge is not a luxury. It is a form of compassionate, evidence-based care that belongs in every palliative oncology team. Having been on both sides of this experience, I believe that with everything I have.

When the Body Is at Its Most Limited: Movement for Bedridden Patients

Perhaps the most important thing I want anyone reading this to understand - patients, families, caregivers, and clinicians alike - is that exercise does not stop being relevant when someone can no longer get out of bed. This is where the misconception runs deepest, and where the absence of a knowledgeable guide does the most harm by omission. A bedridden cancer patient is not beyond the reach of therapeutic movement. They are simply at a point where movement must be reimagined, and where the expertise of someone like an OncoVie® Cancer Exercise Specialist becomes not less important, but more so.

For patients who are fully or largely confined to bed, the goals of movement shift but they do not disappear. The focus turns to preserving whatever functional capacity remains, preventing the cascade of complications that immobility brings - pressure injuries, blood clots, muscle contractures, respiratory decline, and the profound psychological toll of feeling completely passive in one's own body - and maintaining enough strength and mobility to support the small but deeply meaningful activities of daily life. Helping someone reposition themselves in bed. Reaching for a glass of water. Squeezing a loved one's hand with intention. These are not small things. They are dignity. Passive range of motion exercises, performed gently by a caregiver or specialist, move the patient's limbs through their natural range without requiring the patient to generate force themselves. These movements help maintain joint flexibility, stimulate circulation, reduce stiffness and pain, and provide meaningful physical contact and human connection that has its own therapeutic value. For a patient who can contribute even minimally, assisted active range of motion - where the caregiver supports the movement but the patient participates as much as they are able - begins to engage the neuromuscular system in ways that purely passive movement cannot.

Gentle seated or semi-reclined movement - for patients who can be positioned upright even briefly - opens additional possibilities. Ankle circles and foot pumps, shoulder rolls, gentle neck mobility, and supported seated marching all activate muscle groups and circulatory pathways that deteriorate rapidly with full immobility. Even 5-10 minutes of this kind of movement, done consistently and with appropriate guidance, can make a measurable difference in how a patient feels and functions from one day to the next.

What an OncoVie® Cancer Exercise Specialist brings to this population that a well-meaning but untrained caregiver cannot is the clinical knowledge to know what is safe given that specific patient's diagnosis, treatment history, bone involvement, cardiovascular status, and symptom profile on that particular day. Metastatic bone disease, for instance, requires very specific precautions around movement that a general caregiver would have no reason to know. Lymphedema, peripheral neuropathy, and steroid-induced myopathy, each change the exercise calculus in important ways. Getting this wrong can cause harm. Getting it right - with skill, with gentleness, with an understanding of what this patient's body has been through and what it still needs - can be one of the most meaningful gifts anyone offers in the final chapter of a cancer journey.I have sat at bedsides and I have been in the bed. From both places, I can tell you that movement - even the smallest, most careful, most adapted version of it - is an act of hope. It says: you are still here, your body still matters, and we are going to take care of it together for as long as we can.

Being a Caregiver for Someone Diagnosed with Cancer

A caregiver is anyone who is helping their loved one get through cancer treatment. Most of us see taking care of a family member as a no-brainer; it is as natural as breathing. However not everyone is a family member; caregivers may also be friends. Being a caregiver can encompass many things: helping with everyday activities that may include doctor visits, grocery shopping, or even preparing food. In some cases, like my mothers' and mine, it may be long distance! It can involve coordinating medical appointments, online shopping and bill paying, and coordinating other services for your friend or loved one by email or phone. There is an important component that may include emotional and spiritual support. There are many feelings that arise from the moment someone is told "you have cancer," until the day they complete treatment and beyond.

Just being there to listen and let them know you are there for them is critical. Anyone who has been a caregiver will tell you that providing care and support during this challenging time can be incredibly difficult. Most caregivers will put their own feelings and needs aside purposely, or inadvertently. Focusing on the person with cancer, and the many tasks involved for the caregiver, can be very difficult to maintain for a long time. Fundamentally, if the caregiver does not take care of themself, they won't be able to take care of the cancer patient or anyone else.

The caregiver may have spent a lot of time with the cancer patient, or they may not have been an active part of their life, prior to their cancer diagnosis. When caregivers are first "called" to be in this new role, most do not have any previous experience. They may find themselves taking care of their spouse, a parent, a grandparent, a friend, or even a child. While the experience is often overwhelming and somewhat scary at first, many caregivers say that they grew as a person as they shared in their loved one's cancer journey.

Sometimes the caregiver him or herself has health issues that make it even more challenging to physically and emotionally be in a position of taking care of someone else. While the caregiver is trying to help the cancer patient to make treatment decisions and cope with their stress, they may also feel confused and stressed. Many caregivers have said that speaking to a therapist or being a part of a caregiver support group was very helpful. Caregivers need to give themselves time to digest and work through their emotions. Emotions often run high, and many caregivers describe feeling angry with themselves, their family members, or even the patient. Fear, panic, and worry can manifest as anger. Caregivers may feel resentful or bitter because their lives are not their own, or they do not feel appreciated.

Feeling guilty may be one of the most common emotions felt by caregivers. They may feel that they aren't doing enough to help the patient and/or that they are not able to give them the time and attention they need because of their work and family commitments. Some caregivers feel guilty that they are healthy, and their loved one is fighting for their life. It can be difficult to hide their own emotions when they are scared, upset, or angry. Cancer patients themselves often worry about how they will pay their bills, will they be able to keep working, will they lose their job, how the cancer will affect the family, and of course, will they survive. The caregiver must be able to separate the patient's sadness, fear, and depression from their relationship. The caregiver may feel like a "punching bag" when the patient takes their anger and frustration out on them.

Caregivers often express feeling like no one understands what they're going through. Everyone is always asking about the patient, but no one seems concerned for the caregiver. They may not have time to see friends and other family members as well as do things that they used to be able to do. Caregivers need to give themselves permission to grieve their own personal losses as well as the potential loss of their friend or loved one. They must prioritize and do the things that are important and/or bring them joy. They need to be able to rest and recharge even if the patient gets angry at them. Patients are going through their own stages of grief and may not realize the effect their anger has on others around them. Sometimes it's hard for the caregiver to remember that the anger isn't really targeted at them.

They must be honest with themselves as to what they can and can't do for the patient and what they need or want to do for themselves. Caregivers must be encouraged to take care of what's important to them and not to worry about what others may think. Caregivers should ask for what they need and not hold back when it comes to the things that would be most helpful for them. They should make a list of other friends, colleagues, or family members who may be able to help with cooking, cleaning, grocery shopping, yard maintenance, childcare etc. Maybe there is someone else who can share in the responsibility of getting the cancer patient to their doctors' appointments and sitting with them for a few hours each day, or even spending the night looking after them. It can be very disappointing to the caregiver when they ask for help and someone says no to helping. They may take it personally and it may hurt their feelings or even make them angry; especially when people they really expected would help and be there for them let them down.

It can be equally challenging to be away from a loved one who has cancer. The patient may be a widowed parent, and the caregiver is the only one that the parent feels they can count on. This may place a tremendous amount of pressure on the potential caregiver, especially if they have a family of their own to take care of. Caregivers who live far away from their loved ones most must rely on the telephone and email as their source of communication. When they can't get them on the phone, or they don't respond to emails, it can be very frightening to the caregiver. It's easy to panic and jump to the conclusion that something terrible has happened to their parent. In addition, they are faced with determining whether situations can be dealt with over the phone or whether they necessitate an in-person visit. If this requires a flight, that places even more stress on the caregiver, emotionally and financially. The caregiver may feel guilty because they are not able to be there for their parent more often. It will be important for the long-distance caregiver to create a support network of people, who live near their loved one, whom they can call day or night in an emergency, or just to check in and make sure everything is okay. Many long-distance caregivers feel that they must make themselves available 24/7 when they are with their loved one. Out of guilt for not being there all the time, the caregiver allows themselves to be at the patient's beck and call and often lets their personal needs, including work demands, fall by the wayside. They should be encouraged to do things for themselves, even if it's just a few minutes several times per day. They can schedule personal phone calls when their loved one is taking a nap or visiting with their doctor. Perhaps they can set their alarm to get up a ½ hour before their loved one does and go for a walk or do some breathing and meditation.

While there are certain to be times of high tension between the caregiver and the patient, there can also be a breakdown of "walls" that have existed throughout the relationship. There may be a new and deeper connection that is formed bringing them closer than ever before. This may also be a very emotional time if there was previous turbulence in their relationship. They may each realize that they have wasted time and that the time they now share is limited. This can stir up a great deal of emotions and may lead to a deep sadness. It is not uncommon for the caregiver and patient to share their regrets and discuss how they wish things would have been different. This may be much-needed closure for them both to move on and "accept" where they are currently at. Many people become closer when they are facing challenges together. They should try and share special moments and make lasting memories with one another. The relationship may become stronger than ever from all that they are going through together.

Caregivers should find someone that they can open up to about their feelings or fears. They may find it helpful to talk with someone outside the situation. Writing or journaling may be a great outlet for the caregiver to vent their thoughts and feelings. They may want to write about their frustrations, fears, or even anger over the situation. Perhaps they will want to express their thoughts and feelings over the potential loss of their loved one. One technique that is used is to encourage the caregiver to write down whatever comes to their mind at any given moment.

There doesn't have to be any rhyme or reason. It may help to un-clutter all of the thoughts that are swirling in their head.Maybe it even allows them to have a different outlook on their situation and be grateful for the time they get to spend with their loved one. The selfless act of caregiving may help them to find an inner strength that they never knew was there!

It is very easy to let oneself go when caring for someone else. It's like taking care of a newborn baby. Your life is no longer your own. Many caregivers are so busy taking care of their loved one that they overlook their own well-being. It's critical that they take care of their basic needs in order to have the strength to help others. Many caregivers suffer from fatigue, sometimes downright exhaustion. Lack of sleep, an unhealthy or inadequate diet, lack of exercise, and high levels of stress may result in a weaker immune system. They may find themselves gaining or losing weight, losing muscle and generally unhealthy. Although their number one job is to take care of their loved one, they must set aside time for themselves each day for their mental and physical health. Cat naps can be quite energizing if they aren't getting enough quality sleep. Getting outside in nature for some walking and meditation can do wonders. Any kind of exercise, even gardening, cleaning the house, mowing the lawn, or walking up and down the stairs, can improve one's overall disposition. Finding at least 15-30 minutes a day to exercise will absolutely help the caregiver feel better and manage their stress. If the patient is physically able, they would benefit tremendously by finding time in their day to exercise too! While it is important for the caregiver to have some "alone time," this could also be a wonderful boding experience with their loved one. They might exercise together and even try cooking a new and healthy recipe together.

One of the main roles of a caregiver may be to help their loved one work with their health care team. They will probably accompany the patient to their doctor visits, chemotherapy, and radiation sessions. It's a good idea to keep a notebook of the patient's medical information.

This should include prescription doses and times of day that they need to take specific medications. Include the dates of procedures and tests. The patient may be suffering with brain fog from treatment or other medications that they are on. They will rely heavily on the caregiver to take notes at doctor's appointments as well as making sure appointments are kept. Caregivers can make a list of questions and concerns that they have for the medical team. It may be a good idea for the patient to give the caregiver partial power of attorney if important decisions need to be made and the patient is not in a position to do so.

Many patients are afraid to ask too many questions. They don't want to second-guess their doctor or feel that if they get a second opinion that they will be offending their doctor and he or she will "blacklist" them. Getting a second opinion can have a have a huge impact by making the patient feel that they have more control over the situation. They are either reassured by their original doctor's treatment plan, or they have new hope from the new doctor.

Another challenge of being a caregiver is when your loved one is overcome by pain. Their mood can change in the blink of an eye, and you may notice high "highs' and low "lows." The patient may become extremely distant, they may have trouble sleeping, and they may have a difficult time staying focused and completing tasks. No one should have to be in pain or discomfort. The medical team should ask regularly about pain levels, but it's up to the caregiver and the patient to keep the medical team informed. Pain can be managed throughout treatment. Patients may use a combination of prescription medications, meditation, acupuncture, acupressure, massage, yoga, and all forms of exercise. Many people get used to the pain because it becomes a part of everyday life for them. They may forget what it's like to live without it and learn how to manage through each day the best they can. It's important for the caregiver and their loved one to be honest with the doctor about their pain and if it is affecting their daily routine.

Sometimes treatment raises questions about the patient's living situation, especially if the caregiver lives out of town. They will need to determine what kind of help their loved one needs, and for how long? Consideration will need to be given to whether it is safe for the patient to be home alone. While the caregiver may see the need to make changes on behalf of their loved one, the patient's voice still needs to be heard. Many cancer patients, especially when they are older, fear losing their independence and being seen as weak or a or even helpless. Many mental health workers, doctors, nurses, home care providers, and agencies that work with older adults can help mediate the conversation. It's never easy to bring up the subject of advance directives, but it is a conversation that must be had. Advance directives are legal papers that tell the doctors what to do if the patient can't speak for themself. This allows the patient to decide in advance how they want to be treated under various medical circumstances and appoints a person to make financial decisions for the patient when he or she can't make them.

Many caregivers have described the experience of taking care of a friend or loved one during such a difficult period as their own personal journey. They say it has forever changed them and the way they look at life, love, and relationships.

CHAPTER THREE

CANCER AND THE IMMUNE SYSTEM

OBJECTIVE: to gain an understanding of the immune system and its contribution to preventing and fighting cancer.

- What is the function of the immune system?
- What is the difference between the innate and acquired immune systems?
- What is the microbiome and how may it affect cancer?
- How does inflammation contribute to disease?

GOAL: to understand the importance of building a strong immune system in the prevention and management of cancer.

According to Merriam-Webster, the immune system is the bodily system that protects the body from foreign substances, cells, and tissues by producing the immune response, and includes especially the thymus, spleen, lymph nodes, special deposits of lymphoid tissue (such as in the gastrointestinal tract and bone marrow), macrophages, lymphocytes including B cells and T cells, and antibodies. The human body is like a battlefield: every minute of every day, a battle is being waged within us. The immune system functions as our own personal defense force, protecting us from infection and other harmful agents. The enemies are the pathogens - viruses, bacteria, and mutated cells - programmed to cause harm. When this defense force is mobilized, it responds by triggering body aches, fever, inflammation, and swelling as it ramps up to engage the threat.

As multifunctional cells of the innate immune system, macrophages play an essential role in the initial inflammatory response that follows cardiovascular injury, both inducing subsequent damage and facilitating recovery. Cardiac macrophages regulate inflammation, fibrosis, and tissue repair, with their diverse phenotypes and phenotypic changes strongly associated with distinct types and severities of cardiovascular diseases, including coronary heart disease, myocarditis, cardiomyopathy, and heart failure (Feng et al., Frontiers in Immunology, 2025). Meanwhile, current neurological research confirms the brain-protective role of immune cells after stroke. Microglial cells - the brain's resident immune cells - serve as an initial defense mechanism following stroke, clearing out dead cells and debris during the acute neuroinflammatory response (Feng et al., Frontiers in Immunology, 2025). Microglia exhibit phagocytic activity, and their ability to clean neuronal debris has been shown to reduce brain damage after a stroke, with microglia invading the ischemic site earlier than macrophages and serving as the main phagocytes during the first three days post-stroke (Chen et al., Frontiers in Immunology, 2023).

The biggest challenge posed by cancer is that tumor cells are capable of not only evading the immune system's defenses, but actively co-opting immune cells to advance the disease. The tumor microenvironment (TME) is a complex ecosystem of cancer cells, stromal cells, immune cells, and signaling molecules that plays a crucial role in tumor development, metastasis, and immune evasion - functioning not merely as a passive backdrop for tumor growth, but actively shaping the immune response through mechanisms that collectively promote immune suppression and allow tumor cells to avoid immune surveillance. Cancer immune evasion represents a central barrier to effective antitumor immunity and remains one of the most challenging hallmarks of cancer biology (Jiang et al., Signal Transduction and Targeted Therapy, 2025).

Cells in the Innate Immune System:

Cell Type	Main Role	Key Features/ Functions
Neutrophils	First-line defenders; rapid responders	Highly phagocytic; release reactive oxygen species (ROS) and enzymes; form neutrophil extracellular traps (NETs); short-lived but potent
Macrophages	Long-term phagocytes and coordinators of inflammation	Derived from monocytes; engulf pathogens and debris; secrete cytokines (IL-1, TNF-α); present antigens to T cells; include Kupffer cells (liver), microglia (brain)
Monocytes	Circulating precursors of macrophages and dendritic cells	Patrol the bloodstream and migrate into tissues during infection or injury
Dendritic Cells (DCs)	Bridge innate and adaptive immunity	Detect pathogens, process antigens, migrate to lymph nodes, and activate T cells; produce interferons during viral infection
Natural Killer (NK) Cells	Destroy virus-infected and cancer cells	Recognize cells lacking MHC-I; induce apoptosis; release perforin and granzymes; secrete IFN-γ to activate macrophages
Eosinophils	Defense against parasites; allergic inflammation	Release cytotoxic granules and enzymes; modulate immune responses
Basophils	Mediate allergy and inflammation	Circulating cells that release histamine, heparin, and cytokines; contribute to allergic responses
Mast Cells	Regulate inflammation and allergy	Release histamine and proteases; important in wound healing and defense against parasites
Innate Lymphoid Cells (ILCs)	Innate Lymphoid Cells (ILCs) Immune regulators at mucosal barriers	Include ILC1, ILC2, ILC3 subsets that mirror Th1/Th2/Th17 T-cell functions without antigen specificity
Complement System	Defense Network	Plasma proteins that opsonize microbes, recruit immune cells, and form the membrane attack complex (MAC) to lyse pathogens

The acquired immune system (also called adaptive immunity) - is more sophisticated and takes longer to develop a plan of attack. Adaptive immune cells are obtained either from the development of antibodies in response to exposure to an antigen, as from vaccination or an attack of an infectious disease, or from the transmission of antibodies, as from mother to fetus through the placenta or the injection of antiserum.

Cells in the Acquired Immune System:

Cell Type	Main Role	Key Features/ Functions
B Lymphocytes (B Cells)	Produce antibodies (humoral immunity)	Recognize specific antigens via B cell receptors (BCRs); differentiate into plasma cells that secrete antibodies; provide long-term memory through memory B cells
Plasma Cells	Antibody factories	Differentiated B cells that secrete large amounts of antigen-specific antibodies (IgG, IgA, IgM, IgE, IgD); short-lived but highly effective
Memory B Cells	Long-term immune memory	Persist after infection or vaccination; rapidly produce antibodies upon re-exposure to the same antigen
Helper T Cells ($CD4^+$)	Orchestrate immune responses	Secrete cytokines to activate B cells, cytotoxic T cells, and macrophages; include Th1 (cell-mediated), Th2 (humoral), Th17 (mucosal), and Treg (regulatory) subsets
Cytotoxic T Cells ($CD8^+$)	Kill infected or cancerous cells	Recognize antigens presented by MHC class I molecules; release perforin and granzymes to induce apoptosis
Regulatory T Cells (Tregs)	Maintain immune tolerance	Suppress overactive immune responses; prevent autoimmunity; characterized by expression of the FoxP3 transcription factor
Memory T Cells	Provide long-term cellular immunity	Persist after infection; rapidly respond to re-infection; classified as central or effector memory cells
Gamma Delta (γδ) T Cells	Bridge innate and adaptive immunity	Recognize antigens without MHC presentation; found in mucosal tissues; respond rapidly to infection
Antigen-Presenting Cells (APCs)	Link innate and adaptive immunity	Include dendritic cells, macrophages, and B cells; process and present antigens via MHC molecules to activate T cells

The Microbiome's Role in Cancer

The human body is home to trillions of bacteria, fungi, and viruses that live together in a complex community known as the microbiome.The human body is home to trillions of bacteria, fungi, and viruses that live together in a complex community known as the microbiome. Scientists have already linked imbalances in this microbial community to a wide range of conditions including obesity, bowel disease, multiple sclerosis, diabetes, allergies, asthma, and autism - and research is now building a strong case for its role in cancer as well. Studies show that the mix of microorganisms found in cancer patients looks noticeably different from that found in healthy people, and these differences may even predict how well a patient responds to cancer treatment. Researchers have already identified specific bacteria that are found in much higher amounts in people with colorectal cancer and other cancers compared to healthy individuals. Scientists are now investigating whether testing for these bacteria in a patient's stool could provide a simple, non-invasive way to detect cancer early, before symptoms appear (Shen, Xu, and Wang, Turkish Journal of Gastroenterology, 2025).

Many cancers are now known to develop in areas of persistent infection, irritation, or inflammation. When cells continue to multiply in an environment that is constantly inflamed - surrounded by immune cells, growth-promoting signals, and damaging reactive molecules - the risk of those cells becoming cancerous increases significantly. But when cells keep dividing in a persistently inflamed environment and accumulate DNA damage along the way, the conditions for cancer to develop are created (Frontiers in Immunology, 2025). An unhealthy, imbalanced gut microbiome - known as dysbiosis - can directly fuel this process. Harmful shifts in gut bacteria drive chronic inflammation and can promote cancer development, tumor growth, and spread to other parts of the body, by disrupting immune responses, damaging DNA, and altering the environment around tumor cells (Jiang et al., Signal Transduction and Targeted Therapy, 2025).

A 2025 narrative review of 95 clinical studies conducted between 2015-2025 found that cancer patients - particularly those with melanoma and non-small-cell lung cancer - who had greater gut microbial diversity and higher levels of beneficial bacteria tended to have longer progression-free and overall survival and responded better to immunotherapy treatment. In contrast, patients who had received broad-spectrum antibiotics within 30 days of starting immunotherapy consistently had worse outcomes. This suggests that the health and diversity of a patient's gut bacteria at the time of treatment may play an important role in determining how well their body responds to cancer therapy (Solano et al., Medicina, 2025).

Microbiome Facts:

- **Dysbiosis and disease** - a healthy microbiome maintains a careful balance; when this balance is disrupted - a state called dysbiosis - it has been linked to over 50 chronic diseases
- **Functional redundancy** - despite enormous variation between individuals, different microbial communities often perform the same essential functions, a property known as functional redundancy, which provides resilience to the ecosystem.
- **Individual uniqueness** - each person's microbiome is as unique as a fingerprint, shaped by genetics, diet, environ ment, medications, and life history - with no two individuals sharing an identical microbial profile
- **Immune system development** - approximately 70-80% of the body's immune cells reside in the gut, and the microbiome plays a foundational role in training and regulating the immune system throughout life
- **Genetic scale** - the microbiome collectively contains approximately 3.3 million unique genes - around 150 times more than the entire human genome
- **Stability and resilience** - while the microbiome is relatively stable in healthy adults, an acute change in diet can alter microbial composition within as little as 24 hours, with most changes reverting within 48 hours of discontinuation; antibiotic use, illness, and stress can produce more lasting disruptions
- **The gut-brain connection** - contains over 500 million neurons and produces approximately 90% of the body's serotonin, making it the largest component of the enteric nervous system and a key communicator in mood, cognition, and behaviour

Microbiome References:

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What Causes Changes in the Gut Microbiome?

- **Climate change –** is altering the soil microbiome, with elevated atmospheric carbon measurably shifting the community structure of multiple microbial kingdoms, including bacteria, archaea, and fungi. Rising global temperatures reduce soil microbial diversity over the long term - a global meta-analysis of 251 paired observations found that warming reduced bacterial diversity by 16.0% and fungal diversity by 19.7% on average, with effects becoming more pronounced as warming magnitude and experimental duration increased (Dang, Chang, Chen, et al., One Earth, 2025). These disruptions directly alter carbon and nitrogen cycling in soil, impacting nutrient cycling and carbon storage and ultimately determining soil fertility and food quality. Climate change also threatens gut health: exposure to pesticides and chemical substances used in response to climate-related crop failures can lead to gut dysbiosis, contributing to the pathogenesis of intestinal inflammatory disorders. Rising temperatures, altered precipitation patterns, and increased extreme weather events have been shown to alter gut microbiome composition, diversity, and metabolic function.

  Insufficient nutrients in degraded soils are contributing to greater food shortages and an increased risk of malnutrition globally. Recent evidence confirms that malnutrition alters the composition and function of the intestinal microbiota -a state known as dysbiosis - with depletion of beneficial bacterial populations conditioned by both nutrient deficiency and imbalance in macro- and micronutrient intake. In the initial stages, disruption of the gut microbiome presents as mild symptoms; however, leakage of the intestinal barrier and sustained gut microbiome disruption are increasingly recognized as key factors in a range of pathophysiological conditions. Chronic dysbiosis is associated with obesity, malnutrition, inflammatory bowel disease, neurological disorders, and cancer (Naranjo Niño et al., Biomedicines, 2025).

- **Food intake –** diet is now considered one of the most relevant factors influencing the gut microbiome, with significant changes in microbiota composition linked to dietary patterns, particularly the consumption of dietary fiber from fruits, vegetables, and plants (Gérard, Li, and Bhuyan, Frontiers in Nutrition, 2024). A diversified diet is associated with a more diversified microbiome, with high-quality plant-rich diets correlating with increased microbial diversity and production of beneficial short-chain fatty acids. Compared to omnivores, vegetarians and vegans show a greater abundance of fiber-degrading species and lactic acid bacteria, with polyphenols specifically increasing Bifidobacterium and Lactobacillus, while Bacteroides are found in significantly higher abundance in omnivores (Asnicar et al., Nature Microbiology, 2025).

- **Stress –** psychological and physical stressors activate the hypothalamic-pituitary-adrenal (HPA) axis, triggering the release of corticotropin-releasing hormone, which stimulates adrenocorticotropic hormone and subsequently drives glucocorticoid (cortisol) synthesis in the adrenal cortex, alongside the release of catecholamines (epinephrine and norepinephrine) (Bertollo et al., Frontiers in Neuroscience, 2025). The gut microbiota is highly sensitive to these stress mediators, with research confirming that the HPA axis and gut microbiota share bidirectional communication - stress-induced cortisol and catecholamines alter gut microbiota composition, while microbial dysbiosis in turn dysregulates HPA axis activity and amplifies the neuroendocrine stress response (Bertollo et al., Frontiers in Neuroscience, 2025; Chen et al., Frontiers in Immunology, 2025). Current research further demonstrates that gut bacteria act as producers and delivery vehicles for neuroactive compounds -including serotonin, dopamine, GABA, and norepinephrine - directly influencing host neurophysiology through the gut-brain axis (Bertollo et al., Frontiers in Neuroscience, 2025).

- **Exercise –** high-intensity exercise is a physiological stressor that can lead to immunosuppression and gastrointestinal distress, with symptoms ranging from nausea, bloating, and cramping to vomiting and gastrointestinal bleeding. Intense endurance exercise increases intestinal permeability and gastrointestinal damage through splanchnic hypoperfusion - where blood is diverted from the gastrointestinal tract to working muscles, reducing splanchnic blood flow by up to 50% leading to tissue hypoxia, gut ischemia-reperfusion injury, and systemic endotoxemia (Belhaj et al., Gastroenterology, 2025). Exercising to exhaustion can disrupt the balance of both the gut microbiota and the immune system, with high-intensity exercise (≥70% VO_2 max) producing substantially greater increases in intestinal permeability than moderate-intensity exercise (Belhaj et al., Gastroenterology, 2025). In contrast, regular habitual exercise has well-established anti-inflammatory effects - dampening inflammatory markers including CRP, IL-6, and TNF-α, and improving the immunological profile in type 2 diabetes, coronary artery disease, and obesity (Kadoglou et al., Biomolecules, 2025).

- **Chronic illness –** substantial research over the last two decades has demonstrated that the gut microbiome differs markedly in healthy subjects compared to those with disease. Type 2 diabetes, cancer, arthritis, autism, depression, anxiety, sleep disorders, HIV, hypertension, obesity, non-alcoholic liver disease, and cardiometabolic diseases have all been linked to gut microbiota dysbiosis - a pattern consistently reported across more than 58 observational studies examining the relationship between microbiome composition and chronic disease (Kroeze et al., Diabetologia, 2025; Qureshi et al., Cureus, 2024).

- **Antibiotic therapies –** can bring about long-lasting adverse effects, compromising the diversity, composition, and function of the gut microbiota. Broad-spectrum antibiotics indiscriminately disrupt both pathogenic and beneficial microbial communities, with antibiotic-induced alterations persisting for weeks or even months post-treatment and increasing susceptibility to metabolic disorders, immune dysfunction, and opportunistic infections such as Clostridioides difficile (Wahl et al., The EMBO Journal, 2026). Using 16S rRNA gene sequencing, Huang et al. evaluated the short- and long-term effects of ampicillin, vancomycin, metronidazole, and neomycin on murine intestinal microbiota, demonstrating significant dysbiosis and a disruption of competitive balance among bacterial populations within the gut (Huang, Feng, Huo, and Liu, Microbiology Spectrum, 2022). Notably, the combination of multiple antibiotics produced greater and more persistent microbial diversity loss compared to single antibiotic use alone, with further evidence showing that combined chemotherapy and antibiotic treatment results in more prolonged dysbiosis than either treatment individually (Huang, Feng, Huo, and Liu, Microbiology Spectrum, 2022).

- **Gut-brain axis –** describes the bidirectional communication between the central nervous system and the gut microbiota, with gut dysbiosis and intestinal inflammation increasingly linked to the onset of anxiety and depression. Hormones, neurotransmitters, and immunological factors released from the gut signal the brain directly or via autonomic neurons, influencing mood, cognition, and behavior (Bautista et al., Frontiers in Psychiatry, 2025). Recent research has focused on alterations in the gut microbiome as contributing factors to CNS disorders including depressive disorders, schizophrenia, and autism spectrum disorder, with dysbiosis implicated through mechanisms involving neurotransmitter imbalances, neuroinflammation, and disrupted immune regulation (Chen et al., Frontiers in Immunology, 2025). Patients prescribed mood-altering drugs may benefit from probiotic supplementation, as meta-analyses of randomized controlled trials report moderate-to-high evidence that probiotics can alleviate symptoms of depression and anxiety, partly by restoring beneficial gut flora disrupted by both the neurological condition itself and its pharmacological treatment (Asad et al., Nutrition Reviews, 2024).

- **Advanced age –** is associated with marked changes in gut microbiota composition, with Bacteroidetes species and the Firmicutes phylum predominating in the elderly, higher proportions of Bacteroides and Clostridium groups, and a reduction in Ruminococcus, Prevotella, and related genera compared to healthy young adults (Nikolaidis et al., Frontiers in Aging, 2025). Bacteroidetes account for 53% of the core microbiota in elderly individuals, compared with 8-27% in healthy young adults (Ghosh et al., 2021). Members of the Firmicutes and Bacteroidetes phyla stimulate the intestinal inflammasome pathway, reducing gut barrier integrity and allowing leakage of microbial products that upregulate pro-inflammatory factors - including TNFα, IL-6, and IL-1 - promoting a persistent low-grade inflammatory state linked to cognitive decline and dementia (Nikolaidis et al., Frontiers in Aging, 2025). With advancing age, susceptibility to immune-mediated disease increases as pro-inflammatory cytokines (IL-1β, IL-6, TNF-α) rise and anti-inflammatory cytokines (IL-10, IL-4) and antibody production decline - changes associated with both cognitive decline and depressive behavior (Nikolaidis et al., Frontiers in Aging, 2025).



- **Genetics and early-life exposures –** play a foundational role in shaping the gut microbiome. While host genetics modestly influence microbial composition through effects on mucosal immunity and metabolite signalling, mode of birth and early feeding practices exert a far stronger impact on microbial colonisation (Liu and Yang, Frontiers in Microbiology, 2023). Vaginal delivery exposes infants to maternal vaginal and intestinal microbiota rich in Lactobacillus, Prevotella, and Bifidobacterium, promoting immune tolerance and epithelial development, whereas caesarean delivery results in colonisation by environmental skin-associated bacteria such as Staphylococcus and Corynebacterium, with slower acquisition of beneficial anaerobes (Selma-Royo et al., Cell Host & Microbe, 2024)). Breastfeeding further supports a protective microbial profile through human milk oligosaccharides. (HMOs), which selectively nourish Bifidobacterium and Lactobacillus, while formula feeding tends to promote a less stable, more inflammation-prone microbiome (Brockway, 2024). Early antibiotic exposure compounds these effects by depleting key commensal taxa and delaying microbial maturation, with systematic reviews of over 22 million children linking early antibiotic use to significantly increased risks of allergies, obesity, autoimmune disease, and neurodevelopmental disorders (Journal of Allergy and Clinical Immunology, 2024). Together, these findings underscore the critical importance of early microbial nurturing in establishing immune resilience and long-term health.

- **Hormones and reproductive status –** exert profound effects on the gut microbiome, creating a dynamic interplay between endocrine and microbial systems that shapes immune balance, metabolism, and disease risk. Estrogen and progesterone influence microbial composition through their impact on mucosal immunity, gut permeability, and bile acid metabolism, and indirectly through regulation of the estrobolome - the collection of gut microbes capable of metabolizing and recycling estrogens via β-glucuronidase activity (Liaquat et al., Women's Health, 2025). During menopause, declining estrogen is associated with reduced Lactobacillus abundance, altered microbial diversity, and a gut microbiome profile linked to vaginal atrophy, inflammation, and heightened cardiometabolic risk; HRT and microbiome-targeted interventions including probiotics show potential to restore microbial diversity and mitigate menopausal symptoms (Liaquat et al., Women's Health, 2025). Dysregulation of the estrobolome may alter circulating estrogen levels, influencing the development of hormone-dependent malignancies such as breast cancer, through microbial β-glucuronidase activity that modulates enterohepatic estrogen recycling and systemic estrogen exposure (Larnder et al., International Journal of Cancer, 2025). These findings collectively underscore the bidirectional relationship between hormonal status and the microbiome, suggesting microbial balance modulates both endocrine health and cancer susceptibility across a woman's lifespan.



Some recent findings exploring the role of the microbiome in cancer:

2013	2014	2016	2016	2018	2018
University of Michigan researchers show that transferring the gut microbes from a mouse with colon cancer to those with no microbiome sees them develop two times more tumors than mice receiving microbes from a healthy mouse (Zackular et al., 2013) .	Researchers at the European Molecular Biology Laboratory predict the presence of colorectal cancer from the abundance of bacterial species in stool samples, with about the same accuracy as a blood test (Zeller et al., 2014, Molecular Systems Biology).	NYU Langone Medical Center find that people whose oral microbiome includes Porphyromonas gingivalis, linked with gum disease, have a 59% greater risk of developing pancreatic cancer compared to those who don't (Fan et al., Gut 2016).	Researchers from Kumamoto University in Japan find that people whose esophageal tumors test positive for Fusobacterium nucleatum have poorer survival chances (Yamamura et al., 2016, Clinical Cancer Research).	Researchers at MD Anderson Cancer Centre show that people whose malignant melanoma respond to immunotherapy have more diverse /different types of gut bacteria compared with non-responders (Gopalakrishnan et al., Science, 2018).	Routy et al; Science, 2018 conducted a study that suggests that antibiotic use that disrupts the guts microbiota could potentially impair anti-tumor immune responses as well as response to immune checkpoint blockade.

2022	2023	2023	2023	2023	2023
Microorganisms (including bacteria, fungi, viruses, and protozoa) are inhabited on all body surfaces and affect various aspects of host physiology, such as metabolism and immune system development. They might act dual role in tumor treatment or progress by various mechanisms. In particular, they could inhibit or support tumor progress by deterring or promoting pro-tumor inflammation, respectively (Eslami et al., 2022, Journal of Translational Medicine).	Microbiome affects cancer metastasis by regulating Matrix metalloproteinases (MMPs). PD-L1, programmed cell death protein 1 ligand; CEA, carcinoembryonic antigen (Liu et al., Cancers, 2023).	The microbiota can be engineered to improve and enhance its antitumor effects based on microbiota-intrinsic mechanisms. In addition, the intratumoral microbiota can induce innate and adaptive immune responses to prevent tumor progression (Fu et al., Signal Transduction and Targeted Therapy, 2023).	An integrated understanding of the contribution of diet and nutrition to the modulation of specific host-microbiome interactions would greatly complement traditional dietary recommendations and initiate a transition from current general guidelines (Daschner et al., Journal of the Academy of Nutrition and Dietetics, 2023).	An in-depth knowledge of the functions and architecture of various microbiomes, along with their interaction with the host, can support development of individualized dietary guidelines and microbe-altering approaches in future. Furthermore, microbe-based therapies can be used to target specific tumor microenvironments as each microenvironment has its own microbiome community, regulating its intra-tumoral processes (Daschner et al., Journal of the Academy of Nutrition and Dietetics, 2023).	Gut microbiota is closely related to cancer. Intestinal dysbiosis can favor certain microorganisms that inhabit our intestine to increase the risk of different types of cancer through numerous mechanisms such as virulence factors that degrade the products of tumor suppressor genes, toxins that damage DNA, generation of oxidative stress, activation of proinflammatory mechanisms, alteration of cell proliferation and survival pathways, and alteration of the immune system (Fu et al., Signal Transduction and Targeted Therapy, 2023).

2024	2024	2024	2024	2024	2024
Antibiotic exposure in the weeks leading up to immune checkpoint blockade (ICB) can profoundly alter treatment efficacy by disrupting the gut microbiome's immunomodulatory balance. Multiple large-scale cohort and meta-analytic studies revealed that patients who received antibiotics within approximately 60 days prior to starting ICB experienced significantly lower response rates and shorter progression-free and overall survival, while those who received antibiotics after therapy initiation showed no such detriment (Elkrief et al., ASCO Educational Book, 2024; Crespin et al., Frontiers in Oncology, 2023).	Microbiome alterations in gynecologic cancers extend beyond the gut, encompassing oral, vaginal, and endometrial ecosystems, each exerting distinct yet interco…Microbiome alterations in gynecologic cancers extend beyond the gut, encompassing oral, vaginal, and endometrial ecosystems, each exerting distinct yet interconnected effects on carcinogenesis, immune modulation, and treatment response. Disruption of Lactobacillus dominance correlates with increased local inflammation, altered estrogen metabolism via microbial β-glucuronidase activity, and enhanced epithelial proliferation. Gut dysbiosis influences systemic immunity and metabolism, while oral microbial translocation may contribute to pro-inflammatory cytokine cascades. These findings underscore a multisite microbial network influencing gynecologic cancer pathogenesis, suggesting future prevention and therapeutic strategies should integrate microbial assessment across multiple body niches rather than focusing solely on gut flora (Javadi et al., Infectious Agents and Cancer, 2024).	In a 2024 study examining the relationship between the gut microbiome and esophageal squamous cell carcinoma (ESCC), researchers performed 16S rRNA sequencing on fecal samples from ESCC patients and healthy controls to investigate systemic microbial alterations. The study revealed a significant reduction in overall gut microbial diversity among ESCC patients, along with distinct compositional shifts at both the family and genus levels. Notably, the ESCC microbiota was enriched in potentially pro-inflammatory genera such as Fusobacterium, Prevotella, and Veillonella, while beneficial commensals like Faecalibacterium and Bifidobacterium were markedly depleted. These alterations were associated with increased systemic inflammation and disruption of intestinal barrier integrity, supporting a model in which chronic dysbiosis contributes to carcinogenesis through immune dysregulation, microbial metabolite imbalance, and epithelial damage. The authors concluded that gut microbiome profiling could serve as a non-invasive biomarker for early ESCC detection and potentially guide dietary or probiotic strategies aimed at restoring microbial equilibrium and reducing cancer risk(Zhang et al., Frontiers in Oncology, 2024; Gao et al., Microbiology Spectrum, 2024).	A 2024 Mendelian randomization study using East Asian genomic datasets identified causal links between specific gut bacterial genera and esophageal cancer risk. Beneficial taxa such as Bacteroides, Ruminococcus, Eubacterium, and Faecalibacterium were associated with reduced risk, while Enterococcus and Clostridium sensu stricto correlated with higher susceptibility. Protective genera appear to exert anti-inflammatory and barrier-supporting effects, whereas harmful microbes may promote nitrosamine formation and chronic mucosal inflammation. These findings provide genetic-level evidence that gut dysbiosis may causally influence both squamous and adenocarcinoma subtypes of esophageal cancer (Li et al., BMC Cancer, 2024).	Gut microbiota is closely related to cancer. Intestinal dysbiosis can favor certain microorganisms that increase cancer risk through numerous interconnected mechanisms. Specific pathogens deploy virulence factors that degrade tumor suppressor gene products - for example, Fusobacterium nucleatum uses its FadA adhesin to activate β-catenin and NF-κB signaling, driving uncontrolled cell proliferation. Bacterial genotoxins such as colibactin and Bacteroides fragilis toxin directly damage host DNA, inducing chromosomal instability, while elevated reactive oxygen species generate oxidative stress that further compounds mutagenic injury. These insults sustain chronic activation of pro-inflammatory pathways, driving secretion of cytokines such as IL-6, IL-17, and TNF-α. Collectively, these processes disrupt normal cell proliferation and survival signaling, inhibit apoptosis, and remodel host immunity by impairing cytotoxic T cell activity and promoting immunosuppressive populations, ultimately enabling tumors to evade immune surveillance (Mico-Carnero et al., 2023, Nutrients; Eslami et al., 2022, Journal of Translational Medicine).of gastric cancer.	A 2024 study published in Research analyzed gut microbiome profiles from 68 ESCC patients before and after neoadjuvant immunochemotherapy (NICT), alongside healthy controls, using 16S rRNA gene sequencing. Patients who responded to treatment showed significantly higher baseline levels of short-chain fatty acid (SCFA)-producing bacteria - including Faecalibacterium, Eubacterium eligens group, Anaerostipes, and Odoribacter - compared to non-responders, who had enrichment of Veillonella, Campylobacter, and Atopobium. Following treatment, responders also demonstrated a shift toward a more favorable microbiome composition, with a reduction in ESCC-associated pathogens and an increase in beneficial genera. Using machine learning, the authors identified seven key microbial biomarkers capable of predicting treatment response with an accuracy of up to 86.8%, underscoring the gut microbiome's potential as a non-invasive predictive tool for personalizing ESCC immunochemotherapy (Liu et al., 2024, Research).

2024	2025	2025
A 2024 meta-analysis of gut microbiota and breast cancer, pooling data from ten studies involving 734 patients, found that women with breast cancer had significantly reduced gut microbial diversity - especially lower Chao1 indices - compared with healthy controls, with menopausal status identified as a key driver of microbial variability. Patients showed depletion of SCFA-producing genera such as Faecalibacterium prausnitzii, Roseburia inulinivorans, and Ruminococcus, and enrichment of potentially pro-inflammatory taxa. These alterations suggest that gut dysbiosis may disrupt estrogen metabolism, immune regulation, and intestinal integrity, collectively promoting an inflammatory, tumor-favoring milieu (Wu et al., 2024, Clinical and Translational Oncology).	A 2025 review of 95 clinical studies conducted between 2015 and 2025 found that cancer patients - particularly those with melanoma and non-small-cell lung cancer - who had greater gut microbial diversity and higher levels of beneficial bacteria tended to have longer progression-free and overall survival and responded better to immunotherapy treatment. In contrast, patients who received broad-spectrum antibiotics within 30 days of starting immune checkpoint blockade consistently had worse outcomes, underscoring the role of gut microbiota health at the time of treatment initiation as a meaningful determinant of immunotherapy response (Petrelli et al., Medicina, 2025).	Researchers analyzed fecal microbiota from three groups: healthy controls (n = 53), women with benign ovarian tumors (BOTs; n = 91), and women with malignant ovarian tumors (OC; n = 148). They found that the OC group had markedly lower gut microbial diversity and a distinct composition compared with both the healthy and benign groups - specifically, higher levels of Escherichia/Shigella and lower levels of genera such as Coprococcus, Fusicatenibacter, Butyricicoccus, and Oscillibacter. Using a random-forest classifier, the model distinguished OC from healthy with an AUC of 0.86, and BOT from healthy with an AUC of 0.77, suggesting potential non-invasive biomarker value. The authors propose that gut microbiota alterations may reflect systemic shifts linked to ovarian tumor biology - possibly via estrogen metabolism, inflammation, or immune modulation - and could one day support early detection or risk-stratification in ovarian tumor patients (Zhang et al., 2025, Scientific Reports).

CHAPTER FOUR

TYPES OF CANCER AND THEIR SURGICAL PROCEDURES

OBJECTIVE: to gain an understanding of the common cancer surgeries, their acute and chronic side-effects, and projected recovery times.

- Was there an amputation?
- Where and in what direction is the incision(s)?
- When was the surgery performed?
- Does the patient have a medical clearance form?

GOAL: to create a program that will be safe and effective and to know how and when to progress/regress on a daily, weekly, or monthly basis.

As you begin to read about each of the types of cancer and their surgeries, there are some important things for you to consider.

1. When was the surgery completed?
The general rule of thumb is that your client should not perform anything other than range of motion and gentle stretching, in the area of surgery, for at least 6 weeks post-surgery. Different procedures will require longer healing times, as noted under each surgical recovery section. Always obtain Medical Clearance before you begin training, and this includes conducting a full assessment. Keep in mind that while an incision may appear completely healed on the surface, there may still be significant internal trauma and healing taking place beneath the skin. Additionally, healing timelines can be further delayed by adjuvant chemotherapy or radiation therapy, both of which contribute to fatigue, immune suppression, and deconditioning that are independent of surgical recovery. More complex reconstructive procedures - such as TRAM or DIEP flap reconstruction - will generally require considerably longer recovery periods than implant-only procedures, and your programming should reflect this.

2. Where is the surgical incision(s) and how is that affecting your client's posture and range of motion?
Understanding where the surgical incision is located will help you identify potential muscle imbalances, postural compensations, and movement restrictions. If your client has undergone a mastectomy for breast cancer, they will have a horizontal incision where the breast was removed. If scar tissue or adhesions have formed in the area, or if the pectoralis muscles are in spasm, the skin and muscles will tighten, pulling the shoulders into protraction. This can cause the opposing back muscles to become overstretched and weak. Understanding this will help you determine which muscles need to be stretched and which need to be strengthened. Lymph node removal under the arm may further limit shoulder range of motion in the affected arm, and your client must work to fully restore shoulder range of motion before any external load is introduced in that plane of motion.

3. Does your client have surgical drains/drain sites?
Many clients return to exercise while still managing surgical drains, or shortly after their removal. Drain sites can be tender, restrict movement, and limit certain positions. Clients should be instructed to report any increase in drainage, redness, warmth, or swelling at a drain site, as these may indicate infection or other complications requiring medical attention. Exercise programming should avoid movements that place direct tension or pressure on drain sites until they are fully healed.

4. Did your client have lymph nodes removed and, if so, where?
Lymphedema may be the most overlooked complication of cancer surgery and treatment. It is swelling of the area following removal of, or radiation to the lymph nodes. You MUST find out if your client had nodes removed or irradiated, and where! If they have had either or both, you will take baseline measurements of the affected area during the assessment. You will also teach them how to identify "pitting" edema (we will cover this in the lymphedema section of Module 2) and give them the lymphedema precautions that you will also find in that chapter.

They will be at risk for lymphedema for their entire life and will need to perform lymph drainage exercises prior to their workout or sport. It will be critical that they slowly and gradually add frequency, intensity, and duration to their workouts, especially for that part of their body. You should also be cautious of weight-bearing on the affected limb for prolonged periods.

5. Did your client have their testicles removed, or are they on male hormonal therapy?

In the absence of testosterone, your client will lose lean muscle mass and have a difficult time building lean muscle. They will probably gain weight and it will be very difficult to lose weight as well as build muscle. They should see a registered dietician, who specialize in oncology, that can help them with a structured meal plan that will provide the nutrients they need while cutting calories. The extra weight and body fat will increase their risk for lymphedema if they have had lymph nodes removed or irradiated and it also increases their risk for co-morbidities. You should set realistic expectations with them but strive for success. They may have similar side-effects to female menopause and may have gynecomastia (breast tenderness or growth). They will have an elevated risk for osteoporosis and weight training, while not as effective as with testosterone, will be an essential part of their training.

6. Did your client have their ovaries removed?

In the absence of estrogen, your client will be thrown into instant menopause (this may also happen with chemotherapy). If they are not close to peri-menopause there is a good chance that they will resume their menses. They will probably gain weight and it will be very difficult to lose weight as well as build muscle. They should see a registered dietician, who specialize in oncology, that can help them with a structured meal plan that will provide the nutrients they need while cutting calories. The extra weight and body fat will increase their risk for lymphedema if they have had lymph nodes removed or irradiated and it also increases their risk for co-morbidities. You should set realistic expectations with them but strive for success. They will have an elevated risk for osteoporosis and weight training, while not as effective as with testosterone, will be an essential part of their training.

7. Did your client have their spleen removed?

If your client has had their spleen removed, they will be immuno-compromised. You should take all precautions for someone with a compromised immune system and avoid in-person training if you are feeling under-the-weather. Have them ask their doctor if it is okay for them to go swimming as that is typically contraindicated for someone with a compromised immune system.

8. Did your client have all or part of their stomach removed?

If your client has had their stomach removed, in part or in full, please read the guidelines for eating and drinking in the section on stomach cancer. If your client has vomiting or diarrhea, they should not exercise for 24-26 hours. In the case of chronic Dumping Syndrome, they may exercise at a low intensity while making sure to drink plenty of water and replenish their electrolytes.

9. Did your client have their adrenal gland removed?

If your client has had their adrenal glands removed, they will present with symptoms of adrenal insufficiency - fatigue, muscle weakness, low appetite, weight loss, and stomach pain. This fatigue, in conjunction with that from cancer treatment, may make it very difficult to even perform activities of daily living.

10. Did your client have their pancreas removed?

If your client has had their pancreas removed, they will be dependent on insulin injections. They must take their blood sugar level prior to exercising. See blood-sugar norms and diabetes precautions in the pancreatic cancer section.

11. Did your client undergo a transplant (kidney, liver, bone marrow, etc.)?

If your client has undergone any type of transplant, they will be on immunosuppressant drugs to prevent rejection. This means that they will be immunocompromised. You should take all precautions for someone with a compromised immune system and avoid in-person training if you are feeling under-the-weather. They may also have Graft vs. Host Disease. If they are taking cortisone or cortisone-like drugs, they may have an elevated risk for osteoporosis, diabetes, and infections.

12. Does your client have a port-a-cath?

Many cancer clients have a port-a-cath surgically placed in the upper chest area for the delivery of chemotherapy. You must know where your client's port is located, avoid any direct pressure over the site, and be aware that certain upper body movements may be restricted or uncomfortable, particularly in the weeks following placement. Resistance training involving the chest, shoulder, and upper back should be carefully monitored and modified as needed to avoid irritating the port site.

13. Does your client have a stoma or ostomy?

Clients who have undergone colorectal, bladder, or other abdominal surgeries may have a colostomy, ileostomy, or urostomy. You should be aware of the location of the stoma, understand basic precautions related to increases in intra-abdominal pressure during exercise, and avoid exercises or equipment that may place direct contact or pressure over the stoma site.

14. Does your client have a muscle flap?

If your client has a muscle flap there will be an imbalance wherever the flap was taken from. If it is "tunneled", the muscle will continue to respond as it did it its' original location (contract, relax, hypertrophy, and atrophy). Therefore, you will need to choose exercises with care and ask yourself what the "goal" of the particular exercise is. If the Lat has been used for breast reconstruction it will be critical to stabilize the shoulder girdle while stretching tight chest muscles. If they also have an implant, those precautions will also need to be taken. You will want to avoid compound exercises that will involve the Lat as it will now contract and relax in their chest.

If the rectus abdominis has been used for breast reconstruction, your client should avoid all "crunch-type" exercises. They should focus on core-work and strengthening their lower-back. They will probably have excessive lordosis due to weakness in the abs and over-compensation from the low-back. A modified Thomas Test will need to be conducted to rule-out tight hip flexors and weak glutes as a partial cause of the lordosis.

If the sternocleidomastoid (SCM) muscle is removed in a radical neck dissection, there will most likely be synergistic dominance with the levators, upper traps, and scalene muscles that will lead to muscle imbalance and pain. Your client may also have altered head and neck movements as well as limited shoulder range of motion (ROM). You should assess shoulder ROM by using a goniometer. Your client must work to regain shoulder range of motion prior to adding any external load in that plane of motion.



15. Does your client have breast expanders?

If your client currently has breast expanders in place, most surgeons will recommend that they avoid anything that will contract the chest. Because this includes eccentric as well as concentric contractions, ALL back and chest work (isotonic, isokinetic, and isometric) should be avoided until the expanders have been removed.

16. Does your client have breast implants?

If your client has breast implants, you should wait at least 6-weeks post-surgery before doing anything more than gentle ROM and stretching in their upper body. Your client must work to regain shoulder range of motion prior to adding any external load in that plane of motion. Make sure to stretch the chest muscles and strengthen the opposing back muscles to correct round shoulder syndrome. Be careful with prone position or anything that applies pressure to the chest area.

17. Are you working with a child undergoing treatment?

Caring for a pediatric cancer patient undergoing active treatment requires a deeply thoughtful and holistic approach that goes far beyond managing the disease itself. Children receiving chemotherapy, radiation, immunotherapy, or surgical interventions often experience a wide range of side effects - including fatigue, nausea, pain, immunosuppression, and cognitive changes - that can fluctuate dramatically from day to day, making consistent routines extremely difficult to maintain. Because a child's immune system is frequently compromised during treatment, careful attention must be paid to infection risk in all settings, including school environments where exposure to common illnesses can have serious consequences.

This often means difficult decisions must be made about whether a child can attend school in person, requiring close communication between the oncology team, parents, and school administrators to develop individualized plans that balance educational continuity with medical safety. When in-person attendance is not possible, hospital-based tutoring, homebound instruction, or virtual learning options should be actively pursued, as maintaining academic engagement not only preserves cognitive development but also gives the child a sense of normalcy and purpose during an otherwise disruptive time.

Physical activity is equally important to consider, as exercise has been shown to support physical and emotional wellbeing in children with cancer, yet treatment-related fatigue, bone density loss, cardiac concerns, and the risk of injury in immunocompromised patients require that activity levels be carefully tailored and medically guided. Participation in age-appropriate play and recreational activities should be encouraged wherever safely possible, as these experiences are vital to a child's social development, emotional resilience, and sense of identity. Peer relationships can suffer significantly during prolonged treatment, and proactive efforts to maintain social connections - through school visits, video calls with classmates, or hospital play programs - can meaningfully reduce feelings of isolation and anxiety. Throughout all of these considerations, open, honest, and developmentally appropriate communication with the child remains essential, ensuring that they feel informed, respected, and as in control of their daily life as circumstances allow.

Amputation is one of the most physically and psychologically significant interventions a child with cancer may face, most commonly occurring in cases of bone tumors such as osteosarcoma or Ewing's sarcoma when limb-salvage surgery is not a viable option. For the child, losing a limb affects not only physical function but also body image, self-esteem, and sense of identity at a time when development and peer perception are already central concerns. Rehabilitation begins as soon as medically appropriate and typically involves physical and occupational therapy focused on regaining strength, mobility, and independence, as well as prosthetic



fitting and training when applicable. Returning to school and social activities after amputation requires careful coordination, as the child may need accommodations for mobility, adapted physical education, and support in navigating the emotional challenges of looking or functioning differently from peers. Psychological support is equally critical, as children and adolescents may grieve the loss of their limb and require ongoing counseling to process feelings of anger, sadness, or anxiety about the future. Family members also need guidance and support in helping their child adapt positively while avoiding overprotection, which can hinder the child's development of independence and resilience. With the right multidisciplinary support, many children who undergo amputation go on to live full, active lives, and early introduction to peer role models - such as other young amputees or adaptive athletes - can be a powerful source of hope and motivation during recovery.

PROSTATE CANCER

Prostate cancer is the second most commonly diagnosed cancer and the fifth leading cause of cancer death among men worldwide, with over 1,460,000 new cases and 396,000 deaths in 2022 (Schafer et al., European Urology, 2025). Most men over the age of 50 will have some experience with prostate disease, whether an enlarged prostate or cancer. Black men have the highest prostate cancer incidence in the United States, approximately 67% higher than in non-Hispanic white men, and are more likely to present with advanced disease at the time of diagnosis (Kratzer et al., CA: A Cancer Journal for Clinicians, 2025). Prostate cancer death rates have been decreasing since the early 1990s in men of all races and ethnicities, though they remain more than twice as high in Black men compared to any other group (Kratzer et al., CA: A Cancer Journal for Clinicians, 2025).

To better understand the role of genetics and environment in this disparity, researchers have studied prostate cancer rates among African American men and their ancestral populations in West Africa. West African men have substantially lower prostate cancer incidence and mortality compared to African American men - for example, compared to Nigerian men, African American men are markedly more likely to develop prostate cancer and to die from the disease, suggesting that environmental and lifestyle factors may play a significant role alongside genetics. However, there is documented evidence in the literature indicating that prostate cancer in at least one West African country is comparable to rates found in the United States and in Caribbean islands. Another important risk factor is a positive family history; if a man has a father or brother with the disease, his risk of developing prostate cancer is approximately two to three times higher than that of a man with no family history (Saka et al., CA: A Cancer Journal for Clinicians, 2025).

Cancer of the prostate is considered an indolent cancer - one that grows extremely slowly, sometimes taking as long as two to four years to double in size. The current median age at diagnosis is approximately 66-67, and because of this many men with low-risk disease elect to forgo aggressive treatment in favor of active surveillance, a structured monitoring approach involving regular PSA testing, imaging, and periodic biopsy (NCI, SEER Cancer Statistics, 2024). The prostate has two main growth phases: the first occurs during puberty, and the second begins around age 25 and continues throughout life, driven by dihydrotestosterone (DHT) rather than a sudden increase in testosterone. This ongoing hormonal stimulation causes the prostate to gradually enlarge over time. As a result, benign prostatic hyperplasia (BPH) is extremely common in older men, with a clinical prevalence of 50-75% in men over 50, rising to over 80% in men over 70, and as high as 70% in US men between the ages of 60-69 (Bhatt et al., StatPearls, 2025).

As the prostate enlarges, it compresses the urethra, restricting the flow of urine. Men typically feel an urgency to urinate but are unable to void completely. This incomplete emptying can lead to a range of bothersome lower urinary tract symptoms (LUTS), including a weak or interrupted urine stream, increased frequency of urination - particularly at night (nocturia) - straining to begin urination, and a sensation that the bladder has not fully emptied after voiding. Over time, chronic urinary retention can place significant strain on the bladder muscle, potentially leading to bladder wall thickening, reduced bladder capacity, and in more severe cases, urinary tract infections, bladder stones, or kidney damage resulting from backpressure on the upper urinary tract. While these symptoms are most commonly associated with benign prostatic hyperplasia, it is important to note that BPH and prostate cancer can coexist, and urinary symptoms alone cannot reliably distinguish between the two conditions. Men experiencing persistent or worsening urinary symptoms should be evaluated by a healthcare provider, as early assessment allows for appropriate monitoring, timely intervention when necessary, and the opportunity to screen for underlying malignancy.

The obstruction can make urination very painful. Should a cell in the prostate turn into cancer, the testosterone will spur the tumors growth like gasoline fueling a fire. Two options for stopping the supply of testosterone exist; surgically removing the testicles or by administering hormones that either halt testosterone production or block its effect.

With early prostate cancer, there are usually no signs or symptoms, however with more advanced prostate cancer, men may experience a weak or interrupted flow of urine, need to urinate frequently (especially at night), blood in the urine, inability to urinate, or difficulty starting to urinate, urine flow that is not easily stopped, painful or burning urination with radiating pain in the back, pelvis, or hips that doesn't go away, and shortness of breath, feeling very tired, fast heartbeat, dizziness, and pale skin cause by anemia. These symptoms may indicate other prostate problems however, they should not be ignored, and the patient should be seen by a doctor to determine whether it is a cancerous or non-cancerous enlargement. Regular digital exams are recommended to detect early prostate cancer because it often does not cause any symptoms.

For men that are diagnosed with low-risk prostate cancer, treatment may not be necessary immediately. Some men will never need treatment. Many doctors sometimes recommend active surveillance in which regular follow-up blood tests, rectal exams and biopsies may be performed to monitor progression of your cancer. If tests show that the cancer is progressing, the patient may then opt for a prostate cancer treatment such as surgery or radiation. Active surveillance is typically only an option for cancer that is asymptomatic, is expected to grow very slowly and is contained in a small area of the prostate. Another time it may be recommended is when the patient has another serious health condition or is of an advanced age that makes cancer treatment more difficult. The downside is that active surveillance carries the obvious risk that the cancer may metastasize between checkups, reducing the likelihood of a cure.

Gleason Score – is the most common scale that is used to evaluate the grade of prostate cancer cells is called a Gleason score. Gleason scoring combines two numbers and can range from 2 (nonaggressive cancer)-10 (very aggressive cancer).

Most Gleason scores used to assess prostate biopsy samples range from 6-10, with lower numbers seldom being used. A score of six indicates a low-grade prostate cancer. A score of 7 indicates a medium-grade prostate cancer. Scores from 8-10 indicate high-grade cancers.

Procedures:

- **Radical Prostatectomy –** this is the traditional surgical approach in which the surgeon makes a single, large incision to access and remove the prostate gland, surrounding tissues, and often the seminal vesicles

  There are two main open approaches:

  Retropubic approach – the incision is made in the lower abdomen (from just below the navel to the pubic bone). This allows direct access to both the prostate and nearby lymph nodes.

  Perineal Approach – the incision is made between the scrotum and anus. This offers a shorter path to the prostate but doesn't easily allow for lymph node removal.

  When it's used:
  - When minimally invasive technology (laparoscopic or robotic) is unavailable or not suitable
  - In patients where the surgeon prefers direct, tactile control or where visualization is easier via open ac - cess (e.g., very large prostate, complex pelvic anatomy)
  - In some low-resource settings where open surgery remains standard
  - The perineal version is rarely used except in specific cases where lymph nodes don't need to be removed or previous abdominal surgery makes an abdominal approach risky

- **Laparoscopic Radical Prostatectomy –** this technique uses several small incisions in the lower abdomen through which a camera (laparoscope) and surgical instruments are inserted. The surgeon views the operative field on a monitor and manually manipulates long instruments to remove the prostate and associated structures.

  When it's used:
  - For patients with localized prostate cancer (confined to the gland) who are candidates for minimally invasive surgery
  - When robotic systems are unavailable but minimally invasive benefits are desired - such as smaller incisions, less blood loss, and shorter hospital stays
  - In centers where surgeons have specialized laparoscopic training and experience

- **Robotic-Assisted Laparoscopic Radical Prostatectomy –** this advanced form of laparoscopic surgery allows the surgeon to operate from a robotic console, manipulating wristed instruments that provide exceptional precision, flexibility, and 3D high-definition visualization. The robotic system doesn't act autonomously, it enhances the surgeon's control, stability, and accuracy throughout the procedure.

When it's used:

- It is the most common form of radical prostatectomy in many developed countries
- Ideal for localized prostate cancer in patients who are good surgical candidates and wish to minimize downtime
- Preferred for men who prioritize nerve-sparing (for continence and erectile function) because the robot's enhanced visualization can help preserve delicate nerves and structures
- Often used for men with moderate risk or even select high-risk cancers if the disease is still surgically resectable

- **Radical Perineal Prostatectomy –** the surgeon removes the prostate through an incision made in the perineum (the area the scrotum and anus). The surgeon works through a shorter route, directly reaching the prostate without entering the abdominal cavity.

When it's used:

Rarely chosen today, but may be considered in select patients:

- Those who have had extensive prior abdominal surgery (which would make abdominal access difficult or risky)
- When lymph node dissection is not necessary (since it's hard to access nodes from this approach)
- When minimizing abdominal trauma is a priority, such as in patients with significant co-morbidities

Following a prostatectomy, recovery timelines vary slightly depending on the type of surgical procedure, but the general progression of healing, mobility, and activity follows a similar pattern.

Patients who undergo an open radical prostatectomy typically remain in the hospital for two to four days, as this approach involves a larger incision and greater tissue disruption.

Those who have laparoscopic or robotic-assisted procedures are usually discharged sooner. most within 24- 48 hours, since these minimally invasive methods result in less blood loss, reduced postoperative pain, and quicker mobilization A radical perineal prostatectomy also tends to require a 1- day stay, though recovery discomfort is localized in the perineal area and may make sitting difficult for several days.

Walking is encouraged as soon as possible - often within 6-12 hours after surgery for robotic and laparoscopic patients, and within 24 hours for open procedures. The first walks should be short and slow, limited to a few minutes several times per day around the hospital room or hallway. The goal is to promote blood flow, prevent blood clots, and reduce gas buildup from anesthesia. During the first week, walking should be gentle and intermittent, totaling ten to fifteen minutes several times per day. By the second week, most men can tolerate 20-30 minutes of continuous walking at a light pace, as long as they avoid hills, stairs, or carrying anything heavy. Intensity should remain light, breathing should be easy, and conversation possible throughout the activity.

A urinary catheter is almost always placed during surgery and remains for about 7-14 days, depending on the procedure and how well the bladder-urethra connection heals. Catheter duration may be slightly shorter after robotic surgery, since the precision of robotic suturing can reduce leakage and irritation at the anastomosis site. While the catheter is in place, pelvic floor (Kegel) exercises should not be started, as premature activation can disrupt healing and increase discomfort. Once the catheter is removed and urination resumes normally, gentle pelvic floor exercises can begin - usually around days 10-14 post-surgery. Early sessions focus on awareness and light contractions lasting 2-3 seconds for 3-5 repetitions several times per day. The goal at this stage is retraining control rather than building strength.

Strenuous activities including resistance training, running, vigorous cycling, swimming, and contact sports, should be avoided for at least 6-8 weeks after surgery. This precaution prevents stress on the pelvic floor, abdominal incision, and internal sutures.

After eight weeks, light resistance training and moderate aerobic activity can be reintroduced gradually, provided there is no pain, urinary leakage, or fatigue. True strenuous exertion (defined as lifting more than twenty pounds), high-impact movement, or exercises that cause abdominal straining) should typically wait until ten to twelve weeks postoperatively and only after surgeon clearance.

Cycling requires particular caution. The prostate bed and perineum remain highly sensitive for several months following surgery. Pressure from a traditional bicycle seat can cause pain, swelling, or delayed healing. Most urologists recommend avoiding cycling for at least twelve weeks, and longer if significant perineal tenderness persists. When patients resume cycling, it is best to use a recumbent or noseless saddle, keep resistance low, and limit sessions to short durations until full comfort returns.



Potential Side-effects of a Prostatectomy:

- Urinary incontinence
- Bleeding and transfusion risk
- Infection and wound complications
- Lymphedema (if lymph nodes are removed)
- Chronic constipation or bowel dysfunction
- Rectal injury (rare) w/perineal procedure
- Deep vein thrombosis
- Depression and anxiety
- Abdominal or pelvic soreness
- Rectal injury (rare) w/perineal procedure
- Deep vein thrombosis
- Depression and anxiety

- **Transurethral Resection of the Prostate (TURP) –** surgical removal of the prostatic tissue to relieve symptoms. The surgeon passes a flexible cytoscope through the urethra and into the prostate. An electrified wire loop is inserted through the scope and used to cut away the tumor or nonmalignant tissue that is obstructing the flow of urine. This procedure would typically be used for a patient who was diagnosed late in the course of the disease and didn't respond to traditional medical therapy, or who chose watchful waiting and then had progressive local disease that caused bladder outlet obstruction. It is a palliative treatment for relieving pain and restoring normal urine flow. The operation usually takes about an hour.

  After surgery, a catheter is inserted through the penis into the bladder. It remains in place for 1-3 days to help urine drain while the prostate heals. The patient can usually leave the hospital after 1-2 days and return to work in 1-2 weeks. Patients can start doing pelvic floor muscle exercises again as soon as their catheter has been removed (usually one to three weeks after surgery).

When it's used:

- is reserved for cases where conservative treatments such as alpha-blockers or 5-alpha reductase inhibitors have failed, are not tolerated, or where the severity of symptoms or complications warrants more immediate surgical relief
- It is typically used for prostates of moderate size

Potential Side-effects of TURP:

- Catheter discomfort
- Bleeding
- Burning or frequency with urination
- Urinary tract infection (UTI)
- TURP Syndrome

TURP Syndrome Side-effects

Body System	Side Effects/Manifestations
Neurologic	Confusion, agitation, restlessness, headache, dizziness, blurred vision, nausea, vomiting, seizures, coma
Cardiovascular	Hypertension (early), hypotension (late), bradycardia, irregular heartbeat (arrhythmias), chest pain, cardiac arrest (severe cases)
Respiratory	Shortness of breath, pulmonary edema, low oxygen levels, respiratory distress
Visual	Blurred vision, temporary visual loss, light sensitivity (from glycine absorption
Metabolic/Systemic	Hyponatremia (low sodium), fluid overload, hypothermia, fatigue, weakness
Musculoskeletal	Muscle twitching, cramping or tremors due to electrolyte imbalance

• **Bi-lateral Orchiectomy –** is the surgical removal of the testicles, through a small incision in front of the scrotum. This is considered the most effective method of hormonal ablation therapy.

Although patients can go home a few hours after the procedure, it may take two weeks - two months for full recovery. Patients should not lift anything over ten pounds for the first two weeks.

Potential Side-effects of Bi-lateral Orchiectomy:

- Local pain and swelling
- Bruising or hematoma
- Infection
- Decreased muscle mass and strength
- Osteoporosis
- Mood swings
- Weight gain, increase in body fat, and insulin resistance
- Higher risk of metabolic syndrome
- Slightly increased long-term risk of cardiovascular disease

Types of Treatment Used:

- Androgen Deprivation Therapy
- Brachytherapy
- Chemotherapy
- Cryotherapy
- External Beam Radiation Therapy
- High-Intensity Focused Ultrasound
- Laser Ablation / Focal Laser Therapy
- PARP Inhibitor Therapy
- Photodynamic Therapy
- Proton Beam Therapy
- Radioligand Therapy
- Targeted Therapy
- Transurethral Microwave Therapy



Hormone-Refractory Prostate Cancer (HRPC)

Also known as castration-resistant prostate cancer (CRPC), occurs when prostate cancer progresses despite testosterone suppression through androgen deprivation therapy or bilateral orchiectomy. At this stage, disease is typically systemic, affecting bones, lymph nodes, and sometimes the lungs or liver. Treatment transitions from hormonal therapy alone to combination approaches that may include androgen receptor inhibitors (enzalutamide, apalutamide, darolutamide), androgen synthesis blockers (abiraterone with prednisone), chemotherapy (docetaxel or cabazitaxel), bone-targeted therapies (radium-223, bisphospho- nates), immunotherapy (sipuleucel-T), or radioligand therapy (lutetium-177-PSMA). Palliative and supportive care remain central for symptom control and quality of life. HRPC presents challenges such as fatigue, muscle loss, increased risk of osteoporosis, and depression/anxiety. With appropriate medical management, exercise, and nutrition, many men today experience extended survival and improved daily function, as HRPC increasingly behaves like a chronic, controllable condition rather than an immediate terminal phase.



LUNG CANCER

Lung cancer is the most commonly occurring cancer in men and the third most commonly occurring cancer in women, and it is the leading cause of cancer death worldwide (Bray et al., CA: A Cancer Journal for Clinicians, 2024). There were 2,480,675 new cases and 1,817,469 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Lung cancer has replaced breast cancer as the primary cause of cancer death in women globally.

Tobacco use remains the leading risk factor, responsible for approximately 80% of lung cancer deaths (CDC, Lung Cancer Risk Factors, 2024). The remaining 20% of cases arise mainly from occupational and environmental exposures including radon gas, asbestos, and secondhand cigarette smoke (CDC, Lung Cancer Risk Factors, 2024). The incidence of lung cancer decreases when smoking is stopped, and after approximately fifteen years the risk approaches that of a nonsmoker. While cigarette smoking is by far the most important risk factor, risk increases with both the quantity of cigarettes smoked and the duration of smoking. Cigar and pipe smoking also contribute to lung cancer risk. Exposure to radon gas released from soil and building materials is estimated to be the second leading cause of lung cancer in Europe and North America (WHO, Lung Cancer, 2024). Additional risk factors include exposure to secondhand smoke, asbestos, metals containing chromium, cadmium, and arsenic, radiation, air pollution, diesel exhaust, certain organic chemicals, and a history of tuberculosis (CDC, Lung Cancer Risk Factors, 2024).

Nearly half of all lung cancer patients will be diagnosed with metastatic disease at the time of presentation. Lung cancer cells that break off from the original tumor often form a secondary tumor in the brain, and an isolated secondary tumor is potentially curable if treated promptly with chemotherapy and surgery. Only about one in six lung cancers is diagnosed at a localized stage. Current five-year survival rates have improved significantly from earlier estimates: for localized non-small cell lung cancer the five-year survival rate is now approximately 67%, dropping to approximately 40% for regional disease and 9% for distant metastatic disease (NCI, SEER Cancer Statistics, 2024; ACS, Lung Cancer Survival Rates, 2024). The overall five-year survival rate for all stages of non-small cell lung cancer is 32%, compared to approximately 9% for small cell lung cancer, which reflects the more aggressive nature of small cell disease (ACS, Lung Cancer Survival Rates, 2024). There are two main types of lung cancer:

- **Non-Small Cell (NSCLC) –** accounts for approximately 80-85% of all lung cancer diagnoses and includes three main subtypes (ACS, What Is Lung Cancer?, 2024)
    - **Adenocarcinoma –** forms in mucus-producing epithelial cells, typically in the outer regions of the lung. It is the most common lung cancer in never-smokers, particularly women, and tends to grow more slowly than other types.
    - **Squamous-Cell Carcinoma (Epidermoid) –** arises in the bronchi and is more strongly associated with smoking than any other lung cancer type. Well-differentiated tumors tend to grow more slowly than other subtypes.
    - **Large Cell Carcinoma –** can appear in any part of the lung and tends to grow and spread quickly. A subtype, large cell neuroendocrine carcinoma (LCNEC), is highly aggressive and biologically similar to small cell lung cancer.
- **Small Cell Lung Cancer (SCLC) –** also called oat-cell cancer, accounts for approximately 10-15% of lung cancers. It typically originates in the central portion of the lung and is extremely aggressive, spreading to lymph nodes and distant organs rapidly. Most patients have metastatic disease at the time of diagnosis (ACS, What Is Lung Cancer?, 2024).
- **Mesothelioma –** is a separate and distinct cancer from lung cancer. It arises from the mesothelium - the membrane lining the chest cavity (pleura), abdominal cavity (peritoneum), or less commonly the pericardium. Asbestos exposure is the primary and established cause, present in the history of more than 90% of cases (ACS, Causes, Risk Factors, and Prevention of Mesothelioma, 2024; Betancourt et al., Cureus, 2025).

Procedures:

- **Lobectomy –** lobectomy is the surgical removal of one complete lobe of the lung - the right lung has three lobes (upper, middle, and lower), while the left has two (upper and lower). It is considered the standard and most common curative procedure for non-small cell lung cancer (NSCLC) that is confined to a single lobe and has not spread to distant tissues. During the procedure, the surgeon removes the affected lobe along with its associated blood vessels, bronchial branch, and nearby lymph nodes to ensure complete excision of the tumor and accurate staging.

  Lobectomy can be performed through:
  - Open thoracotomy – a large incision is made between the ribs
  - Minimally invasive approaches such as video-assisted thoracoscopic surgery (VATS) or robotic-assisted lobectomy, which use smaller incisions, cameras, and specialized instruments

When it's used:

- Considered the gold standard for most cases of early- to mid-stage NSCLC confined to one lobe
- Performed when the patient has sufficient pulmonary reserve and overall fitness for surgery
- May be done through open thoracotomy or minimally invasive techniques such as VATS or robotic-assisted lobectomy

Following a lobectomy, most patients remain in the hospital for approximately 3-7 days, depending on the surgical approach and overall recovery rate. Those undergoing minimally invasive techniques such as VATS or robotic surgery typically experience shorter stays than patients recovering from an open thoracotomy. During this period, the focus is on pain management, maintaining lung expansion through breathing exercises, and gradually increasing mobility to prevent complications such as pneumonia or blood clots. Patients are encouraged to begin walking short distances as soon as possible, progressing slowly as energy and comfort allow.

Once discharged, the first four weeks of recovery are characterized by fatigue, mild breathlessness, and soreness at the incision site. Daily activities are performed at a relaxed pace, with plenty of rest periods and an emphasis on allowing the lung to heal.

Lifting, pushing, or pulling heavy objects should be avoided, as should any actions that cause straining or discomfort. It is important to maintain good posture, take deep breaths regularly, and allow the body to rebuild stamina naturally. Between weeks 5-8, energy levels gradually improve, though patients may still tire easily with exertion. Light household activities and short walks become easier, and breathing becomes more efficient as lung function continues to recover. It remains essential to avoid overexertion or high-impact activity, as the internal tissues and chest wall are still healing. Individuals should listen to their bodies, increase movement gradually, and stop any activity that causes pain, shortness of breath, or fatigue.

By weeks 9-12, most patients regain a significant portion of their preoperative strength and lung function, though endurance may still be lower than normal. At this stage, daily living tasks can generally be performed without assistance, and light to moderate activity is well tolerated. Strenuous exercise, heavy lifting, or high-intensity physical effort should still be postponed until cleared by the surgeon. Throughout the three-month recovery period, the key priorities are maintaining gentle, consistent movement, protecting the healing tissues, and progressing gradually to restore confidence, mobility, and overall well-being.

- **Segmentectomy (Segmental Resection) –** also known as segmental resection, it involves the surgical removal of one or more anatomical segments within a single lobe of the lung. By removing only the affected segment(s), this procedure preserves a greater portion of healthy lung tissue than a lobectomy, while providing more complete removal than a wedge resection. Segmentectomy is most often used for early-stage non–small cell lung cancer (NSCLC) when the tumor is small (≤2 cm), localized, and surrounded by normal lung tissue, or when the patient has limited pulmonary reserve due to conditions such as emphysema or COPD. It's also appropriate for patients with small, slow-growing, or ground-glass-appearing tumors detected on screening CT scans, as well as for certain metastatic lesions confined to one segment.

This lung-sparing approach is typically performed using video-assisted thoracoscopic surgery (VATS) or robotic-assisted surgery, which allows for precise dissection of segmental bronchi and vessels with minimal trauma. Hospital stays are generally 3-5 days, and recovery is faster and less painful than after open thoracotomy.

Segmentectomy has gained prominence following recent trials (such as JCOG0802 and CALGB 140503),which showed comparable survival rates to lobectomy for small, early-stage tumors. Because less lung tissue is removed, postoperative breathing capacity is better preserved, making it an excellent option for older adults or those with preexisting lung disease.

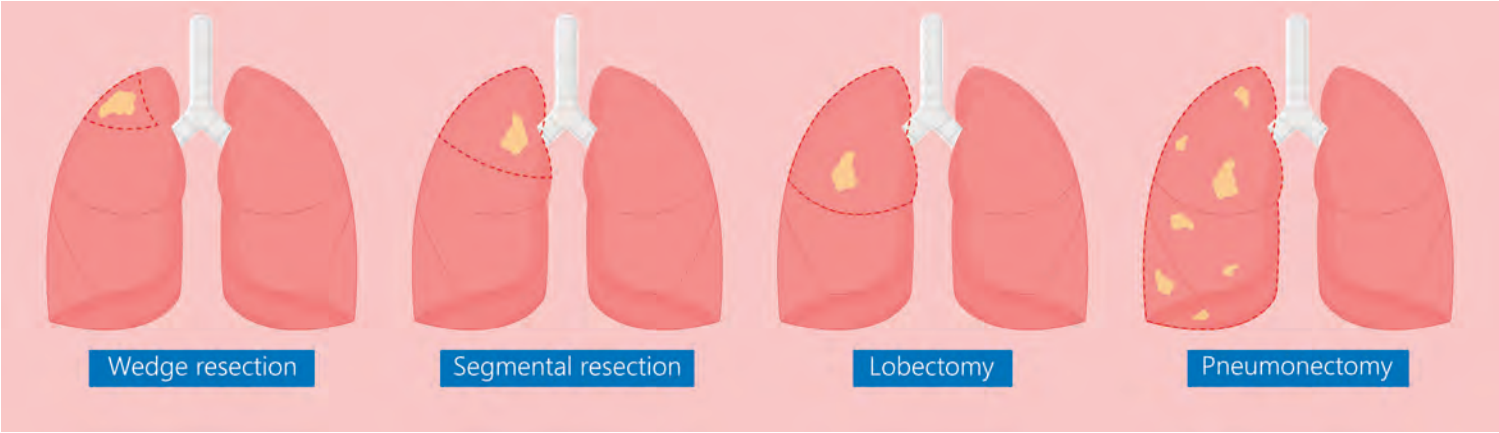
When it's used:

- Increasingly performed for small, early-stage NSCLC tumors (<2 cm), particularly in patients with reduced lung function
- Selected when the tumor is peripherally located and clear margins can be obtained
- Now accepted as oncologically equivalent to lobectomy in carefully selected Stage IA cases

Following a segmentectomy, most patients remain in the hospital for 3-5 days, with the focus on pain control, lung expansion, and prevention of complications such as infection or air leaks. Walking begins soon after surgery, and breathing exercises are encouraged to support lung re-expansion and circulation. During the first month at home, activity should remain light and paced with frequent rest. Patients should avoid lifting, pushing, or pulling anything heavier than about 5-10 pounds, as excessive strain can interfere with internal healing and increase discomfort.

From weeks 5-8, energy levels improve and breathing becomes easier, allowing for a gradual return to normal household activities and short walks. Lifting limits may increase slightly to around 15 pounds if there is no pain or shortness of breath, but strenuous activity or heavy resistance exercise should still be avoided.

By weeks 9-12, most individuals can resume moderate daily activity with improved stamina and confidence. Light strength training may be introduced if cleared by the surgical team, but heavier lifting and high-intensity workouts should wait until the chest and lung have fully healed - usually around three months or longer. Overall, recovery after segmentectomy emphasizes steady progress, careful pacing, and gradual reconditioning to restore comfort, strength, and lung function safely.



- **Wedge Resection –** involves removing a small, wedge-shaped portion of lung tissue that contains the tumor along with a thin margin of surrounding healthy tissue. Unlike a lobectomy or segmentectomy, this procedure does not follow the natural anatomic divisions of the lung - it simply excises the localized area where the tumor sits. Because it removes the least amount of tissue, it is considered the most conservative and lung-sparing of all curative resections.

  Wedge resection is primarily used in patients with early-stage non-small cell lung cancer (NSCLC) who have small, peripheral tumors typically less than 2 cm in size. It is also chosen when a patient's lung function or general health wouldn not safely tolerate a more extensive surgery, such as a lobectomy or segmentectomy. Common examples include older adults, individuals with severe COPD, or those with multiple co-morbidities. In addition to primary lung cancer, wedge resections are also used for diagnostic purposes. While wedge resection provides an important surgical option for select patients, it has a slightly higher recurrence risk compared to lobectomy because less surrounding tissue and lymph nodes are removed. Therefore, it's best suited for very small, well-defined, and early lesions or when preserving lung capacity akes priority overextensive tumor clearance.

  When it's used:

  - For very small, peripheral tumors in patients who cannot tolerate a larger resection
  - Often chosen for frail or elderly patients, or those with impaired lung function
  - Sometimes used for diagnostic or metastasectomy (removal of metastases from another primary cancer)

Following a wedge resection, most patients stay in the hospital for 2-4 days, depending on the surgical approach and how quickly their lung re-expands after surgery. During this time, the focus is on managing pain,preventing infection, and encouraging gentle movement and breathing exercises to keep the lungs clear. Patients are typically encouraged to walk short distances within the first day or two to promote circulation and reduce the risk of complications.

During the first month at home, recovery should proceed slowly and without physical strain. Fatigue, mild shortness of breath, and incision discomfort are common. Activity should be limited to light daily tasks, and lifting should be restricted to no more than 5-10 pounds. Pushing, pulling, or reaching overhead should also be avoided, as these movements can increase discomfort or slow healing. The goal during this phase is to maintain gentle movement, proper posture, and steady breathing while the surgical site heals internally.

Between weeks 5-8, most patients begin to notice improved stamina and easier breathing. Normal household tasks and short walks become more comfortable, but activity should still be approached gradually. Lifting limits may increase to around 15 pounds if there is no pain, swelling, or shortness of breath. Strenuous activity, resistance exercise, or any movement that causes strain should be postponed until cleared by the surgeon.

By weeks 9-12, the majority of patients feel stronger and are able to manage normal daily activities with minimal fatigue. Light strength or conditioning exercises may be introduced under medical guidance, though heavier lifting and intense exertion should be delayed until full healing has occurred - typically around three months. Overall, recovery from a wedge resection focuses on gradual progression,avoiding excessive strain, and allowing the lung and chest wall to adapt safely to normal function.

- **Video-Assisted Thoracoscopic Surgery (VATS) –** a minimally invasive surgical approach using small incisions, a thoracoscope (camera), and specialized instruments to perform lobectomy, segmentectomy, or wedge resection.

When it's used:

- For early-stage lung cancer when tumor size, location, and patient anatomy permit
- Reduces pain, hospital stay, and complications compared to open thoracotomy

- **Sleeve Lobectomy –** involves removing one lobe of the lung along with a segment of the bronchus (the main airway) that contains the tumor, then surgically reconnecting the remaining bronchial ends to preserve the rest of the lung. This complex but highly effective operation allows for complete tumor removal while maintaining as much healthy lung tissue and function as possible. It is considered a lung-preserving alternative to pneumonectomy, which removes the entire lung.

This procedure is most often used for centrally located non-small cell lung cancers (NSCLC) that involve the main bronchus or lobar bronchus but have not spread extensively to surrounding lung tissue or lymph nodes. It is also appropriate for certain carcinoid tumors or benign airway tumors that would otherwise require a full pneumonectomy to achieve clear margins. By sparing the unaffected lobes, sleeve lobectomy helps reduce long-term respiratory complications and improves quality of life after surgery.

When it's used:

- For centrally located tumors that involve the main bronchus but do not require removing the entire lung
- Preferred over pneumonectomy because it preserves lung function while achieving clear margins

Following a sleeve lobectomy, most patients remain in the hospital for approximately 5-7 days, as this surgery involves removing one lobe of the lung along with a section of the bronchus and then reconnecting the airway. The initial recovery period focuses on pain control, monitoring the new bronchial connection for leaks or narrowing, and promoting lung expansion through deep breathing and controlled coughing. Patients are encouraged to sit upright and begin short, assisted walks within the first 24-48 hours to improve circulation and prevent complications such as pneumonia or blood clots.

During the first four weeks after discharge, energy levels are often low, and fatigue, mild shortness of breath, or incision discomfort are common. Activity should remain light and well-paced, with frequent rest periods throughout the day. Lifting, pushing, or pulling objects heavier than 5-10 pounds should be avoided, and overhead reaching should be limited to prevent strain on the healing chest wall and airway. Maintaining upright posture and consistent, relaxed breathing helps restore lung function and prevent stiffness in the shoulders and chest.

Between weeks 5-8, patients typically notice gradual improvement in stamina and breathing. Light daily activities become easier, and short walks can be extended as comfort allows, provided there is no pain or breathlessness. Lifting restrictions may increase slightly to around 15 pounds if the surgeon confirms proper healing. However, strenuous activity, resistance training, and high-intensity exercise should still be avoided to protect the bronchial connection and prevent airway complications.

By weeks 9-12, most patients feel stronger and more capable of handling regular daily activities. Breathing becomes smoother and more efficient, though endurance may still lag slightly behind pre-surgery levels. Light strength or conditioning exercises may be introduced with medical approval, focusing on gradual progression rather than intensity. Lifting heavier weights or performing demanding physical activity should wait until full healing is confirmed - typically three months or longer. Overall, recovery after a sleeve lobectomy should be steady and deliberate, emphasizing protection of the airway repair, gentle activity progression, and restoration of comfort and functional breathing.

- **Pneumonectomy –** the complete surgical removal of one entire lung, including all its lobes, blood vessels, and the associated main bronchus on that side. It is the most extensive type of lung resection and is typically performed when a tumor involves multiple lobes, the main bronchus, or the central structures of the lung, making lesser resections (such as lobectomy or sleeve lobectomy) inadequate for complete removal. Because it removes an entire lung, the procedure demands significant physiological reserve and is reserved for patients with strong cardiac and pulmonary function.This surgery is most often indicated for centrally located non-small cell lung cancers (NSCLC), particularly those invading the main pulmonary artery, main bronchus, or mediastinal structures where a clear margin cannot be achieved otherwise. It may also be performed for rare extensive carcinoid tumors, certain mesotheliomas, or recurrent disease after previous lung surgery when localized to one side.

When it's used:

- For large or central tumors involving multiple lobes, the main pulmonary artery, or hilum.
- Considered only in patients with excellent lung and cardiac function who can tolerate losing an entire lung.

Following a pneumonectomy, most patients stay in the hospital for about 7-10 days, as this is the most extensive type of lung surgery and requires close monitoring of breathing, heart rhythm, and fluid balance. Patients are usually encouraged to sit upright and begin short, slow walks within the first couple of days to maintain circulation and prevent complications such as pneumonia or blood clots. Breathing exercises and coughing techniques are introduced early, though they may initially feel difficult due to reduced lung capacity.

During the first four weeks after discharge, recovery should proceed cautiously. Fatigue, shortness of breath, and discomfort around the incision are common, and patients should allow for frequent rest breaks between light activities. Lifting, pushing, or pulling anything heavier than 5-10 pounds should be avoided to prevent stress on the chest wall and to allow the internal tissues to heal properly. Movements involving bending, twisting, or overhead reaching can increase strain and should also be minimized. Maintaining an upright posture, practicing .

Between weeks 5-8, gradual improvement in stamina and comfort is expected, though energy levels may still fluctuate. Light household activities and gentle walking can be increased slowly, as long as they do not cause breathlessness or pain. Lifting limits may rise modestly to around 10-15 pounds if the surgeon confirms adequate healing, but strenuous activity, resistance training, and high-impact exercise remain off-limits.

Because only one lung remains, patients should take extra care to avoid respiratory infections and to maintain strong breathing habits throughout the day.

By weeks 9-12, most patients are capable of managing basic daily activities with better energy and control, though endurance and strength remain reduced compared to pre-surgery levels. Light to moderate activity is generally tolerated, but recovery should remain gradual and free of strain. Lifting heavier objects or engaging in physically demanding tasks should be delayed until the surgeon confirms full internal healing - often at or beyond the three-month mark. Over time, the remaining lung expands and compensates for some of the lost capacity, but long-term recovery focuses on maintaining efficiency of breathing, conserving energy, and supporting quality of life through consistent, steady movement.

- **Thoracotomy –** a surgical incision made into the chest wall to provide direct, open access to the lungs, heart, esophagus, or mediastinum. It serves as a primary surgical approach rather than a specific cancer-removal procedure and allows surgeons to perform complex operations such as lobectomy, pneumonectomy, tumor removal, or repair of major vessels and airways. The incision is typically made between the ribs on the side of the chest (posterolateral or anterolateral thoracotomy), spreading or occasionally removing part of a rib to gain a clearfield of view. Thoracotomy is generally performed when a minimally invasive approach - such as video-assisted thoracoscopic surgery (VATS) or robotic-assisted surgery - is not feasible due to the tumor's size, location, or extent of invasion. It is also required for emergencies, such as traumatic lung injuries or cases where bleeding or adhesions prevent the safe use of smaller incisions.

When it's used:

- As an approach rather than a cancer-specific procedure
- Used for large or complex resections, tumors invading chest wall or vessels, or when minimally invasive surgery isn't possible

Following a thoracotomy, most patients remain in the hospital for 5-10 days, depending on the extent of the surgery and overall recovery progress. Because this procedure involves spreading or removing part of a rib to access the chest cavity, postoperative pain and stiffness are typically more significant than with minimally invasive approaches. Early recovery focuses on pain control, maintaining lung expansion through deep breathing, and encouraging gentle movement to prevent complications such as pneumonia or blood clots. Patients are usually encouraged to begin sitting up and walking short distances within the first day or two to promote circulation and support lung function.

During the first four weeks after discharge, activity should be limited to short, low-effort movements performed at a comfortable pace. Fatigue, soreness, and restricted shoulder mobility on the operated side are common. Lifting, pushing, or pulling anything heavier than 5-10 pounds should be avoided, and overhead movements should be minimized to reduce stress on the incision and chest muscles. Posture awareness, steady breathing, and gentle arm movement within pain-free limits help prevent stiffness and support healing.

Rest periods throughout the day are essential to prevent overexertion and manage fatigue. Between weeks 5-8, most patients begin to experience gradual improvement in breathing and mobility, though some discomfort with deep inhalation or stretching may persist. Walking and light daily activities can be increased slowly, but effort should remain moderate and controlled. Lifting limits may increase slightly to about 15 pounds if there are no signs of strain or swelling. Activities that cause pain or fatigue should be avoided, and any return to work or structured exercise should be discussed with the healthcare team.

By weeks 9-12, patients typically regain greater comfort and flexibility in the chest and shoulder, with improved endurance for daily activities. Light to moderate movement, such as extended walking or household chores, is generally well tolerated. However, some individuals may continue to experience mild numbness or tightness around the incision, which can persist for several months. Heavier lifting and high-intensity exercise should be postponed until the surgical team confirms full recovery - typically around three months or later. The overall focus after thoracotomy is on gradual, steady improvement, allowing the chest wall to heal while restoring posture, breathing coordination, and confidence in movement.

- **Mediastinoscopy –** is most often performed to determine whether lung cancer has spread to mediastinal lymph nodes. before deciding on a surgical treatment plan, such as lobectomy or pneumonectomy. Mediastinoscopy is typically done under general anesthesia and takes about one hour. Because the incision is small and the scope is guided carefully alongside the windpipe, the procedure is minimally invasive compared to open chest surgery. It may also be used to diagnose other conditions such as sarcoidosis, lymphoma, or infections like tuberculosis that affect mediastinal lymph nodes.

When it's used:

- For staging lung cancer (determining if mediastinal lymph nodes are involved before major surgery)
- Also used to diagnose mediastinal masses or lymphomas

- **Thoracoscopy (Pleuroscopy) –** a minimally invasive procedure allows the surgeon to directly visualize the lungs, pleura (the lining around the lungs), and chest cavity. It can be performed for both diagnostic and therapeutic purposes. Diagnostic thoracoscopy is often used when imaging or needle biopsy results are inconclusive. It enables direct sampling of pleural tissue or fluid to diagnose conditions such as lung cancer, mesothelioma, pleural effusion,tuberculosis, or inflammatory diseases. Therapeutically, thoracoscopy may be used to drain fluid or air from the pleural space, remove small tumors, or perform pleurodesis - a procedure that seals the pleural layers together to prevent recurrent fluid buildup.

When it's used:

- For diagnosis or management of pleural disease, pleural effusions, or pleural metastases
- Sometimes used therapeutically for pleurodesis (fusion of pleura to prevent fluid buildup)

- **Thoracentesis –** is a needle-based procedure used to remove excess fluid or air from the pleural space - the area between the lungs and the inner chest wall. It is typically performed for diagnostic or therapeutic purposes and is one of the least invasive interventions involving the chest. During the procedure, a thin needle or catheter is inserted through the chest wall, often guided by ultrasound, to safely withdraw fluid or relieve pressure around the lung. From a diagnostic s standpoint, thoracentesis helps identify the cause of pleural effusion (fluid buildup), which may result from cancer, infection, heart failure, or inflammatory conditions. The collected fluid is analyzed for signs of infection, malignancy, or biochemical changes. Therapeutically, thoracentesis can provide immediate relief from shortness of breath, chest tightness, or discomfort caused by the accumulation of fluid or air.

When it's used:

- To relieve shortness of breath in patients with pleural effusion caused by cancer or other conditions
- For diagnostic sampling of pleural fluid

> Patients typically will need to spend 5-7 days in the hospital after any major lung surgery. Full recovery from lung cancer surgery typically takes several weeks - several months. If the surgery is done through a thoracotomy, the surgeon must spread ribs to get to the lungs, so there may be pain in the incision site for quite some time after surgery. Activity should be limited for at least a month or two. People who have VATS instead of thoracotomy tend to have less pain after surgery and to recover more quickly.
>
> No lifting or carrying anything heavier than 10 pounds for two weeks after VATS (up to eight weeks for open surgery). Be careful when using the arms and upper body for the first six weeks.
>
> Many lung cancer patients experience shortness of breath and have difficulty breathing. Restoring breathing will help with endurance and quality of life and will enable lung cancer patients to accomplish their activities of daily living with greater ease.

Teach diaphragmatic breathing through pursed lips as it will strengthen the diaphragm and the abdominal muscles. This will allow more air to move in and out of the lungs with less tiring of the chest muscles. When the diaphragm becomes weak, the patient compensates by using the shoulders and other muscles to help them breathe. Patients with shortness of breath and limited breathing capacity due to their cancer should perform upper body stretching exercises daily to increase lung capacity.

A stretching program will restore mobility in the chest and back that allows for easier movement of the lungs and diaphragm. Make sure not to apply pressure against the chest either in prone position or against equipment if there is pain or discomfort.



Potential Side-effects of all Lung Cancer Surgeries:

- Pain or discomfort at the incision site
- Fatigue and weakness
- Shortness of breath, especially with exertion
- Temporary cough or sore throat (from intubation)
- Risk of infection (wound or pneumonia)
- Risk of bleeding or blood clots (DVT, pulmonary embolism)
- Air leak from lung tissue (prolonged if healing is slow)
- Shoulder or chest wall stiffness
- Emotional distress or anxiety related to breathing changes

Types of Treatment Used:

- Ablative therapies (radiofrequency ablation, microwave ablation)
- Anti-angiogenic therapy
- Chemotherapy
- Immunotherapy
- Precision/targeted therapy
- Radiotherapy

CANCER OF THE COLON/RECTUM

Colorectal cancer is the third most commonly occurring cancer worldwide. There were 1,926,425 new cases and 904,019 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Incidence rates have been decreasing overall for most of the past two decades due to colorectal cancer screening tests that allow for early detection and removal of polyps before they turn into cancer. However, incidence rates have increased by approximately 2.9% per year in people younger than 50 and 0.4% per year in adults aged 50-64, and colorectal cancer has now become the leading cause of cancer death in men under 50 and the second leading cause in women of the same age group (ACS, Colorectal Cancer Statistics, updated 2024).

Colorectal cancer refers to cancer of the large intestine. The first five feet of the intestine is called the colon and the last 6-8 inches is called the rectum. Because it is sometimes difficult to pinpoint a tumor in the large bowel, the colon and rectum are often grouped together as the colorectum. Colon cancer and rectal cancer share many features in common. Most colorectal cancers start as a growth on the inner lining of the colon or rectum called a polyp. Some types of polyps can change into cancer over the course of many years, but not all polyps will become cancerous. The chance of a polyp becoming cancerous depends on the type of polyp. The main types of polyps are (ACS, What Is Colorectal Cancer?, 2024):

- Adenomatous Polyps (adenomas)
- Hyperplastic Polyps and Inflammatory Polyps
- Sessile Serrated Lesions

Other factors that can increase someone's risk of developing colorectal cancer include having a polyp larger than 1 cm, having more than two polyps, or if dysplasia is seen in the polyp after it is removed (American Cancer Society, 2024). The colon is divided into four sections: the ascending colon, transverse colon, descending colon, and sigmoid colon. Most colorectal cancers arise in the sigmoid colon.Any change in bowel habits that persists for more than two weeks warrants prompt evaluation by a medical professional. Symptoms that should not be ignored include persistent narrowing of the size of the stools, gas pains, cramps, rectal bleeding or blood in the stool, and unexplained fatigue or weight loss. In 2024, the Center for Disease Control has indicated that the following lifestyle factors increase the risk of colorectal cancer (ACS, Colorectal Cancer Risk Factors, 2024; Wagle et al., CA: A Cancer Journal for Clinicians, 2025):

- Diet - high consumption of red meat and processed meat (bacon, sausage, hot dogs), low-fiber diet, high-fat diet, low intake of calcium and vitamin D, and high consumption of ultra-processed foods
- Sedentary lifestyle and lack of regular exercise
- Obesity, particularly having excess fat in the waist area, rather than the hips or thighs
- Gut microbiome dysbiosis - an imbalanced gut microbiome, influenced by diet and lifestyle, is increasingly recognized as a contributing factor
- Cigarette smoking - both the number of cigarettes per day and smoking initiation are associated with increased risk
- Moderate to heavy alcohol intake; studies consistently show that consumption above moderate levels significantly increases colorectal cancer risk, with heavy drinking associated with a 26% increased risk of distal colon cancer in men and a dose-response relationship confirmed across tumor sites and beverage types
- Inherited genetic conditions (lynch Syndrome & hereditary non-polyposis colorectal cancer or familial adenomatous polyposis (FAP)
- Type 2 diabetes - insulin resistance and elevated blood glucose create a pro-inflammatory environment that promotes tumor development
- Having a personal history of high-risk colorectal polyps
- Inherited genetic conditions, including Lynch Syndrome and familial adenomatous polyposis (FAP)

Types of Colorectal Cancer:

There are many types of colorectal cancer, the most common of which is adenocarcinoma, accounting for approximately 95% of all colorectal cancers. Rarer types include carcinoid tumors, gastrointestinal stromal tumors, and colorectal lymphoma (NCI, Rectal Cancer Treatment PDQ, 2024; ACS, What Is Colorectal Cancer?, 2024). Hereditary colorectal cancers - meaning that several generations of a family have had colorectal cancer - include hereditary nonpolyposis colorectal cancer (HNPCC/Lynch syndrome) and familial adenomatous polyposis (FAP) (ACS, Colorectal Cancer Risk Factors, 2024).

Although colon and rectal cancers are usually grouped together, there are differences in the way they are treated. Surgery for rectal cancer is often more complex than surgery for colon cancer, due to the narrow confines of the pelvis. This area contains the nerves responsible for sexual and bladder function, so particular care must be taken to avoid damaging them. Rectal cancer is also more likely to recur locally after surgery than colon cancer (Lotfollahzadeh, Kashyap, Tsoris, et al., StatPearls, 2023; ACS, What Is Colorectal Cancer?, 2024).

- **Adenocarcinomas –** are tumors that start in the lining of internal organs. "Adeno" means gland. These tumors start in cells with glandular properties, or cells that se crete. They can form in many different organs, such as the lung or the breast. In colorectal cancer, early tumors start as small adenomatous polyps that continue to grow and can then turn into malignant tumors.

There are two less common subtypes of adenocarcinomas:

- **Mucinous Adenocarcinoma –** is made up of about 60% mucus. The mucus may cause cancer cells to spread more quickly and become more aggressive than typical adenocarcinomas. Mucinous adenocarcinomas account for 10-15% percent of all rectal and colon adeno carcinomas (What Is Colorectal Cancer?, 2024).

- **Signet Ring Cell Adenocarcinoma –** account for fewer than 1% of all colon cancers. Named for its appearance under a microscope, signet ring cell adenocarcinoma is typically aggressive and may be more difficult to treat, with 5-year overall survival rates as low as 20% in patients with full signet ring cell tumors compared to approximately 55% in conventional adenocarcinoma (Gronnier et al., Cancers, 2023; Allart et al., Cancers, 2026

- **Gastrointestinal Stromal Tumors (GIST) –** are a rare type of colorectal cancer that forms in special cells found in the lining of the gastrointestinal (GI) tract called interstitial cells of Cajal (ICCs). Approximately 60% develop in the stomach, 30% in the small intestine, and 3-5% in the rectum. GISTs are classified as sarcomas, or cancers that begin in the connective and mesenchymal tissues (Serrano et al., Cancers, 2023; Italiano et al., PMC, 2023).

- **Primary Colorectal Lymphomas –** a type of non-Hodgkin lymphoma, this cancer type develops in the lymphatic system, specifically in cells called lymphocytes. Lymphocytes are a type of white blood cell that helps the body fight infections. Lymphoma may develop in many parts of the body, including the lymph nodes, bone marrow, spleen, thymus, and the digestive tract. Primary colorectal lymphomas account for 0.5% of all colorectal cancers and about 5% of lymphomas. This colorectal cancer type usually develops later in life and is more common in men (NCI, Rectal Cancer Treatment PDQ, 2024).

- **Carcinoid Tumors –** develop in nerve cells called neuroendocrine cells, which help regulate hormone production. These tumors are among a group of cancers called neuroendocrine tumors (NETs). Carcinoid tumor cells are slow-growing and may develop in the lungs and/or gastrointestinal tract. They account for about 1% of all colorectal cancers and half of all cancers found in the small intestine. Carcinoid tumors also sometimes produce hormones that may lead to various symptoms, depending on the type of hormone .Approximately 10% of individuals with these tumors experience carcinoid syndrome - characterized by flushing of the face, diarrhea, wheezing, and rapid heartbeat - caused by hormone-like substances released by the tumor (ACS, What Is Colorectal Cancer?, 2024).

- **Colon and Rectal Leiomyosarcomas –** are another form of sarcoma. Leiomyosarcoma essentially means “cancer of smooth muscle.” The colon and rectum have three layers of the type of muscle affected by leiomyosarcoma, and all three work together to guide waste through the digestive tract. This rare type of colorectal cancer accounts for about 0.1% of all colorectal cases (NCI, Rectal Cancer Treatment PDQ, 2024).

- **Colon and Rectal Melanomas –** most associated with skin cancer, these may start to develop anywhere, including in the colon or rectum, or may spread to the GI tract from the primary melanoma site. Melanomas account for 1-3% of all cancers that develop in the digestive system (ACS, What Is Colorectal Cancer?, 2024).

Procedures:

- **Polypectomy / Local Excision –** this minimally invasive procedure removes a small tumor or polyp from the inner lining of the colon using a colonoscope or flexible surgical tool. It is generally performed during a colonoscopy and is appropriate for very early-stage cancers that have not grown beyond the mucosal layer or spread to lymph nodes. Because it preserves the rest of the colon, it is considered curative in select cases where margins are clear and no invasion is present.

When it's used:

- Used for very early-stage colon cancers or precancerous polyps confined to the inner lining (mucosa)
- Appropriate when the tumor is small, superficial, and shows no invasion into deeper layers or lymph nodes
- Typically performed during screening colonoscopy for localized lesions with clear margins.

Following a polypectomy/local excision, recovery is typically rapid compared with major colorectal surgeries, since the procedure is minimally invasive and does not involve abdominal incisions or bowel reconnection. Most patients go home the same day or within 24 hours. Hospital time depends on the size, depth, and location of the lesion removed, but serious complications are uncommon. During the hospital stay, patients are monitored briefly for signs of bleeding, perforation, or pain before being discharged with dietary and activity guidelines.

During the first week, mild abdominal cramping, bloating, or small amounts of rectal bleeding are common. Patients are encouraged to rest but remain lightly active, as gentle walking promotes healthy bowel function and reduces the risk of gas retention. Straining, lifting heavy objects, or vigorous exercise should be avoided during this time to minimize pressure within the abdomen and allow the bowel wall to heal. A soft, low-fiber diet may be recommended for a few days before returning to normal eating habits.

From weeks 2-4, most individuals resume normal daily activities and work without restriction, provided there are no symptoms such as bleeding, pain, or fatigue. Moderate, low-impact activities such as walking, stretching, or gentle yoga are generally safe, but heavy lifting, high-intensity exercise, or abdominal workouts should still be avoided for at least 2-3 weeks after the procedure.

Between weeks 5-12, the colon lining continues to heal completely, and most patients are fully recovered. At this stage, there are no major restrictions on physical activity, and regular exercise can be gradually resumed as tolerated. Any strenuous activity involving core strain - such as heavy lifting, sprinting, or high-resistance training should only be reintroduced once the patient is symptom-free and cleared by their physician. Ongoing follow-up may include colonoscopy or imaging to ensure the polyp site has healed properly and that no residual or recurrent lesions are present.

- **Partial Colectomy (Segmental Reesection / Hemicolectomy) –** this is the most common surgery for colon cancer. The surgeon removes the portion of the colon containing the tumor, along with a margin of healthy tissue and nearby lymph nodes, and then reconnects the remaining ends of the bowel (anastomosis). This approach provides a balance between effective cancer removal and preservation of bowel function. The extent of resection depends on where the tumor is located.

  - **Right Hemicolectomy -** removal of the ascending colon (right side) and part of the transverse colon.

  - **Left Hemicolectomy -** removal of the descending colon (left side).

  - **Sigmoid Colectomy (Sigmoidectomy) -** removal of the sigmoid colon, the S-shaped portion near the rectum.

  - **Transverse Colectomy -** removal of the middle section of the colon.

  - **Segmental Colectomy -** removal of a smaller segment within one of these sections when the tumor is localized.

When it's used:

- Used for stage I-III colon cancers confined to one section of the colon

- Indicated when the tumor has invaded the bowel wall or lymph nodes but remains localized enough for curative removal

- Selected when there is adequate healthy colon remaining to reconnect the bowel after resection

- Suitable for patients with good general health and sufficient pulmonary and cardiac function to tolerate major surgery

Following a colectomy, recovery takes place gradually over several weeks as the body adapts to the loss of a portion or all of the colon and the bowel adjusts to its new function. Hospital stays typically range from 4-7 days for minimally invasive procedures such as laparoscopic or robotic colectomy and up to 10 days for open surgery or cases involving complications. During the hospital phase, the focus is on pain control, bowel function recovery, and prevention of complications such as infection, ileus (temporary paralysis of the bowel), or blood clots. Patients usually begin walking within 24 hours after surgery to promote circulation, reduce stiffness, and encourage intestinal movement. Once bowel sounds return and the patient can tolerate liquids and soft food, discharge is usually appropriate.

During the first four weeks at home, fatigue, abdominal soreness, and irregular bowel habits are common. It is normal for bowel movements to be loose or more frequent during this period as the remaining colon adapts. Activity should be limited to gentle walking and light daily movements, avoiding strain or twisting of the abdomen. Lifting, pushing, or pulling objects heavier than 5-10 pounds should be avoided to protect the abdominal incision and prevent hernias.

Patients are encouraged to maintain upright posture, take frequent short walks, and rest between activities to promote healing. Driving, sexual activity, and returning to work should wait until pain has subsided and mobility has improved - usually by the end of the first month.

Between weeks 5-8, energy levels gradually improve, and most patients begin to resume light household tasks or return to part-time work. Walking distances can be increased, and simple stretching may be introduced to maintain flexibility. However, activities that cause abdominal pressure, such as lifting more than 15 pounds, bending repeatedly, or high-impact exercise, should still be avoided.

Patients with a temporary stoma may need to adjust their routines around stoma care and pouch management, ensuring hydration and nutrition are maintained.

By weeks 9-12, most individuals experience a noticeable return of strength and endurance. Bowel patterns usually stabilize, and abdominal discomfort continues to diminish. At this stage, light to moderate exercise can be resumed, including stationary cycling, gentle resistance work, and longer walks, provided there is no pain or fatigue. Heavy lifting, core-intensive training, and strenuous aerobic exercise should wait until at least 12 weeks post-surgery and only after clearance from the surgeon. Full recovery, meaning unrestricted activity, stable digestion,and complete tissue healing, typically takes 3-6 months, depending on the extent of surgery and the patient's overall health

- **Total or Subtotal Colectomy –** involves removal of nearly all or the entire colon, typically used when there are multiple tumors, diffuse disease, or a hereditary condition such as familial adenomatous polyposis. After removal, the surgeon connects the small intestine to the rectum or creates a stoma to divert waste. This operation sacrifices more bowel length but provides the most comprehensive tumor clearance.

When it's used:

- Used when primary reconnection (anastomosis) is un safe due to infection, inflammation, or poor healing conditions.
- Indicated when bowel obstruction, perforation, or emergency surgery prevents safe continuity restoration
- Sometimes performed temporarily to divert stool away from a healing connection after low or difficult resections
- May be permanent in advanced disease or when the rectum and sphincter must be removed

Following a total or subtotal colectomy, recovery is generally more complex and prolonged than after a partial colectomy because a larger section - or the entire colon - has been removed. Hospital stays typically range from 5-10 days, depending on whether the surgery was performed laparoscopically or through an open incision, and on how quickly bowel function returns. During the hospital phase, patients are closely monitored for pain control, hydration, and early complications such as infection, bleeding, or anastomotic leakage.

Walking is encouraged within 24 hours after surgery to prevent blood clots,stimulate bowel activity, and promote circulation. Because the small intestine must now adapt to handling most of the digestive process, bowel movements can be frequent and watery for several weeks. Once the patient can tolerate fluids and soft foods and the bowels are functioning, discharge is typically considered.

During the first month at home, fatigue and weakness are common, and it can take time for appetite and energy to return. Abdominal tenderness and changes in bowel habits - such as urgency, loose stools, or gas discomfort - are expected as the gastrointestinal tract adjusts. Activity should be limited to light walking and basic household tasks. Lifting, pushing, or pulling objects heavier than 5-10 pounds should be strictly avoided to protect the abdominal wall and internal sutures. Patients with a stoma require additional guidance on pouch care, hydration, and preventing skin irritation, as fluid loss and electrolyte imbalance can occur more easily after extensive colon removal.

Between weeks 5-8, strength gradually improves, and walking distances can increase at a comfortable pace. A regular eating pattern usually returns, though patients may need to eat smaller, more frequent meals and avoid high-fat or high-fiber foods until digestion stabilizes. Activities that create strain or abdominal pressure - such as lifting more than 15 pounds, bending repeatedly, or high-impact movement - should still be avoided. Rest remains an important part of recovery, as fatigue can fluctuate daily.

By weeks 9-12, most individuals are capable of resuming moderate daily activities, including light exercise such as walking, stationary cycling, and gentle stretching. Patients with a stoma typically become more confident managing their appliance and can resume many normal routines. Strenuous activity, heavy lifting, abdominal workouts, or high-intensity training should not begin until after 12 weeks and only with the surgeon's clearance. Full recovery, meaning stable bowel function, complete wound healing, and restored endurance - may take three to six months, depending on the patient's overall health, the extent of surgery, and any underlying conditions.

- **Colectomy with Stoma (Colostomy or Ileostomy) –** when reconnection of the colon is not possible or safe, a stoma is created. The bowel is brought to the surface of the abdomen, and stool is collected in a pouch outside the body. This may be temporary, allowing the bowel to heal before reattachment, or permanent if reconnection is not feasible. It is used when there is significant inflammation, poor healing potential, or bowel obstruction.

When it's used:

- Emergency surgery: when the bowel is obstructed, perforated, or severely inflamed, making reconnection too risky
- Poor healing conditions: in cases of infection, contamination of the abdominal cavity, or compromised blood supply to the remaining bowel
- Low rectal or complex resections: when the anastomosis (bowel connection) is very low in the pelvis and needs time to heal, a temporary stoma diverts stool away from the site
- Advanced or recurrent cancer: when curative surgery is not possible or the rectum and anal sphincter must be removed, resulting in a permanent colostomy
- Severe comorbidities or poor overall health: when the patient's condition would not tolerate the additional strain of bowel reconnection during the same operation

Following a total or subtotal colectomy with a stoma (colostomy or ileostomy), recovery takes longer and requires additional adaptation - both physically and emotionally - as the body adjusts to a new way of eliminating waste. Hospital stays typically range from 7-10 days, depending on whether the surgery was performed laparoscopically or as an open procedure, and on how quickly bowel function stabilizes. During this period, the focus is on pain management, hydration, and learning how to care for the stoma. Nurses provide education on pouch changes, skin protection, and recognizing signs of infection or leakage. Patients begin walking within 24 hours after surgery to improve circulation, promote bowel movement through the small intestine, and reduce the risk of blood clots. Once oral intake is tolerated, the stoma is functioning, and the patient feels comfortable with stoma care, discharge is considered appropriate.

During the first month at home, fatigue and abdominal tenderness are expected, and adjusting to stoma care can feel overwhelming. The abdomen and peristomal skin may be sensitive, and swelling around the stoma is common early on. Physical activity should be limited to short, slow walks and gentle daily movement. Lifting, pushing, or pulling anything heavier than 5-10 pound should be strictly avoided to prevent strain on the abdominal incision and reduce the risk of developing a parastomal hernia. Hydration is critical - especially after an ileostomy - since the large intestine, which normally absorbs much of the body's fluids, is no longer present. Small, frequent meals with moderate fiber are recommended while the digestive system adjusts. Rest periods throughout the day help manage fatigue and promote healing.

Between weeks 5-8, energy levels improve gradually, and walking distances can increase at a comfortable pace. By this stage, most patients can manage their stoma independently and resume basic household tasks, provided they avoid heavy lifting or twisting of the torso. Light stretching or range-of-motion exercises can be introduced, but abdominal and core work should still be avoided. Hydration and electrolyte balance continue to require attention, particularly for those with an ileostomy. Foods that cause gas, blockages, or odor should be introduced slowly, and medical follow-up is essential to assess stoma healing and pouch fit.

By weeks 9-12, strength and confidence typically improve, and most patients resume moderate daily activity, including light walking, stationary cycling, or gentle yoga. Stoma care becomes more routine, and bowel output patterns begin to stabilize. Heavy resistance training, running, or exercises that place pressure on the abdomen - such as planks, sit-ups, or weightlifting - should still be postponed until at least twelve weeks post-surgery, or longer if healing is incomplete. Core strengthening and higher-impact fitness can be gradually reintroduced under medical guidance, focusing on avoiding excessive strain near the stoma. Full recovery after a total or subtotal colectomy witha stoma may take 3-6 months, depending on surgical complexity, individual healing, and adaptation to stoma care.

- **Laparoscopic or Robotic Colectomy (minimally invasive approach) –** these methods use small incisions and specialized instruments guided by a camera or robotic system to perform the same procedures as traditional open colectomy. The benefits include less postoperative pain, smaller scars, faster recovery, and shorter hospital stays. This approach is suitable for most localized colon cancers when performed by experienced surgeons.

When it's used:

- Used for localized colon cancers in patients who are suitable for minimally invasive surgery
- Chosen when tumors are small, resectable, and there is no extensive local invasion or metastasis
- Preferred for patients seeking faster recovery, less postoperative pain, and minimal scarring
- Increasingly used for most elective resections in experienced surgical centers worldwide

Following a laparoscopic or robotic colectomy, recovery is generally faster and less painful than with open surgery because the procedure uses several small incisions rather than one large one. Hospital stays typically last between 3 and 5 days, though many patients undergoing robotic-assisted surgery may be discharged even sooner if bowel function returns quickly.

During hospitalization, the primary goals are pain management, gradual reintroduction of fluids and food, and early ambulation. Patients are encouraged to begin walking within 12-24 hours after surgery to reduce the risk of blood clots, stimulate bowel activity, and promote overall recovery. Once patients can tolerate a light diet and their bowel function begins to normalize, discharge is usually appropriate.

During the first month at home, most individuals experience mild fatigue, occasional abdominal discomfort, and changes in bowel habits, such as bloating or frequent stools. Physical activity should be limited to light, non-strenuous movements such as walking short distances several times per day. Lifting or carrying objects heavier than 10 pounds should be avoided to prevent stress on the healing incisions. Driving and returning to work should wait until pain is well controlled and reaction times have returned to normal-typically within 2-4 weeks, depending on the individual's recovery and job demands.

Between weeks 5-8, energy levels generally improve, and patients can increase walking distances or begin light stretching and gentle mobility exercises. Most can resume household chores and desk work without restriction but should still avoid any motion that strains the abdominal muscles, including bending, twisting, or lifting weights over 15 pounds). Bowel regularity usually stabilizes during this period, though diet adjustments may continue based on tolerance.

By weeks 9-12, most patients are capable of returning to normal routines, including moderate exercise such as brisk walking, low-resistance cycling, or gentle yoga. The small incisions are typically well healed, though deep internal tissues continue to strengthen. Heavy lifting, running, abdominal workouts, and high-impact exercise should be postponed until the three-month mark and only resumed once cleared by the surgeon. Complete recovery - defined by stable bowel function, restored strength, and full mobility - usually occurs within 8-12 weeks.

- **Emergency or Palliative Resections –** in some advanced or complicated cases such as bowel obstruction, perforation, or uncontrollable bleeding – surgery may be performed to relieve symptoms rather than to cure the cancer. The surgeon may remove or bypass the tumor, create a colostomy, or perform limited resection. The intent is to improve comfort, prevent infection, and restore bowel function rather than achieve long-term remission.

When it's used:

- Used in emergencies such as bowel obstruction, perforation, or severe bleeding caused by tumor growth
- Indicated for symptom relief rather than cure in advanced or metastatic disease
- May involve bypassing or removing the obstructed bowel segment, creating a stoma, or controlling bleeding
- Helps improve comfort, prevent infection, and restore intestinal function when curative treatment is not possible

Following an emergency or palliative colectomy, recovery varies widely depending on the reason for surgery, the patient's overall condition, and whether complications such as bowel perforation, obstruction, or bleeding were present before the operation. Hospital stays are typically longer than for planned procedures, often ranging from 7-14 days or more, since patients undergoing emergency surgery are frequently weaker or have other health issues that delay recovery. During hospitalization, the primary focus is stabilizing vital signs, controlling infection or inflammation, and ensuring the bowel and surrounding tissues heal properly. Pain management, hydration, and gradual reintroduction of oral intake are closely monitored. Walking is encouraged as soon as safely possible - usually within the first 48 hours – to promote circulation, reduce stiffness, and prevent pneumonia or blood clots.

The first month at home is focused on regaining basic strength and preventing complications such as wound infection, hernias, or dehydration. Activity should re main light, limited to slow walking and essential daily tasks. Lifting or carrying objects heavier than 5-10 pounds should be avoided to reduce abdominal strain. Depending on the extent of surgery, some patients may have a temporary or permanent stoma and will require time and education to adjust to stoma care.

Those recovering from emergency operations may also be coping with malnutrition or fatigue from prior illness, making rest and gradual progression especially important.

Between weeks 5-8, most patients begin regaining energy and can increase walking distance and frequency. Diet and bowel function gradually stabilize, though irregularities such as loose stools or mild cramping are common. Gentle stretching and breathing exercises may be helpful for mobility, but heavy exertion, twisting, or lifting more than 15 pounds should still be avoided. Emotional recovery is also an important part of this phase, especially for individuals living with advanced disease or a new stoma.

By weeks 9-12, strength and endurance typically improve, allowing patients to return to light daily activities. For those who underwent surgery with palliative intent, exercise is guided more by comfort and energy levels than by strict progression. Gentle, low-impact movement such as walking,easy cycling, or basic mobility exercises, can support circulation, mood, and independence. High-intensity activity, core strain, or weightlifting should be avoided indefinitely unless the patient has made exceptional progress and receives medical clearance.

Overall, recovery after an emergency or palliative resection focuses less on physical performance and more on restoring function, managing symptoms, and maintaining quality of life. Healing may take several months, and pacing activity to match individual tolerance - alongside emotional and nutritional support - is essential for optimal recovery and comfort.

• **Low Anterior Resection (LAR) –** a low anterior resection involves removing the rectosigmoid portion of the colon and upper part of the rectum, where the tumor is located, while preserving the anal sphincter and normal bowel continuity. The healthy ends of the colon and rectum are then reconnected (anastomosed). This approach allows the patient to maintain normal bowel control and avoid a permanent colostomy.

It is still very commonly performed worldwide, particularly for:

- Mid-to upper-rectal cancers that are located above 5-6 cm from the anal verge, where there is enough healthy tissue below the tumor to reconnect safely.
- Early- to mid-stage rectal cancers (stage I-III) that have not invaded the anal sphincter or pelvic floor muscles.
- Select sigmoid colon cancers that extend into the upper rectum.

The operation may be done through open, laparoscopic, or robotic-assisted approaches, depending on surgeon expertise and tumor characteristics. Minimally invasive methods have become more prevalent due to their lower complication rates, faster recovery, and similar long-term oncologic outcomes.

When it's used:

- Used for rectosigmoid or upper rectal cancers located approximately 5-12 cm from the anal verge
- Indicated for stage I-III tumors that have not invaded the anal sphincter or pelvic floor muscles
- Selected when the goal is to preserve normal bowel continuity and avoid a permanent colostomy
- Suitable for patients with good sphincter control and adequate blood supply to permit safe reconnection
- Often combined with a temporary diverting ileostomy to protect the surgical connection while it heals

Following a low anterior resection (LAR), recovery tends to be gradual, as the body heals from both the bowel resection and the reattachment of the colon to the remaining rectum. Hospital stays typically last between 5-7 days for minimally invasive procedures, and up to ten days for open surgeries or more complex cases. The focus during hospitalization is on controlling pain, monitoring bowel function, and ensuring the anastomosis (bowel connection) heals properly. A temporary diverting ileostomy is often created to protect the reconnected section of the bowel. Early ambulation - beginning within 24 hours - is strongly encouraged to reduce the risk of blood clots, improve circulation, and promote return of bowel activity. Once the patient can tolerate fluids and a soft diet and bowel movement resumes, discharge is considered appropriate.

During the first month at home, fatigue and changes in bowel habits are common. It is important to avoid straining or sitting for prolonged periods. Activity should focus on gentle walking and light daily movement, avoiding lifting more than 5-10 pounds or engaging in any activity that increases abdominal pressure. Driving, sexual activity, and returning to work should wait until pain is well managed and energy levels improve - usually by 4-6 weeks.

Between weeks 5-8, most individuals begin to regain strength and confidence in movement. Walking distances can be increased gradually, and light stretching or gentle yoga may be introduced if cleared by the surgeon. If a temporary stoma is present, this period also allows for adaptation to stoma care and routine management. Bowel control continues to improve, but irregularity is still expected. Activities involving bending, twisting, or lifting more than 15 pounds should still be avoided.

By weeks 9-12, most patients experience better energy, reduced discomfort, and improved bowel regulation. Moderate activities such as longer walks, stationary cycling, and gentle resistance exercises may be resumed, provided there is no pain or fatigue. Core or abdominal strengthening and high-impact activity should be delayed until at least twelve weeks post-surgery and only after medical clearance, as the anastomosis and pelvic floor continue to heal.

Full recovery after a low anterior resection typically occurs over 3-6 months, depending on surgical complexity and whether an ileostomy was created. Bowel patterns may take several months to stabilize, and patients often benefit from dietary adjustments and pelvic floor retraining to improve function. The focus during the first three months is gradual reconditioning, avoiding abdominal strain, and allowing both physical and bowel function to recover safely.

- **Abdominoperineal Resection (APR) –** an abdominoperineal resection removes the rectum, anal canal, and surrounding tissue, including the sphincter muscles. The colon is then brought through the abdominal wall to form a permanent colostomy. This procedure is performed when there is no safe way to reconnect the bowel while preserving continence, typically because the tumor is too close to or involves the anal sphincter.

When it's used:

- Low rectal cancers (within 4-5 cm of the anal verge) n that cannot be adequately excised with clear margins through a low anterior resection
- Tumors invading the anal sphincter or levator ani muscles, where sphincter preservation would leave cancer behind
- Recurrent rectal cancers or those not responsive to chemoradiation
- Locally advanced anal adenocarcinomas or some cases of anal squamous carcinoma not suitable for non-surgical management.
- Locally advanced rectal cancer invading adjacent pelvic organs such as the bladder, uterus, vagina, prostate, or sacrum
- Recurrent colorectal cancer after prior resection or radiation, when confined to the pelvis and resectable en bloc
- Locally invasive gynecologic malignancies (such as cervical or vaginal cancer) involving the rectum or bladder
- Select cases of palliative intent, to relieve severe pain, obstruction, infection, or fistulas caused by invasive pelvic disease
- Persistent disease following chemoradiation, where complete resection offers a chance for long-term survival

Following an abdominoperineal resection (APR), recovery typically requires more time and care than other colorectal surgeries because it involves both an abdominal incision and a perineal wound. Hospital stays generally range from 7-10 days, although this can vary depending on the patient's health, the surgical approach (open vs. laparoscopic), and whether complications such as infection or delayed healing occur. During hospitalization, the focus is on pain control, wound management, and learning how to care for the permanent colostomy. The perineal incision can cause discomfort when sitting, so patients are encouraged to use cushions and change positions frequently. Walking usually begins within 24 hours after surgery to promote circulation, prevent clots, and aid bowel function through the remaining intestine. Discharge occurs once the stoma is functioning, pain is manageable, and patients are confident with basic stoma care.

The first four weeks at home are focused on rest, gradual mobility, and wound care. Fatigue, soreness, and drainage from the perineal wound are common. Walking is the safest form of exercise during this period, starting with short, slow sessions several times per day. Lifting, pushing, or pulling anything heavier than 5-10 pounds should be avoided to protect both incisions and prevent hernias near the stoma. Sitting for long periods should be minimized until the perineal area heals, and a soft cushion should be used for comfort. Maintaining hydration and a low-fiber diet early on helps prevent straining and allows the digestive system to adjust to colostomy function.

Between weeks 5-8, energy levels improve, and walking distances can increase at a steady pace. Most patients can perform light household tasks, provided they avoid bending, twisting, or heavy lifting. Gentle stretching may be introduced to restore mobility, but anything that places pressure on the perineum or abdomen should be postponed. Stoma management typically becomes easier during this time, and the perineal incision continues to close and strengthen.

By weeks 9-12, most individuals experience noticeable gains in strength and independence. Moderate activity such as walking longer distances, gentle yoga, or stationary cycling may be resumed as long as it does not High-impact movements, abdominal exercises, and lifting more than 15-20

pounds should still be avoided to prevent strain or hernia formation. Sitting comfort gradually improves, but full perineal healing can take several months.

Complete recovery from an abdominoperineal resection typically occurs within 3-6 months, though adaptation to a permanent colostomy may take longer.

- **Pelvic Exenteration –** pelvic exenteration is a far more extensive operation involving the removal of multiple pelvic organs - such as the rectum, bladder, reproductive organs, and sometimes part of the bony pelvis - to achieve complete removal of locally advanced or recurrent cancer. The procedure may be total, anterior, or posterior, depending on which structures are removed. Although pelvic exenteration carries high morbidity and a long recovery, it remains a potentially curative option for select patients with no distant metastases. Improvements in imaging, patient selection, reconstructive surgery, and peri-operative care have led to better survival and quality-of-life outcomes in recent years.

When it's used:

- Locally advanced rectal cancers that invade adjacent pelvic organs but have not spread distantly
- Recurrent colorectal or gynecologic cancers confined to the pelvis after prior surgery or radiation
- Palliative indications, in highly selected cases, to relieve pain,infection, or obstruction when other treatments fail

Following a pelvic exenteration, recovery is extensive and requires a multidisciplinary approach to address both the physical and emotional challenges of such a major operation. Hospital stays typically range from 10-21 days, depending on the extent of the surgery and whether it involved removal of adjacent organs such as the bladder, reproductive organs, or part of the bony pelvis. The immediate postoperative focus is on pain management, infection prevention, and monitoring for complications such as bleeding, wound breakdown, or abscess formation.

Patients are closely observed in a high-dependency or intensive care unit during the first few days, as multiple surgical sites and drains require careful management. Nutrition is reintroduced slowly - usually starting with clear fluids and progressing to soft foods once bowel activity resumes.

Patients often have one or more stomas (colostomy, ileostomy, or urostomy), and stoma education begins as soon as they are stable enough to participate. Gentle assisted walking usually starts within 48-72 hours to improve circulation, reduce stiffness, and prevent clots.

During the first month at home, recovery remains slow and focused on wound care, energy conservation, and learning to manage new bodily functions. Patients often experience fatigue, abdominal and pelvic tenderness, and significant adjustments to body image and daily routines, especially if permanent stomas are present. Physical activity should be minimal and limited to short, gentle walks several times a day, gradually increasing in duration as tolerated. Lifting, bending, twisting, or carrying objects heavier than 5-10 pounds should be strictly avoided to prevent wound separation or hernia formation. Hydration and nutrition are essential for healing, and small, frequent meals are often better tolerated. Emotional and psychological support are equally important during this phase, as patients adapt to major lifestyle changes.

Between weeks 5-8, energy levels begin to improve, and walking distances can be increased at a slow, steady pace. Light household activities may be resumed if they do not involve strain or fatigue. Some patients begin gentle stretching or physical therapy to restore mobility and prevent stiffness in the hips and lower back. Any exercise involving the abdominal or pelvic region should be avoided, as deep tissue healing continues. Wound sites, particularly perineal or pelvic incisions, often take several months to fully close and must be kept clean and dry to prevent infection.

By weeks 9-12, most individuals experience gradual increases in stamina and a greater ability to perform daily activities. Low-impact exercises such as walking, light stationary cycling, or gentle range-of-motion exercises can usually be performed without discomfort. However, heavy resistance training, running, or any movement that increases intra-abdominal pressure should be postponed until at least 12-16 weeks post-surgery and only after medical clearance. Adaptation to stoma care and urinary diversion continues during this period, with support from wound and ostomy care nurses.

Full recovery following a pelvic exenteration can take six months to a year, depending on surgical complexity, reconstruction, and the patient's baseline health. Many patients benefit from ongoing physical therapy, nutritional counseling, and psychological support.

Potential Side-effects from most Colorectal Surgeries:

- Pain and tenderness at the incision site(s), especially with movement or coughing.
- Fatigue and weakness due to anesthesia, blood loss, or reduced nutrition intake.
- Abdominal bloating or cramping as bowel function gradually returns.
- Changes in bowel habits, such as loose stools, constipation, urgency, or frequent bowel movements.
- Anastomotic leak (in surgeries involving bowel reconnection) leakage of intestinal contents at the surgical join, potentially causing infection or abscess
- Wound infection or abscess formation near the incision or in the pelvic cavity.
- Postoperative ileus - temporary slowing or paralysis of bowel activity leading to nausea, bloating, or vomiting.
- Adhesions or intestinal obstruction due to scar tissue formation.
- Urinary retention or bladder dysfunction (especially in low rectal or pelvic surgeries where nerves are affected).
- Sexual dysfunction resulting from nerve damage in the pelvic area.

Digestive and nutritional effects:

- Reduced nutrient absorption (more likely after large resections)
- Dehydration due to increased stool frequency or reduced colon length
- Food intolerance or difficulty digesting high-fiber or fatty foods early in recovery
- Weight loss or malnutrition if dietary intake is inadequate

Stoma-related side effects (for colostomy or ileostomy procedures):

- Deep vein thrombosis (DVT) or pulmonary embolism (PE) due to prolonged immobility after surgery
- Skin irritation (peristomal dermatitis) from leakage, adhesives, or frequent pouch changes
- Parastomal hernia - bulging near the stoma from weakened abdominal muscles
- Stoma prolapse (bowel protruding too far outward) or stoma retraction (sinking below skin level)
- Stomal bleeding or minor trauma during cleaning
- Stomal blockage or obstruction from undigested food or scar tissue
- Infection or abscess around the stoma site
- Dehydration or electrolyte imbalance, particularly with high-output ileostomies
- Excess gas, odor, or leakage affecting comfort and confidence

Body image changes and adjustment challenges, especially after permanent stoma creation:

- Anxiety or depression related to lifestyle adaptation or cancer recovery
- Social discomfort or fear of odor and leakage during daily activities
- Sleep disturbance from pain, stoma output, or anxiety

Types of Treatment Used:

- Ablative therapies (e.g., radio frequency ablation, microwave ablation)
- Anti-angiogenic therapy
- Chemotherapy (systemic cytotoxic agents)
- Immunotherapy (such as immune checkpoint inhibitors, BiTEs)
- Maintenance therapy (post-induction treatment to prolong remission)
- Precision or targeted therapy (drugs aimed at molecular drivers like EGFR, ALK, or ROS1)
- Proton therapy and advanced radiation modalities (e.g., stereotactic body radiation therapy, SBRT)
- Radiotherapy (external beam, 3D-conformal, intensity-modulated)

CANCER OF THE BLADDER

Globally, bladder cancer is the ninth most commonly diagnosed cancer overall and the sixth most common in men (Filho, Briganti, Jemal, and Bray, European Urology, 2025). There were an estimated 614,298 new cases and 220,596 deaths worldwide in 2022, making bladder cancer the 13th leading cause of cancer death globally (Filho et al., European Urology, 2025). Bladder cancer develops because of uncontrolled growth of abnormal cells in the bladder, typically beginning in the urothelium - the lining inside the ureter, bladder, urethra, and parts of the kidneys. The type of bladder cancer depends on which cells and layers are affected.

Men are 3-4 times more likely to develop bladder cancer than women (BCAN, About Bladder Cancer, 2025). More than 60% of all bladder cancer cases occur in higher-income countries, with the highest incidence rates seen in Southern and Western Europe and North America, and the lowest in Middle Africa and South-Central Asia (Filho et al., European Urology, 2025).

The most common symptoms include blood in the urine, increased frequency or urgency of urination, pain or irritation during urination, and low back pain. Smoking is the most well-established risk factor for bladder cancer - current smokers are approximately four times more likely to develop bladder cancer than non-smokers, with tobacco use estimated to account for 50-65% of all bladder cancers in men and approximately 50% in women based on current smoking prevalence patterns (NCI, Bladder Cancer Risk Factors, 2024). Additional risk factors include occupational exposures in the dye, rubber, leather, aluminum, and painting industries, certain bladder birth defects, and living in communities with high levels of arsenic in drinking water. Approximately 70% of bladder cancers are non-muscle invasive at the time of diagnosis, meaning the cancer has not penetrated the bladder wall (NCI, SEER Cancer Statistics: Bladder Cancer, 2024).

Individuals with a family member who has or has had bladder cancer are at increased risk, which may be attributed to shared exposure to carcinogens or shared genetic abnormalities. Specifically, mutations in genes including NAT2 and GSTM1 may alter the body's breakdown of certain toxins, which can lead to malignancies in the bladder wall. The overall five-year survival rate for bladder cancer is approximately 78%, rising to 96% for non-muscle invasive cases but dropping sharply when the cancer spreads beyond the bladder (ACS, Bladder Cancer Survival Rates, 2025). Most cases can be treated without removing the bladder; however, when cancer has invaded the bladder wall, removal of the bladder or a combination of radiation and chemotherapy must be considered. Cancer confined to the lining of the bladder is classified as non-muscle invasive bladder cancer, while cancer that spreads through the lining into the muscle wall or nearby organs and lymph nodes is classified as invasive bladder cancer.

Types of Bladder Cancer:

- **Transitional Cell Carcinoma (TCC) (also known as Urothelial Carcinoma) –** is the most common form of bladder cancer, accounting for over 90% of cases (NCI, SEER Cancer Statistics: Bladder Cancer, 2024). Approximately 75% of newly diagnosed cases are non-muscle invasive bladder cancer (NMIBC), while the remaining 25% are muscle-invasive or metastatic at presentation (NCI, SEER Cancer Statistics: Bladder Cancer, 2024). In non-muscle invasive cases, while not immediately life-threatening, recurrence rates are high - with 50-70% of patients experiencing recurrence after initial treatment and up to 30% progressing to muscle-invasive disease (Vera-Donoso et al., Cancers, 2025). In the more advanced cases, the cancer has either penetrated the bladder's muscular wall or metastasized to other organs, carrying a significantly poorer prognosis - with a 5-year survival rate of approximately 35% for stage T2 and as low as 5% for distant metastatic disease (NCI, SEER Cancer Statistics: Bladder Cancer, 2024). There are two principal subtypes of urothelial carcinoma:
    - **Papillary Carcinoma –** grows out from the inner surface of the bladder toward the hollow center in fingerlike projections. When papillary TCC is very low grade, it may be called “papillary neoplasm” of low-malignant potential, and typically has a very good outcome.
    - **Flat Carcinoma –** does not grow out of the urothelium toward the center of the bladder. Rather, flat carcinomas remain on the surface of the bladder wall. If a flat carcinoma is confined to the urothelium, it is called “noninvasive flat carcinoma” or “flat carcinoma in situ.”
- **Adenocarcinoma –** closely resembles the gland-forming cells seen in colon cancers and accounts for 1-2% of all cases (ACS, What Is Bladder Cancer?, 2024).
- **Squamous Cell Carcinoma –** a rare non-urothelial subtype arising from flat, scale-like cells that can develop in the bladder lining in response to chronic irritation and inflammation - accounting for approximately 3-5% (ACS, What Is Bladder Cancer?, 2024).
- **Small Cell Carcinoma –** an extremely rare and highly aggressive neuroendocrine malignancy, accounting for less than 1% of all bladder cancers (ACS, What Is Bladder Cancer?, 2024).
- **Sarcoma –** a very rare type of bladder cancer that begins in the connective tissue of the muscle or fat layers of the bladder wall (ACS, What Is Bladder Cancer?, 2024).

- **Transurethral Resection of the Bladder Tumor (TURBT) –** is the most common and gold-standard treatment for early-stage or superficial bladder tumors. A resectoscope is inserted through the urethra and into the bladder - this procedure does not require cutting into the abdomen. The resectoscope contains a small electrified loop of wire that is used to cut the tumor off the bladder wall while simultaneously cauterizing the site to prevent bleeding (BCAN, Bladder Cancer TURBT, 2025). After resection, additional steps may be taken to ensure complete tumor destruction. Remaining cancer cells may be treated by burning the base of the tumor (fulguration) under direct visualization through the scope. Cancer can also be destroyed using a high-energy laser, with holmium and thulium laser techniques now widely used as effective and minimally invasive alternatives to conventional electrosurgical resection (Thota, Vasudevan, and Jumde, Cureus, 2025).

When it’s used:

- First-line for diagnosis and treatment of non–muscle invasive bladder cancer (Ta, T1, CIS)
- Removes visible tumors via the urethra without external incision; allows staging and grading; may be curative for superficial disease

> Most patients go home the same day or after an overnight stay. Mild burning during urination and blood in the urine are common for several days. Light walking can start within 24 hours. Heavy lifting, strenuous activity, and cycling should be avoided for 2-3 weeks to prevent bleeding. By four weeks, normal daily activity can resume. Exercise intensity can gradually return to baseline by six weeks if there is no hematuria or discomfort.

Potential Side Effects of TURBT:

- Bleeding and pain during urination right after
- Incontinence

- **Cystectomy –** is the removal of all or part of the bladder and possibly the removal of nearby lymph nodes and organs that may contain cancer. If the bladder is removed, the surgeon creates a new way for urine to leave the body. In some cases, a urinary diversion is performed to create a new way to for the body to store and pass urine.

- **Partial Cystectomy –** is the removal of part of the bladder. It is used to treat cancer that has invaded the bladder wall in just one area. Partial cystectomy is only a good choice if the cancer is not near the openings where urine enters or leaves the bladder. Nearby lymph nodes may also be removed and examined. The main advantage is that it allows a person to keep their bladder and does not require reconstructive surgery. The remaining bladder may not be able to hold as much urine, requiring more frequent urination. The main concern with this type of surgery is that bladder cancer can still recur in another part of the bladder wall, which is not a concern after radical cystectomy.

When it's used:

- Selected solitary, muscle-invasive tumors in favorable locations (away from the bladder neck/trigone) with no carcinoma in situ elsewhere

- Removes only part of the bladder, preserving urinary function and capacity while achieving negative margins

Hospital stay typically lasts 5-7 days. Pain, fatigue, and temporary bowel irregularities are common early on. Walking begins within 24 hours to prevent blood clots and promote bowel movement. For the first month, lifting over 10 pounds and core straining should be avoided. By six weeks, most light activities can resume, though energy levels may still fluctuate. Full return to moderate exercise and household tasks usually occurs between 8-12 weeks, provided there are no leaks or infection.



- **Radical Cystectomy –** if the cancer is larger or spread to more than one part of the bladder, a radical cystectomy is needed. This operation removes the entire bladder and nearby lymph nodes.

In men, the prostate, seminal vessels, and part of the vas deferens is also removed. In women, the cervix, ovaries, fallopian tubes, the uterus, and a small portion of the vagina, are often removed well as the bladder. Cystectomies are typically done through an incision in the abdomen. This can be performed through "open" or laparoscopic surgery. Laparoscopic surgery may result in less pain and quicker recovery after the procedure, but since it has not been around as long as the open" surgery, it's not clear if it is equally as effective. The patient will need to stay in the hospital for about a week after the surgery.

When it's used:

- Muscle-invasive disease (T2 or higher) or high-risk non-muscle-invasive cancer unresponsive to intravesical therapy

- Provides definitive local control by removing the entire bladder and nearby organs at risk of harboring microscopic disease

This is a major operation with a hospital stay of 7-10 days, longer if complications occur or a complex diversion is created. Early recovery focuses on pain management, bowel function, and mobility. Walking begins within 24 hours but should be slow and frequent.

During the first four weeks at home, fatigue, loss of appetite, abdominal tenderness, and general weakness are expected and normal. All lifting, pushing, or pulling of objects exceeding 5-10 pounds must be strictly avoided during this period to reduce the risk of incisional hernia. Swimming, and submerging in water should similarly be avoided until the surgical site is fully healed and cleared by the surgeon.

Between weeks 4-6, walking duration and pace can be progressively increased. Light, non-strenuous activities of daily living may be resumed as comfort allows. Core engagement - including coughing, laughing, or any activity that increases intra-abdominal pressure - should still be approached with caution during this phase.

By weeks 6-8, low-impact aerobic activity such as leisurely cycling on a stationary bike or light swimming may be introduced with physician approval. However, any exercise that significantly engages the abdominal muscles, increases intra-abdominal pressure, or risks impact to the surgical site remains contraindicated at this stage. Resistance training, heavy lifting, abdominal strengthening exercises such as sit-ups, planks, or crunches, and high-impact activities such as running or jumping should not be attempted.

Full return to strenuous exercise, abdominal strengthening, and heavy resistance training should wait until at least 10-12 weeks post-surgery and only after explicit medical clearance from the surgical team. Even then, return to exercise should be gradual and progressive, beginning with light resistance and building incrementally over several weeks. Patients who had a urinary diversion - particularly those with a stoma - should take additional precautions around activities that increase abdominal pressure, as these can affect stoma function and increase hernia risk at the stoma site.

Potential Side-effects of Cystectomies:

- Pain, tenderness, and bruising around the abdominal incision or port sites
- Fatigue, weakness, and decreased endurance for several weeks due to anesthesia, blood loss, and catabolic stress
- Swelling or numbness around the incision area
- Temporary loss of appetite, nausea, or mild bowel irregularities (constipation or diarrhea) as intestinal function returns
- Risk of infection at the incision or deep tissues
- Deep vein thrombosis (DVT) or pulmonary embolism from post operative immobility
- Prolonged ileus (temporary bowel paralysis), causing bloating and vomiting
- Wound separation or delayed healing, especially in patients with diabetes or poor nutrition

- **Pelvic Lymph Node Dissection (PLND) –** a surgery to remove the lymph nodes from the pelvis. A PLND is also called a pelvic lymphadenectomy, ilioinguinal lymphadenectomy or deep groin dissection. Lymph fluid from organs in the pelvis drains into the pelvic lymph nodes and therefore can carry cancer cells from the bladder, prostate, ovaries, testicles, penis, seminal vesicles, lower abdominal wall, rectum, anus, perineum and inguinal lymph nodes.

When it's used:

- Performed with radical or partial cystectomy
- Removes regional lymph nodes for staging accuracy and local disease control; may improve survival

Performed with cystectomy, recovery mirrors that of the main surgery. Discomfort in the lower abdomen or groin and temporary leg swelling can occur. Light walking is safe within days. Avoid heavy lower-body exercise or weight training for 6-8 weeks to prevent lymphedema. Compression garments and gradual activity progression help reduce swelling and restore mobility.

Reconstructive Surgery After a Cystectomy:

- **Urostomy (Incontinent Diversion) –** a urostomy is an opening (stoma) in the abdomen that connects to the urinary tract to allow urine to drain freely from the body. Urine is collected and stored in a small bag, called a urostomy pouch, which can be emptied at the patient's convenience. The pouch is attached to the skin around the stoma and worn outside the body.

The two main types of urostomy include:

- **Ileal Conduit –** a piece of intestine is removed to create a passageway for urine. The ureters are attached to the piece of intestine, then the intestine is attached to an opening in the abdomen, creating an opening (stoma). The urine flows from the ureters, through the piece of intestine, and out the stoma.

> Recovery parallels radical cystectomy since the conduit is created during the same procedure. Hospitalization averages 7-10 days. Gentle walking is encouraged daily, but lifting more than 10 pounds should be avoided to prevent parastomal hernia. By two months, patients can resume light to moderate activity, though abdominal strain and high-impact exercise should be postponed until three months or longer. Swimming is possible once incisions and stoma sites are fully healed.

- **Cutaneous Ureterostomy –** one or both ureters are attached directly to a stoma in the abdomen.

> Recovery after a cutaneous urostomy typically involves a five- to seven-day hospital stay, during which pain is managed, fluids are balanced, and patients begin walking within 24 hours to prevent complications. Because no bowel segment is used, recovery is generally faster than with other urinary diversions. At home, the first month focuses on rest, hydration, and learning stoma care, while avoiding bending, twisting, or lifting more than 5-10 pounds to prevent bleeding or hernia.
>
> Gentle walking several times a day helps circulation and strength. By 5-8 weeks, energy improves and walking can increase to 20-30 minutes daily, but heavy lifting, core work, or abdominal strain should still be avoided.
>
> Between 9-12 weeks, most people return to normal routines and light exercise, though lifting over 15-20 pounds and high-impact activity should wait until at least three months. Full recovery, with stable stamina and independent stoma management, generally occurs within 3-6 months, provided hydration, skin protection, and safe movement habits are maintained.

- **Continent Diversion –** another way for urine to drain in which a pouch is made from the piece of intestine that is attached to the ureters. One end of the pouch is connected to an opening (stoma) in the skin on the front of the abdomen. A valve is created in the pouch to allow urine to be stored there. The patient empties the pouch several times a day by putting a drainage tube (catheter) into the stoma through the valve. Some people prefer this method because there is no external pouch.

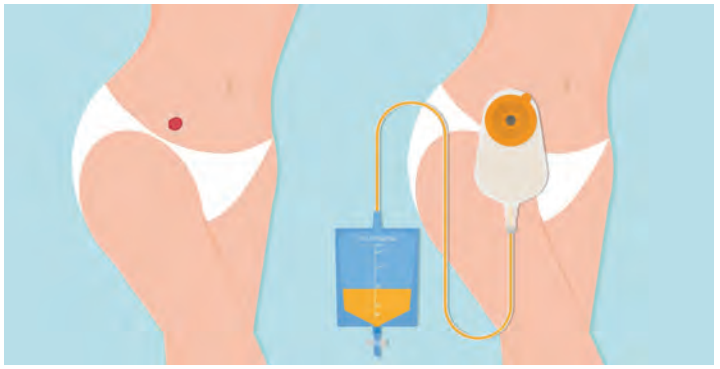
> Recovery following a continent urinary diversion, such as an Indiana or Koch pouch, is more complex than after an ileal conduit because it involves constructing an internal urine reservoir and a catheterizable stoma. Hospital stays typically range from eight to twelve days, as the bowel must heal and patients must learn how to catheterize the new reservoir. In the hospital, the focus is on pain control, restoring bowel function, maintaining hydration, and education on catheterization technique, pouch irrigation, and skin care. Walking begins within 24 hours after surgery to reduce the risk of blood clots and promote intestinal motility. Discharge is usually appropriate once bowel function returns, fluid intake is adequate, and the patient demonstrates confidence with pouch management.
>
> During the first four weeks at home, fatigue, bloating, and abdominal tenderness are common. Because the abdominal wall and bowel both require healing, physical activity should remain light. Lifting, pushing, or pulling more than 5-10 pounds should be avoided. Gentle walking several times daily helps circulation and energy recovery but should not cause fatigue or strain. The internal reservoir must be catheterized every few hours to prevent overfilling, and patients often need rest between these care routines. Hydration is essential to prevent mucus build-up and infection, and meals should be small and easy to digest while the bowel continues to adapt.

Between weeks 5-8, stamina and confidence increase. Patients can extend walking time to 20-30 minutes daily, and light household tasks may resume if they do not involve lifting, bending, or twisting. The abdominal incision may still feel tight, and pulling sensations around the stoma are common, so exercises targeting the abdomen or core should be avoided.

Lifting limits increase slightly to around 15 pounds, but caution is required to prevent hernia formation. By this stage, most individuals can self-manage catheterization and irrigation comfortably, although mild fatigue often persists.

By weeks 9-12, bowel function, energy, and strength improve noticeably. Most patients resume moderate daily activities, and light exercise such as longer walks or stationary cycling can begin if cleared by the surgeon. Upper-body resistance exercises may be reintroduced with low weights, provided there is no abdominal discomfort. Activities that increase intra-abdominal pressure, such as sit-ups, planks, or lifting more than 20 pounds, should still be postponed until at least three months post-surgery. Swimming or immersion activities can be considered once the stoma and incision are fully healed. Full functional recovery, including confident catheterization, stable energy, and tolerance for moderate exercise, generally occurs within 3-6 months, depending on age, baseline fitness, and any postoperative complications.





- **Neobladder –** a newer method routes the urine back into the urethra, restoring urination. One way to do this is to create a neobladder (new bladder made of a piece of intestine). As with the incontinent and continent diversion, the ureters are connected to the neobladder. The difference is that the neobladder is also sewn to the urethra. This lets the patient urinate normally. Over several months, most people regain the ability to urinate normally during the day, although many people might still have some incontinence at night. If the cancer has spread or can't be removed with surgery, a diversion may be made without removing the bladder. In this case, the purpose of the palliative surgery is to prevent or relieve blockage of urine flow, rather than try to cure the cancer.

Following construction of an orthotopic neobladder, recovery is gradual and requires significant adaptation as the body adjusts to a new internal bladder made from a segment of small intestine. Hospitalization typically lasts 10-14 days, as this surgery is more complex than other urinary diversions. In the hospital, the main goals are to manage pain, restore bowel function, maintain hydration, and monitor the new bladder's integrity. Patients have a urinary catheter for 1-2 weeks to allow the neobladder to heal, and walking begins within 24 hours to improve cir culation and prevent clots.

Fatigue, bloating, and mild bowel irregularities are common during this period. Patients remain hospitalized until bowel function returns, oral intake is tolerated, and any drains or catheters are functioning properly.

During the first four weeks at home, recovery focuses on rest, hydration, and gradual reintroduction of movement. Fatigue and weakness are expected, and mild abdominal discomfort can persist. The catheter is usually removed within 2-3 weeks, after which bladder training begins to teach the new reservoir to hold and empty urine. Pelvic floor exercises are often introduced under medical guidance once cleared by the surgeon. Activity should be limited to short, gentle walks several times daily, avoiding lifting, bending, or twisting. Anything over 5-10 pounds should be avoided to prevent strain on internal sutures and the abdominal incision.

Between weeks 5-8, endurance improves, and walking duration can increase to 20-30 minutes per day. Light household tasks may resume as long as they do not involve significant exertion or lifting more than 15 pounds. Pelvic floor training continues to help improve continence, and mild urinary leakage-especially at night - is normal as the neobladder stretches and muscles strengthen. Gentle stretching is allowed, but abdominal or core exercises should still be avoided. Fatigue can remain noticeable, so rest periods should be built into the day.

By weeks 9-12, most patients regain steady energy and mobility, though bladder capacity and continence continue to evolve. Walking can extend to 30-45 minutes daily, and light resistance training for the upper body can begin with medical clearance. Activities that create abdominal strain, such as sit-ups, planks, or lifting over 20 pounds, should still be postponed. Driving, sexual activity, and moderate exercise can resume once pain-free and medically cleared. Full recovery, including bladder control improvement, stable endurance, and resumption of normal routines, generally occurs between 3-6 months. Long-term success depends on consistent hydration, scheduled voiding, and regular follow-up to monitor neobladder function and kidney health.

Reconstructive Procedures:

Reconstruction Type	Purpose	Common Complications/Side Effects
Ideal Conduit	Reliable urinary diversion for most patients	Skin irritation, parastomal hernia, stoma prolapse/retraction, infection, electrolyte imbalance
Continent Cutaneous Reservoir	Internal storage, catheterized stoma (no bag)	Stomal stenosis, pouchitis, stones, acidosis, need for lifelong catheterization
Orthotopic Neobladder	Voiding via urethra, no stoma	Incontinence, retention, acidosis, stones, infections, sexual dysfunction
Ureterosigmoidostomy	Urine drains into rectum (historical)	Infection, acidosis, cancer risk, incontinence
Cutaneous Ureterostomy	Simplest external drainage	Stoma stenosis, infection, leakage, poor durability
Ureteroenteric Anastomosis	Connects ureters to bowel	Stricture, leak, infections, hydronephrosis
Pelvis/Perineal Reconstruction	Structural support post-cystectomy	Flap failure, infection, seroma, delayed healing

Types of Treatment Used:

- Intravesical therapy (BCG, gemcitabine, mitomycin C, gene therapy)
- Systemic chemotherapy (cisplatin-based, carboplatin-based)
- Immunotherapy (checkpoint inhibitors, cytokine-based therapy)
- Targeted therapy (FGFR inhibitors, HER2/Nectin-4/Trop-2 targets)
- Combination chemoradiation (bladder-sparing)
- Radiation therapy (IMRT, IGRT, SBRT, proton therapy)
- Gene and viral vector therapy
- Antibody-drug conjugates (ADCs)
- Anti-angiogenic therapy

CANCER OF THE KIDNEY

Globally, 434,840 new cases and 155,953 deaths from kidney cancer were recorded in 2022. Kidney cancer ranks as the sixth and ninth leading new cancer diagnosis for men and women respectively, and renal cell carcinoma accounts for approximately 90% of incident cases and most of the associated morbidity and deaths. Kidney cancer is responsible for approximately 2% of all adult malignancies (Cirillo et al., Nephrology Dialysis Transplantation, 2024).

Each kidney contains more than a million microscopic filtering units called nephrons, each associated with a renal tubule that joins with others to form collecting ducts that deposit urine in the renal pelvis. When cancer arises in the main part of the kidney containing the renal tubules it is called a renal cortical tumor, and cancer arising in the renal pelvis is called a transitional cell or urothelial tumor. Renal cortical tumors are a diverse group that can exhibit very different clinical behaviors, with varying risks of metastasis, and may be either benign or malignant.

Early-stage kidney cancer usually has no symptoms, but as the tumor grows there may be blood in the urine, pain or a lump in the lower back or abdomen, fatigue, loss of appetite, unexplained weight loss, fever, swelling in the legs and ankles, or in men a cluster of enlarged veins around a testicle called a varicocele. The major modifiable risk factors include smoking, obesity, hypertension, chronic kidney disease, occupational exposure to harmful substances such as trichloroethylene, lack of physical exercise, type 2 diabetes, acquired cystic disease, and heavy alcohol consumption (ACS, Kidney Cancer Risk Factors, 2025). Tobacco use carries the largest risk specifically for cancer of the renal pelvis, particularly among heavy smokers. Genetic susceptibility is estimated to account for 2-4% of renal cell carcinoma cases (Capitanio et al., JAMA, 2024).

Von Hippel-Lindau (VHL) syndrome is inherited through an autosomal dominant pattern and is caused by germline mutations of the VHL tumor suppressor gene located on chromosome 3p25-26. Clear cell renal cell carcinoma in VHL syndrome is frequently multifocal or bilateral, occurring in up to 50% of patients, and lifelong surveillance is required for early detection and management (NCI, Von Hippel-Lindau Disease PDQ, 2024). The five-year overall survival rate for kidney cancer ranges from 40-75% depending on geographic area and stage at diagnosis, with the wide range largely reflecting disparities in early detection and treatment access between high-income and lower-income countries (Cirillo et al., Nephrology Dialysis Transplantation, 2024). For localized disease, the five-year survival rate approaches 93%, but this drops considerably when the cancer has spread (NCI, SEER Cancer Statistics: Kidney Cancer, 2024).

Renal cortical tumors, also called renal cell carcinoma (RCC), are the most common type of kidney cancer. The three main subtypes are clear cell RCC (approximately 75-80% of cases), papillary RCC (10-15%), and chromophobe RCC (approximately 5%), each with distinct clinical and molecular characteristics (Capitanio et al., JAMA, 2024).

- **Collecting Duct RCC –** also known as Bellini duct carci noma - is an exceptionally rare and highly aggressive sub-type of renal cell carcinoma, accounting for less than 1% of all RCC (El Maoudda et al., Cureus, 2025)

- **Unclassified RCC –** a heterogeneous group of renal tumors that fail to meet the diagnostic criteria for any of the rec-ognized histological subtypes of RCC as defined by the WHO 2022 classification, accounting for approximately 4-6% of all RCC (Capitanio et al., JAMA, 2024).

- **Transitional Cell Carcinoma –** is like a bladder tumor. The type of cells that line the inside of the bladder also line the inside of the ureters and the renal pelvis. Cancers that arise from these cells behave similarly, whether they grow in the bladder or in the collecting system (renal pelvis and ureter). Under the microscope, the cells look like other urothelial carcinomas, such as bladder cancer. Studies have shown that, like bladder cancer, these cancers are often linked to cigarette smoking and being exposed to certain cancer-causing chemicals in the workplace. The chances for cure drop dramatically if the tumor has grown into the ureter wall or main part of the kidney or if it demonstrates more aggres-sive histological features (NCI, Renal Cell Cancer Treatment PDQ, 2024).

- **Wilms Tumor (Nephroblastoma) –** is a rare kidney cancer that primarily affects children and is the most common renal malignancy in the pediatric population, accounting for ap-proximately 6-7% of all childhood cancers and more than 85-90% of all pediatric renal tumors (Ehrlich et al., Journal of the American College of Surgeons, 2024). It most commonly presents in children aged 3-4 years as a painless abdominal mass, becoming significantly less common after age 5, though it can occur in older children and, rarely, in adults (StatPearls, Wilms Tumor, 2024). Wilms tumor typically af-fects one kidney, though approximately 5% of cases involve both kidneys simultaneously (StatPearls, Wilms Tumor, 2024). Factors that may increase the risk of Wilms tumor include:

  - **Race –** black children in North America and Europe have a slightly higher risk compared to children of other races, while Asian-American and Hispanic children ap-pear to have a notably lower risk (Ehrlich et al., Journal of the American College of Surgeons, 2024.

  - **Having a family history of Wilms Tumor –** having a first-degree relative with a history of Wilms tumor in-creases the risk of developing the disease, as a small percentage of cases have a hereditary basis (ACS, What Is Wilms Tumor?, 2024).

Procedures:

- **Partial Nephrectomy –** involves removing only the tumor and a small rim of surrounding healthy tissue while preserving the rest of the kidney. It is considered the gold standard for most small, localized kidney cancers because it maintains renal function and offers equivalent oncologic outcomes to full kidney removal in appropriate cases. The renal artery is temporarily clamped to control bleeding (using warm or cold ischemia techniques), and the collecting system and vessels are meticulously repaired afterward. The procedure may be performed through several approaches, each chosen based on tumor characteristics, surgeon expertise, and patient factors.

Types of Partial Nephrectomy:

- **Open Partial Nephrectomy –** the traditional approach through a flank or abdominal incision. Used for large, complex, or centrally located tumors where tactile feedback and full exposure are important. Often chosen for challenging cases with prior surgeries or extensive scarring.

- **Laparoscopic Partial Nephrectomy –** minimally invasive approach using small incisions and long instruments guided by a camera. Offers shorter hospital stays and less postoperative pain but requires significant surgical expertise. Best suited for small, peripheral, and less complex tumors.

- **Robotic-assisted Partial Nephrectomy –** the most common minimally invasive nephron-sparing technique in many centers. The surgeon operates robotic instruments from a console, providing enhanced precision, dexterity, and 3D visualization. Particularly beneficial for tumors in challenging locations (e.g., posterior or hilar) and allows faster recovery with excellent oncologic and functional outcomes.

- **Off-clamp (zero ischemia) Partial Nephrectomy –** the tumor is removed without clamping the renal artery, preserving continuous blood flow and minimizing ischemic injury. Used for small, exophytic tumors where bleeding risk can be controlled. Especially advantageous in patients with pre-existing kidney disease or solitary kidneys.

- **Selective or Segmental Artery Clamping –** only the specific arterial branch supplying the tumor-bearing segment is clamped, sparing the rest of the kidney from ischemia. Balances the benefits of bleeding control with greater preservation of global renal function.

- **Cold Ischemia Partial Nephrectomy –** involves cooling the kidney with ice or cold perfusion during surgery to protect tissue while the artery is clamped. Typically used in open surgery for complex or prolonged resections where warm ischemia time would exceed 25-30 minutes (Kazama et al., BJU International, 2025).

- **Enucleation (tumor shelling technique) –** a variant where the tumor is dissected along its natural pseudocapsule without removing additional normal parenchyma. Indicated for small, exophytic, well-encapsulated tumors or hereditary multifocal disease where maximum renal preservation is critical.

When it's used:

- Preferred for most cT1 masses (≤4 cm) and many cT1b (4-7 cm) when technically feasible
- Patients with a solitary kidney, bilateral tumors, pre-existing chronic kidney disease (CKD)
- Genetic syndromes (e.g., VHL)
- Strong need to preserve renal function

Following nephrectomy, whether partial or radical, recovery depends on the surgical approach, the extent of kidney removal, and the patient's overall health. Hospital stays are typically shorter after minimally invasive procedures and longer for open surgeries or when complications arise. On average, patients stay in the hospital 2-4 days after laparoscopic or robotic surgery and up to seven days after open surgery. During the hospital phase, pain management, hydration, wound care, and early mobilization are the primary goals. Walking usually begins within 24 hours to promote blood circulation, support lung function, and reduce the risk of blood clots or pneumonia. Once patients can tolerate food, have adequate pain control, and maintain stable kidney function, discharge is usually appropriate.

In the first four weeks at home, fatigue, soreness near the incision site, and reduced stamina are common. Physical activity should be limited to gentle walking several times daily, with rest breaks as needed. Patients should avoid bending, twisting, or lifting anything heavier than 5-10 pounds to protect the surgical site and internal healing. Hydration is especially important, as the remaining kidney must adapt to handle full filtration duties. Strenuous tasks, yard work, or exercise that raises blood pressure should be postponed. By the end of the first month, most people can perform light household activities and drive short distances if they are no longer taking pain medication.

Between weeks 5-8, energy levels gradually improve, and walking can be increased to 20-30 minutes at a comfortable pace once or twice per day. Stretching and gentle mobility exercises may be introduced to restore range of motion, particularly after open surgery. Lifting should still be restricted to under 15 pounds. Individuals may begin to return to part-time work or light duties, depending on recovery progress and medical advice. Any swelling, redness, or persistent pain around the incision should be evaluated promptly.

From weeks 9-12, most patients regain normal stamina and can safely return to moderate activity, including longer walks, stationary cycling, or light resistance training under supervision. Core-intensive or high-impact activities such as running, jumping, or heavy lifting should still be delayed until at least three months after surgery or until cleared by the surgeon. Hydration and balanced nutrition remain priorities to support kidney health. Full recovery - including restored energy, stable kidney function, and tolerance for unrestricted activity - typically takes 3-6 months, depending on the procedure type and individual healing capacity.

Potential Side-effects of a Nephrectomy:

- Pain and tenderness at the incision sites (open or laparoscopic)
- Fatigue and temporary weakness for several weeks after surgery
- Bleeding or hematoma around the kidney or in the urine (hematuria)
- Urine leak from the collecting system repair
- Injury to nearby organs such as bowel, spleen, pancreas, or liver
- Infection at the incision or internally near the kidney
- Vascular complications such as pseudoaneurysm or arteriovenous fistula
- Transient decline in kidney function due to temporary ischemia
- Hernia formation at port or incision sites
- Deep vein thrombosis (DVT) or pulmonary embolism (PE) from reduced mobility
- Persistent flank pain or numbness from nerve irritation
- Positive surgical margins requiring further evaluation or treatment

Types of Treatment Used:

- Immune checkpoint inhibitor therapy
- Targeted therapy
- Combination immunotherapy with VEGFR-TKI
- HIF-2α inhibitor therapy
- Adoptive cell therapy / CAR T-cell therapy in RCC
- Personalized cancer vaccines
- Chemotherapy (rare)
- Radiotherapy (rare)

CANCER OF THE PANCREAS

There were 510,992 new cases and 467,005 deaths from pancreatic cancer worldwide in 2022, with mortality nearly equaling incidence (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Although pancreatic cancer is only the 12th most commonly diagnosed cancer globally, it is the sixth leading cause of cancer-related death worldwide and the third leading cause in the United States (Bray et al., CA: A Cancer Journal for Clinicians, 2024; ACS, Key Statistics for Pancreatic Cancer, 2024). It is on track to become the second leading cause of cancer death in the United States before 2030, overtaking colorectal and breast cancers (Cicenas et al., Cancers, 2025).

Pancreatic cancer is often described as "silent and deadly" because it silently harbors a growing tumor for an extended period before producing symptoms. When symptoms do finally appear, they are frequently mistaken for other conditions such as hepatitis, gallstones, or diabetes, leading to further diagnostic delays. By the time the tumor is detected, it has usually already spread beyond the pancreas. Pancreatic cancer most commonly presents at an advanced stage, and surgical resection - the only currently available option for cure - is possible in only 15–20% of patients at the time of diagnosis (Puckett and Garfield, StatPearls, 2024). For patients who do undergo successful surgical resection, the five-year survival rate ranges from 20-37% depending on tumor size, lymph node involvement, and margin status, and improves further when followed by adjuvant chemotherapy (Mizrahi et al., The Lancet, 2020).

The overall five-year survival rate for all stages of pancreatic cancer combined has improved to 13% as of 2024, up from just 6% a decade ago, driven primarily by earlier diagnoses and improved management of localized disease (ACS, Key Statistics for Pancreatic Cancer, 2024). Despite this progress, the prognosis for advanced disease remains extremely poor, with a five-year survival rate of only 3% for patients diagnosed with distant metastases (NCI, SEER Cancer Statistics: Pancreas, 2024). Recurrence after treatment is very likely, and the disease continues to carry one of the lowest survival rates of any cancer type.

More than 90% of pancreatic cancers are exocrine in origin, with pancreatic ductal adenocarcinoma (PDAC) being by far the most common type. These tumors typically arise in the head of the pancreas and frequently produce obstructive jaundice from an accumulation of bile in the bloodstream due to compression of the common bile duct. Tumors in the body or tail of the pancreas are farther from the bile duct and typically do not trigger jaundice in the early stages, contributing further to late detection. The five-year survival rate for exocrine pancreatic tumors is approximately 8% (ACS, Pancreatic Cancer Survival Rates, 2024).

The remaining approximately 5-7% of pancreatic cancers arise in the endocrine tissue of the pancreas and are referred to as pancreatic neuroendocrine tumors (PNETs), previously called islet cell carcinomas. These tumors develop in the hormone-producing islet cells that regulate blood sugar. PNETs are significantly less aggressive than exocrine pancreatic cancer, and many are either non-functional or slow-growing, resulting in a far more favorable prognosis with a five-year survival rate of approximately 72% (ACS, Pancreatic Cancer Survival Rates, 2024). Functional PNETs produce hormones such as insulin, glucagon, or gastrin, and their clinical presentation depends on which hormone is secreted in excess. Approximately 5-10% of pancreatic cancers have a hereditary genetic cause, including associations with Lynch syndrome, Peutz-Jeghers syndrome, Von Hippel-Lindau syndrome, and multiple endocrine neoplasia type 1 (Mizrahi et al., StatPearls, 2023).

Symptoms of pancreatic cancer include upper abdominal or lower back pain that gradually worsens and is most severe at night, back pain that is aggravated by lying flat and relieved by sitting up or lying in a fetal position, pain in the back that is relieved by bending forward or by standing, pain that occurs several hours after meals and is more severe at night, loss of appetite, blood clots, fatigue, weight loss, change in bowel habits, diarrhea or greasy stools, depression, severe constipation, jaundice, and the sudden onset of diabetes.

Approximately 20-25% of all pancreatic cancers are attributed to cigarette smoking, with smokers being approximately twice as likely to develop the disease compared to non-smokers; cigar smoking and smokeless tobacco also confer elevated risk (ACS, Pancreatic Cancer Risk Factors, 2024). A 2023 multiethnic cohort study of 182,011 participants found that 50 pack-years of smoking was associated with a 91% increased risk of pancreatic cancer relative to never-smokers, with each additional year of smoking cessation corresponding to a 9% progressive reduction in excess risk (Bogumil et al., Cancer Causes and Control, 2023). Additional established risk factors include a personal or family history of pancreatitis, type 2 diabetes - particularly of more than five years' duration - obesity, older age (typically above 60), and heavy alcohol consumption, which can promote chronic pancreatitis and subsequent malignant transformation. Approximately 5-10% of pancreatic cancer cases are related to inherited gene mutations, and individuals with the following hereditary syndromes are at significantly elevated risk: Lynch syndrome, multiple endocrine neoplasia type 1 (MEN1), von Hippel-Lindau syndrome, Peutz-Jeghers syndrome, hereditary breast and ovarian cancer syndrome (BRCA1/BRCA2), familial atypical mole-malignant melanoma (FAMMM) syndrome, and hereditary pancreatitis (ACS, Pancreatic Cancer Risk Factors, 2024).

The type of operation will depend on the stage of the disease, age, and overall condition. There are 2 general types of surgery used for pancreatic cancer:

- Potentially curative surgery is used when imaging tests suggest that it is possible to remove all cancer
- Palliative surgery may be done if imaging tests show that the tumor is too widespread to be completely removed. This is done to relieve symptoms or to prevent certain complications like a blocked bile duct or intestinal tract.

Research consistently shows that positive resection margins are associated with significantly poorer survival outcomes compared to margin-negative resection, and achieving clear margins (R0) is the most important surgical quality indicator in pancreatic cancer surgery (Pedrazzoli, Surgical Oncology, 2023). Only up to 20% of patients are considered eligible for surgical resection at the time of diagnosis, as most pancreatic cancers are discovered only after the disease has already spread beyond the pancreas (NCI, SEER Cancer Statistics: Pancreas, 2024). Pancreatic surgery poses significant technical challenges and is associated with a considerable morbidity rate ranging from 20% to 30%, making it one of the most demanding operations in all of surgery and one of the most physically taxing for patients to undergo. Patients must carefully weigh the potential benefits and risks with their surgical team before proceeding. When surgery involves removal of all or part of the pancreas - whether through the Whipple procedure (pancreaticoduodenectomy), distal pancreatectomy, or total pancreatectomy - the recovery period is prolonged and challenging. Patients typically require pancreatic enzyme replacement therapy (PERT) to aid digestion, insulin therapy to manage blood sugar if sufficient insulin-producing tissue has been removed, and dietary modifications to reduce digestive strain. Malabsorption and difficulty maintaining weight are common post-surgical challenges that can significantly slow recovery and affect quality of life, often requiring ongoing nutritional support and monitoring by a registered dietitian (Dominguez-Muñoz et al., United European Gastroenterology Journal, 2025).

The mortality landscape changed dramatically at the 2026 ASCO Annual Meeting Plenary Session, where the Phase 3 RASolute 302 trial of daraxonrasib - a RAS(ON) multi-selective inhibitor targeting both mutant and wild-type RAS - drew a standing ovation. In previously treated patients with metastatic pancreatic ductal adenocarcinoma, the trial demonstrated a median overall survival of 13.2 months versus 6.7 months for standard chemotherapy, with a hazard ratio of 0.40 (95% CI: 0.30-0.54; p<0.0001), representing a 60% reduction in the risk of death with a manageable safety profile and fewer serious adverse events than chemotherapy (Wolpin, Wainberg, Hendifar, et al., Journal of Clinical Oncology, 2026, Abstract LBA5; O'Reilly, Wainberg, Hendifar, et al., New England Journal of Medicine, 2026). These results have been declared landscape-changing by leading experts, with daraxonrasib positioned as the new standard of care in the second-line setting, FDA regulatory submission already underway, and trials evaluating first-line use ongoing.

Procedures:

- **Whipple Procedure (Pancreatoduodenectomy) –** surgical removal of the head and neck of the pancreas, sometimes the body of the pancreas, the gallbladder, part of the stomach, the lower half of the bile duct, part of the small intestine, and some surrounding tissue. This is the most common procedure to remove a cancer in the exocrine pancreas. The remaining bile duct is attached to the small intestine so that the bile from the liver can continue to enter the small intestine. Finally, the stomach is reattached to the small intestine so food can pass through the digestive tract. After this operation, the patient can generally produce adequate amounts of insulin and digestive enzymes.

Most often, this operation is done through a large incision down the middle of the stomach. Occasionally it can be performed as a laparoscopic procedure, which is sometimes known as keyhole surgery. This is a complex operation that requires a highly skilled surgeon. It carries a relatively high risk of complications that can be life threatening.

When it's used:

- Tumors located in the pancreatic head or uncinate process that are confined to the gland and have no major arterial invasion
- Cancers of the distal bile duct that pass through the head of the pancreas and require en bloc removal for clear margins
- Ampullary (ampulla of Vater) tumors where the bile and pancreatic ducts join before entering the small intestine
- Duodenal cancers involving the first or second portion of the duodenum near the pancreas
- Select borderline-resectable tumors with limited vascular involvement that become operable after neoadjuvant therapy (chemotherapy or chemoradiation)
- Non-malignant but high-risk or symptomatic lesions in the pancreatic head

Hospital stays are typically 7-10 days for open surgery, or 5-7 when performed using minimally invasive robotic or laparoscopic techniques. Early mobilization is initiated within the first 24 hours, with short assisted walks as soon as the patient is stable. During the first 4-6 weeks at home, all activity must remain gentle and progressive. Short walks several times per day form the cornerstone of early recovery and should be gradually extended in both duration and distance as energy allows. Lifting anything heavier than 10 pounds, bending, twisting, and any activity that engages or strains the core must be strictly avoided for a minimum of 6 weeks to protect the multiple surgical anastomoses and reduce risk of hernia, wound dehiscence, and intern al strain.

High-energy activities such as jogging, cycling, tennis, and contact sports should not be attempted during this period. Fatigue is common and often significant during this phase, lasting 6-8 weeks or longer, and activity periods should always be balanced with adequate rest.

Between weeks 5-8, light stretching, gentle flexibility exercises, and low-impact activity such as swimming or stationary cycling can be cautiously introduced as pain subsides and the surgical drain, if still in place, has been removed.

Between months 2-3, walking distance and pace can be progressively increased, with a return to normal daily activities typically achievable by 4-6 weeks post-discharge for most patients. Strenuous exercise, heavy resistance training, and core strengthening should not be resumed until at least 3 months post-operatively to avoid hernia formation or strain at the operative site.

Potential Side-effects of a Whipple Procedure:

- Pancreatic fistula
- Delayed gastric emptying Bile leak
- Post-pancreatectomy hemorrhage
- Intra-abdominal abscess
- Wound infection
- Malnutrition/weight loss
- New or worsened diabetes Exocrine insufficiency (steatorrhea)
- Anastomotic ulcer
- Deep Vein Thrombosis (DVT)
- Pulmonary Embolism (PE)

• **Distal Pancreatectomy –** surgical removal of the body and tail of the pancreas and usually the spleen. This procedure is used most often with islet cell carcinoma found in the tail and body of the pancreas. It is not used very often with exocrine cancers because these cancers have usually spread.

When it's used:

- Resectable tumors of the body/tail
- En bloc with spleen for PDAC
- Spleen-preserving for small low-grade neoplasms or neuroendocrine tumors

Hospital stays are typically 5-7 days following distal pancreatectomy, or 3-5 days if the procedure was performed laparoscopically or robotically. Early mobilization begins within the first 24 hours, with short assisted walks encouraged as soon as the patient is stable. During the first 4-6 weeks at home, activity must remain light and moderate - gentle walking several times per day is recommended, while bending, twisting, lifting more than 10 pounds, and any core-engaging movements should be strictly avoided to re duce the risk of hernia, wound dehiscence, and strain on the surgical site

. The primary post-operative complications - pancreatic fistula, along with bleeding and infection - mean that exertion levels must be carefully monitored during this period, as increased intra-abdominal pressure can compromise healing.

Between weeks 5-8, light stretching, gentle yoga, and low-impact activity can be gradually introduced as pain subsides and the surgical drain, if still in place, has been removed. By three months, most patients can progressively return to normal levels of daily activity and endurance exercise, though strenuous exercise, heavy resistance training, and core strengthening should still be approached cautiously to avoid hernia formation or internal strain at the operative site.

• **Total Pancreatectomy –** surgical removal of the entire pancreas, part of the stomach, part of the small intestine, the common bile duct, the gallbladder, the spleen, and nearby lymph nodes. This procedure is not often used to treat exocrine cancers because there doesn't seem to be any marked advantage for removing the entire pancreas. While it is possible to live without a pancreas, when the islet cells are removed, people are unable to produce insulin. They then develop diabetes and become dependent on insulin.

People who have had this surgery also need to take pancreatic enzyme pills to help them digest certain foods.

When it's used:

- Extensive main-duct involvement
- Positive margins not correctable by limited resection
- Select genetic syndromes
- Some locally advanced cases after response to therapy

Hospital stays following total pancreatectomy are typically 7-10 days, compared to other pancreatic surgeries. Early mobilization begins within the first 24 hours, with assisted walking encouraged as soon as the patient is stable and blood glucose is under control - a particularly important consideration given that total pancreatectomy results in complete insulin deficiency and diabetes requiring immediate insulin management.

During the first 6-8 weeks at home, all activity must remain gentle and progressive - short walks several times per day are the foundation of early recovery and should be gradually extended in duration and distance as energy permits. Lifting anything heavier than 10 pounds, bending, twisting, and any core-engaging or straining movements must be strictly avoided for a minimum of 6 weeks to protect the extensive abdominal closure and reduce the risk of hernia formation. Fatigue is typically more pronounced and prolonged after total pancreatectomy, often persisting 6-8 weeks or longer, and patients should balance all activity periods with adequate rest.

Between weeks 6-10, light stretching, gentle flexibility work, and low-impact activities such as swimming or cycling on a stationary bike can be cautiously introduced, guided by the surgical team and tailored to the patient's individual glycemic stability and overall recovery trajectory. Strenuous exercise, heavy resistance training, jogging, and high-impact activities should not be resumed until at least 3 months post-operatively, and ideally only with clearance from the surgical team and input from a physiotherapist. Exercise intensity and timing relative to meals and insulin administration require careful coordination throughout recovery and long-term, with blood glucose monitoring before, during, and after exercise strongly recommended to prevent hypoglycemia.

- **Central Pancreatectomy (Parenchyma-Sparing) –** resection of the pancreatic neck/body with preservation of head and tail; requires two cut surfaces with pancreaticoenteric anastomosis distally and proximal stump closure.

When it's used:

- Small benign/low-grade tumors in the mid-gland where maximal endocrine/exocrine preservation is desired (more common for neuroendocrine or cystic neoplasms, not PDAC)

Hospital stays following central pancreatectomy are typically 8-12 days. Early mobilization begins with assisted walking initiated as soon as the patient is stable. The complex metabolic and insulin management considerations that complicate exercise programming after total pancreatectomy are generally not a concern, allowing for a more straightforward recovery trajectory.

During the first 6 weeks at home, all activity must remain gentle and progressive. Short walks several times per day form the foundation of early recovery and should be gradually extended in duration and distance as energy and comfort permit. Lifting anything heavier than 10 pounds, bending, twisting, and any core-engaging or straining movements must be strictly avoided for a minimum of 6 weeks to protect the surgical repair and reduce the risk of hernia formation. Fatigue is common during this period.

Between weeks 6-10, light stretching, gentle flexibility work, and low-impact activities such as swimming or stationary cycling can be cautiously introduced as pain subsides and energy levels improve. By three months, most patients can progressively return to normal levels of daily activity and endurance exercise, though strenuous exercise, heavy resistance training, and core strengthening should be approached cautiously to ensure safe and progressive loading of the abdominal musculature and avoid hernia formation at the operative site.

Potential Side-effects of Central Pancreatectomy:

- Higher pancreatic fistula rates than distal pancreatectomy
- Bleeding
- Abscess; but better long-term endocrine/exocrine preservation when healing is uneventful

- **Tumor Enucleation –** involves shelling out a small, well-circumscribed lesion without removing pancreatic parenchyma beyond the capsule.

When it's used:

- Small, superficial neuroendocrine tumors or benign lesions ≥2-3 mm from the main pancreatic duct; not used for Pancreatic Ductal Adenocarcinoma

Potential Side-effects of Tumor Enucleation:

- Pancreatic fistula
- Pancreatitis
- Bleeding

- **Vascular resection and reconstruction (venous ± arterial) -** en bloc resection of involved portal vein/superior mesenteric vein with end-to-end anastomosis or graft; selected arterial resections (common hepatic/SMA/celiac) in highly specialized centers.

When it's used:

- Borderline-resectable/locally advanced tumors with limited venous involvement and response to neoadjuvant therapy
- Arterial resections only in exceptional cases with strong multidisciplinary consensus

Hospital stays range from 10-14 days depending on the extent of vascular involvement and complexity of reconstruction. Early mobilization begins with assisted walk ing initiated as soon as the patient is stable. The recovery and exercise progression broadly mirrors that of standard open pancreatectomy, with two important modifications. First, all activity restrictions should be applied more conservatively - the 6-8 week lifting and ac tivity restriction represents a minimum rather than a target, and progression to light stretching and low-impact exercise should not occur until weeks 8-12, subject to surgical team clearance and confirmation of graft patency on vascular surveillance imaging. Second, pa - tients receiving anticoagulation therapy to protect the vascular reconstruction must avoid any activities carry ing a fall or contact risk for the duration of treatment. Routine CT surveillance provides important checkpoints for safely advancing, and return to strenuous exercise, resistance training, and core strengthening should not occur until at least 3-4 months post-operatively (typically 4-6 weeks later than after standard pancreatectomy.

- **Minimally Invasive Surgery –** may be used to remove pancreatic neuroendocrine tumors (NETs). It involves using a thin, lighted tube called a laparoscope with a camera on its tip, through tiny incisions in the clients' abdomen. It is used to remove pancreatic cysts, tumors, and all or part of the gland. Sometimes if the tumor is small, just the tumor itself is removed. This is called enucleation. This operation may be done using a laparoscope, so that only a few small incisions are needed. This operation may be all that is needed to treat an insulinoma, since this type of tumor is often benign. Small gastrinomas (tumors 2 inches or less) may also be treated with enucleation, but sometimes the duodenum (the first part of the small intestine) is removed as well. Larger gastrinomas may require a pancreaticoduodenectomy or a distal pancreatectomy, depending on the location of the tumor. The lymph nodes around the pancreas are also removed in some cases so that they can be checked for signs of cancer spread. Surgery may be used to remove metastases when it has spread to the liver (the most common site of spread) and the lungs. Removing metastases can improve symptoms and prolong life in clients with pancreatic NETs. In rare cases, liver transplantation may be used to treat pancreatic NETs that have spread to the liver.

When it's used:

- Resectable disease
- Small tumors with no vascular involvement

Hospital stays following minimally invasive Whipple or pancreatectomy are typically 3-7 days, compared to 7-10 days for open surgery. Activity restrictions during the first four weeks therefore remain closely aligned with those applied after open procedures. Lifting any thing heavier than 5-10 pounds is prohibited for a minimum of 4-6 weeks, and bending, twisting, straining, jogging, cycling, racquet sports, and contact sports must all be avoided during this period to protect the surgical repair and reduce the risk of hernia or wound complications.

Short walks should be performed several times daily from the first days at home, with distance and duration increased gradually at each outing as energy and comfort allow. Stair climbing is permitted but should be approached slowly with rest breaks as needed. Fatigue is common following minimally invasive surgery, though it tends to be less pronounced and shorter in duration than after open surgery. By the end of week four, most patients will notice a gradual improvement in energy, walking tolerance, and overall functional capacity.

By weeks 4-6, patients can begin with light stretching, gentle yoga, and low-impact activities such as swimming or stationary cycling often appropriate from around weeks 4-5, subject to surgical team clearance. By 6-8 weeks, most patients can return to the majority of normal daily activities and begin progressively increasing aerobic activity. Light resistance training targeting large muscle groups can be cautiously introduced following medical clearance, with core strengthening exercises deferred until 10-12 weeks to protect the surgical site. A return to full, unrestricted exercise is generally achievable by 3 months in uncomplicated cases.

Potential Side-effects of all Pancreatectomies:

- Constipation
- Pain
- Post-operative bleeding
- Fatigue
- Cramping and diarrhea
- Weight loss of 10-15 pounds
- Fistula (leak) can potentially occur as a result of the failure of sutures to seal the new connection
- Delayed gastric emptying (a condition in which food and liquids are slow to leave the stomach)
- Pancreatic anastomotic leak (this is a leak in the connection that the surgeon makes between the remainder of the pancreas and the other structures in the abdomen)
- Lower extremity lymphedema
- Insulin dependence (because entire pancreas is removed, patient will become diabetic)
- Osteopenia (18% reduction in bone mineral content)
- Liver disease
- Immunocompromization and overwhelming post-splenectomy infections

- **Palliative Surgery –** if the cancer has spread too far to be removed completely, any surgery being considered would be palliative (intended to relieve or prevent symptoms). Because pancreatic cancer can progress quickly, most doctors do not advise major surgery for palliation, especially for people who are in poor health. Sometimes surgery might begin with the hope it will cure the patient, but the surgeon discovers this is not possible. In this case, the surgeon might continue the operation as a palliative procedure (bypass surgery) to relieve or prevent symptoms. Cancers growing in the head of the pancreas can block the common bile duct as it passes through this part of the pancreas. This can cause pain and digestive problems because bile can't get into the intestine. The bile chemicals will also build up in the body. This can cause jaundice, nausea, vomiting, and other problems.

When it's used:

- Unresectable or metastatic disease with symptomatic biliary or duodenal obstruction when endoscopic stenting is not feasible or has failed

Compared to the other pancreatic surgical procedures biliary bypass differs in several important respects. The hospital stay is shorter - typically 5-7 days for open surgery and 2-4 days laparoscopically. Activity restrictions are less stringent, with a 10-pound lifting limit applied for 4-6 weeks rather than the 6-8 weeks required after the Whipple, total pancreatectomy, or vascular reconstruction procedures. The metabolic context is also simpler - unlike total pancreatectomy, there are no insulin or blood glucose management considerations affecting exercise timing, and unlike distal pancreatectomy with splenectomy, there are no post-splenectomy infection precautions to observe.

All other procedures in this group are performed with curative or resective intent, and exercise programming is directed toward progressive return to full fitness and long-term functional recovery. Biliary bypass is palliative, and the aims of exercise therefore shift funda mentally toward maintaining functional independence, managing fatigue, preserving muscle mass, and optimising quality of life. Light stretching and progressive walking can be introduced from weeks 4-8, but progression beyond this point is governed by disease burden, symptom control, and individual performance status rather than a standardized surgical recovery pathway. For patients with an external biliary drainage catheter in place, swimming and water immersion are contraindicated for the duration, and all activity must account for catheter security and drainage bag management. Physiotherapy and palliative care team input are strongly recommended throughout.

Potential Side-effects of Palliative Surgery:

- Anastomotic leak
- Cholangitis
- Delayed gastric emptying
- Infection

- **Endoscopic Stent Placement –** when the tumor is blocking the bile duct, surgery can be done to put in a stent (a thin tube) to drain bile that has built up in the area. The doctor may choose to place the stent through a catheter that drains to the outside of the body, or the stent may go around the blocked area and drain the bile into the small intestine.

- **Biliary Bypass Surgery –** this procedure is performed when an inoperable tumor is blocking the duodenum, causing bile fluid to build up in the gallbladder, or when it is blocking the common bile duct that passes through the pancreas. In the first situation, the surgeon bypasses the bile duct to the jejunum, the section of the small intestine below the duodenum. In the next situation, a catheter tube is surgically implanted in the bile duct. The fluid then drains into a small external bag. A nerve block is performed during the operation to relieve pain.

Types of Treatment Used:

- Chemotherapy
- Radiation therapy
- Combination chemoradiation
- Targeted therapy
- Immunotherapy (immune checkpoint inhibitors, T-cell therapies, vaccines)
- Antibody - drug conjugates (ADCs) or novel biologic agents
- Tumor Treating Fields (TTFields) therapy (device-based, adjunct to chemotherapy)
- Gene therapy and oncolytic viral therapy

DIABETES:

Exercise can help patients with diabetes improve blood sugar control while reducing the risk of heart disease, vascular complications, and nerve damage. Type 2 diabetes mellitus is associated with insulin resistance and impaired glucose utilization, which can contribute to the buildup of fat in the arterial walls and increase the risk of atherosclerosis, hypertension, and cardiovascular events. Regular exercise helps maintain a healthy weight and improves the body's ability to utilize glucose, reducing fat accumulation in arteries and blood vessels and mitigating associated cardiovascular risk (Brown, Knox, and Pierce, Frontiers in Clinical Diabetes and Healthcare, 2025).

Obesity is a particular concern in type 2 diabetes. When a person carries excess weight, the sensitivity of glucose-utilizing cells to insulin decreases, causing glucose to remain in the bloodstream rather than being taken up by cells. Weight loss through regular exercise can significantly improve insulin sensitivity and glycemic control, and in some individuals may support diabetes remission — defined by the ADA as achieving an HbA1c below 6.5% for at least three months without glucose-lowering medications (ADA, Standards of Care in Diabetes, 2025).

Diabetes can impair blood flow to the feet and cause peripheral neuropathy - nerve damage that reduces sensation, impairs balance and coordination, causes muscle weakness, and leads to loss of reflexes particularly in the ankles, altering gait and increasing fall risk (Akhtar, Biomolecules and Biomedicine, 2024). These changes can result in the development of blisters or sores on the feet without the patient being aware. Foot hygiene activities such as pedicures and shaving also carry added risk - if the skin is nicked or cut, bacteria can enter the wound, and impaired healing increases the risk of infection, ulceration, and in severe cases amputation if infection damages tissue and bone extensively.

Blood sugar should be monitored before, during, and after exercise. Tracking these records reveals how the patient's body is responding to physical activity and helps prevent dangerous blood sugar fluctuations. When a patient is taking insulin or any other medication that can cause hypoglycemia, blood sugar should be checked approximately 30 minutes prior to exercising to determine whether levels are stable, rising, or falling and whether it is safe to proceed (ADA, Standards of Care in Diabetes, 2025)

Typical Blood Sugar Responses by Type of Exercise (Zhang et al., Frontiers in Physiology, 2025)

Exercise Type	Immediate Effect	Later Effect (up to 48 hours)
Moderate Aerobic (30-60 minutes)	Mild drop (10-30 mg/dl)	Increased insulin sensitivity; lower fasting glucose
Long-duration or Endurance (>60)	Significant drop; risk of hypoglycemia	Sustained lower glucose
High-Intensity Interval Training (HIIT)	Short-term rise	Longer-term glucose, improved insulin response
Strength/Resistance Training	Small rise or stable	Reduced overall glucose and improved insulin action
Gentle Activity (yoga, stretching)	Minimal change	Stress reduction improves glucose control

Here are some general guidelines to follow based on their blood sugar levels:

- **Lower than 90 –** blood sugar may be too low to exercise safely. They should eat a small snack of simple carbohydrates such as fruit, juice, or crackers prior to beginning a workout.
- **90-250 –** this is a safe blood sugar range with virtually no restrictions
- **Above 250 –** this is a time when it would be advisable for them to check their urine for ketones (substances made when your body breaks down fat for energy). If there are excess ketones, it means that the body doesn't have enough Insulin to control the blood sugar levels. If they exercise when there is a high level of ketones, they risk ketoacidosis – a serious complication of diabetes that requires immediate treatment. It is best for them to wait to exercise until they have a low level of ketones in their urine.

Some important points to remember about working with diabetics:

1. Exercise should be done in moderation with a proper warm-up and cooldown
2. Exercise is best when done approximately at the same time every day; this helps to control blood sugar
3. Shoes should be well-fitting and designed for the appropriate activity they are participating in
4. Diabetics should wear socks and be alert for blisters. If they already have foot problems such as peripheral neuropathy, they should avoid high-impact activities and be cautious when performing activities with a risk of falling.
5. For longer sessions (>60 min), check blood sugar every 30-60 minutes if possible.
6. Maintain hydration and have glucose tabs or a carbo hydrate source handy.
7. After activity, recheck glucose immediately and again 2-4 hours later to monitor for delayed hypoglycemia (common after aerobic or mixed training).

Special Considerations in Pancreatic Cancer or Post-Surgery

After Partial or Total Pancreatectomy:

- Insulin production is reduced or absent; blood glucose can fluctuate widely
- Insulin-dependent diabetes ("type 3c diabetes") may develop
- Exercise enhances insulin sensitivity-doses may need adjustment to prevent hypoglycemia
- Carbohydrate intake before exercise becomes essential, especially if appetite or absorption are impaired

With Exocrine Insufficiency (Enzyme Replacement Required):

- Malabsorption may alter nutrient availability, making energy and glucose balance less predictable
- Proper enzyme use with meals/snacks before exercise helps stabilize glucose

With Chemotherapy or Cachexia:

- Fatigue and muscle loss can affect glucose metabolism; moderate, low-impact exercise is best tolerated
- Regular glucose checks guide nutrition and medication adjustments

CERVICAL CANCER

Cervical cancer is the fourth most common cancer in women globally, with approximately 662,301 new cases and 348,874 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Approximately 94% of all deaths from cervical cancer occur in low- and middle-income countries (WHO, Cervical Cancer Fact Sheet, 2024). Cervical cancer remains the most common cancer in women overall in 25 countries (WHO, Cervical Cancer Fact Sheet, 2024). In the United States, an estimated 13,820 people were diagnosed with invasive cervical cancer and 4,360 died from the disease in 2024 (ACS, Key Statistics for Cervical Cancer, 2024).

Cervical cancer occurs when abnormal cells on the cervix grow out of control. Approximately 99.7% of cervical cancers are caused by persistent infection with human papillomavirus (HPV), a sexually transmitted virus that directly infects the squamous cell epithelium of mucosal surfaces (Crifase and Parker, StatPearls, updated June 2025). There are many types of HPV; not all cause cervical cancer. Some types cause genital warts, while other high-risk types - particularly HPV 16 and 18, which together account for more than 70% of cervical cancers - may cause no visible symptoms for years while silently driving cellular changes that can progress to cancer (WHO, Cervical Cancer Fact Sheet, 2024). Women living with HIV are six times more likely to develop cervical cancer compared to women without HIV (WHO, Cervical Cancer Fact Sheet, 2024).

The two main types of cervical cancer are squamous cell carcinoma, which begins in the thin flat cells lining the cervix and accounts for the majority of cases, and adenocarcinoma, which begins in the mucus-producing glandular cells of the cervix. Less common types include adenosquamous carcinoma and small cell carcinoma. Prevention and vaccination represent the most powerful tools available against cervical cancer. Three HPV vaccines have been approved: Gardasil-9 (9-valent), Gardasil (quadrivalent), and Cervarix (bivalent), all of which are effective against HPV types 16 and 18. In the United States, only Gardasil-9 is currently administered due to its broader protection against nine HPV types (Nabi, Mimba, and Akunne, Preventing Chronic Disease, 2025). The CDC recommends vaccination between ages 9-26, with earlier vaccination preferred as it provides protection before potential HPV exposure. Early vaccination has resulted in more than an 80% reduction in HPV infections and a 40% reduction in cervical precancers (Nabi, Mimba, and Akunne, Preventing Chronic Disease, 2025).

The Pap smear has contributed to more than a 70% decrease in cervical cancer incidence and mortality in countries where it is widely available (Cirik and Tosun, StatPearls, updated June 2025). However, HPV DNA testing is now recognized as having higher sensitivity than the Pap smear alone and is increasingly used as a primary screening tool or in co-testing alongside the Pap smear (ACS, Cervical Cancer Screening, 2024). For high-risk women aged 30 and older, WHO recommends HPV DNA testing in combination with the Pap smear. In 2024, the FDA approved two tests allowing women to collect their own cervical samples within a clinician's office, and in 2025 the FDA approved the Teal Wand for at-home self-collection, significantly expanding access to screening (AACR, Cancer Progress Report, 2025). A suspicious Pap smear or positive HPV test is followed by colposcopy and cervical biopsy for definitive diagnosis. In cases where biopsy results are inconclusive, removal of a larger tissue sample through cervical conization may be necessary. In countries where screening is not available, cervical cancer is usually more advanced at presentation and carries a poorer prognosis. Symptoms in early cervical cancer are typically absent, which is why regular screening is critical. As the cancer grows, symptoms may include unusual vaginal bleeding such as bleeding between menstrual periods, after intercourse, or after menopause; heavier or longer menstrual periods; unusual vaginal discharge; and pelvic pain. Bleeding is typically bright red and unpredictable in timing, amount, and duration. While these symptoms may have causes other than cancer, any woman experiencing them should seek prompt medical evaluation (WHO, Cervical Cancer Fact Sheet, 2024).

Procedures:

- **Surgical Conization (Cone Biopsy) –** surgical conization, also called a cone biopsy, is a procedure in which a cone-shaped section of tissue is removed from the cervix, including the transformation zone where most precancerous and early cancerous changes develop. It can be performed using different techniques such as cold-knife conization (a scalpel excision), LEEP or LLETZ (a heated loop excision device), or CO_2 laser excision. Cold-knife methods offer the best margin accuracy, while LEEP is common worldwide because it is accessible and cost-effective. Conization is used to treat high-grade cervical dysplasia, adenocarcinoma in situ, and very early cervical cancer, particularly when fertility preservation is desired. It may also be performed when margins from a previous excision were positive or when colposcopy suggests disease extending into the endocervical canal.

When it's used:

- To diagnose or treat high-grade precancerous lesions (CIN 2-3)
- For adenocarcinoma in situ
- For very early microinvasive cervical cancer (stage IA1 some IA2)
- When fertility preservation is desired and disease is limited
- When prior tests (colposcopy/ECC) show abnormalities extending into the canal
- When margin status will determine whether additional surgery is needed

Surgical conization is almost always performed as an outpatient procedure, and the hospital stay is typically very short. Most patients remain in the facility for 2-8 hours after the procedure for monitoring, depending on whether local anesthesia, sedation, or general anesthesia was used. Overnight admission is extremely rare unless complications arise.

The first two weeks after the procedure are focused on protection and gentle mobility while the cervix begins its initial healing. Exercise during this stage centers on easy walking for 5-15 minutes once or twice daily, prioritizing circulation and comfort without increasing pelvic blood flow. Breathing-based core engagement, such as diaphragmatic breathing and light transverse abdominis activation, helps maintain neuromuscular awareness without generating pressure through the pelvic floor.

Between weeks 2-6, the aim is to rebuild foundational strength, improve posture, and restore basic pelvic coordination. Walking increases to 20-30 minutes per day at a comfortable pace, with small inclines introduced around week four if there is no spotting. Strength training remains low intensity. Incorporate core exercise, keeping the load low and movement controlled. Pelvic floor exercises can increase in effort slightly but must still include relaxation after each contraction.

From weeks 6-12, most individuals can transition into low-impact cardiovascular training and moderate-strength exercise. Brisk walking becomes the primary conditioning activity, with options such as low -resistance cycling, swimming, or later elliptical work often introduced around weeks 8-10. Strength training and core training can increase moderately.

Any new or increased bleeding, pelvic heaviness, sharp pain, or unusual fatigue at any stage is a signal to scale back and return to earlier guidelines. Most patients are ready to resume full exercise routines by 8-12 weeks after surgery while supporting optimal cervical healing and pelvic floor health.

Potential Side-effects of Surgical Conization:

- Pain and cramping
- Bleeding and spotting
- Fatigue
- Cervical stenosis (narrowing of the cervical canal)
- Spotting with intercourse or exercise

- **Simple (Total) Hysterectomy –** removes the uterus and cervix while preserving the parametrial tissues and upper vagina. It may also include removal of the fallopian tubes or ovaries depending on the diagnosis and patient preference. This operation can be performed abdominally, vaginally, laparoscopically, or robotically, with minimally invasive approaches offering less pain and quicker recovery. It is commonly used for early-stage cervical cancer limited to the cervix (such as stage IA2), severe cervical dysplasia, fibroids, abnormal uterine bleeding, adenomyosis, or uterine prolapse when conservative treatments fail. Because the cervix is removed, periods stop permanently, and pregnancy is no longer possible; ovary removal results in immediate menopause.

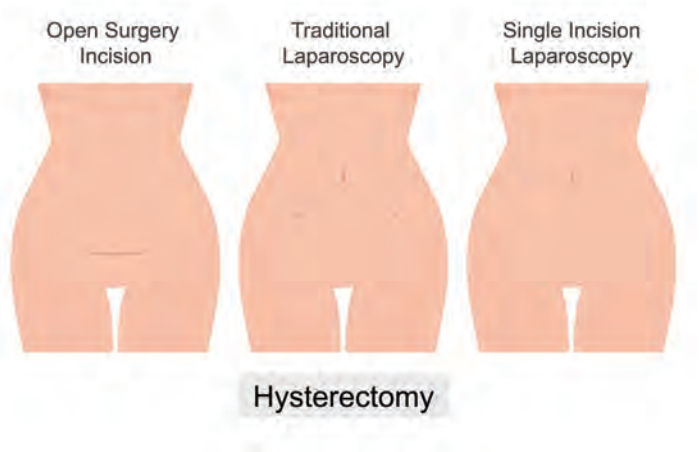
When it's used:

- For certain early-stage cervical cancers (very limited IA1 without risk factors)
- More often used for endometrial cancer, benign disease, or prophylaxis - not as common for cervical cancer
- When cancer is extremely superficial and has minima invasion

Hospital stays are typically 1-3 days, sometimes performed as same-day discharge if laparoscopic. Light bleeding and abdominal or pelvic soreness are expected during the initial recovery phase, and fatigue is common for the first several days. During the first two weeks, the priority is gentle movement that promotes circulation without straining the abdominal wall or pelvic floor. Walking for 5-10 minutes at a relaxed pace can be done several times per day. Deep core engagement, heavy lifting, and high-impact activities should be avoided.

Weeks 2-6, activity can increase gradually as long as no new pain, bleeding, or pelvic pressure develops. Walking can be extended to 20-30 minutes per day, along with body-weight lower body exercises and upper-body exercises with light dumbbells. Core exercise should remain low intensity and avoid anything that causes abdominal bulging or strain.

After 6 weeks most individuals can transition to a more structured and progressive exercise program. Low-impact cardiovascular options such as brisk walking, stationary cycling, and swimming can be added gradually. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Pelvic floor and deep core coordination remain important even after the uterus has been removed, because the pelvic support system has been altered.



- **Radical Hysterectomy (open, laparoscopic, or robotic) –** a radical hysterectomy is a comprehensive surgical procedure used primarily for cervical cancers that are still localized but have extended beyond the very earliest stages - typically stage IA2 to IB2, and select small IIA tumors. Unlike a simple or total hysterectomy, this operation removes not only the uterus and cervix but also a wider margin of surrounding tissues that may harbor microscopic cancer spread. These include the parametrium (the fibrous and vascular tissue around the cervix), the uterosacral ligaments, and the upper portion of the vagina. Pelvic lymph nodes are usually removed during the same surgery to determine whether cancer has spread. The ovaries may be preserved in younger patients unless risk factors suggest removal.

The procedure can be performed through an open abdominal incision or using minimally invasive laparoscopic or robotic techniques, depending on tumor characteristics and surgical expertise. Because more tissue and ligaments are removed, this surgery has a longer recovery period and a higher risk of affecting bladder and bowel function, as the nerves that control these organs run through the parametrial tissues. The most common early side effects include pelvic pain, fatigue, bladder retention or urgency, constipation, and reduced stamina. Long-term effects may include sexual discomfort due to vaginal shortening, pelvic floor weakness, complications related to nerve disruption, and, rarely, lymphedema if lymph nodes are removed. Despite these risks, a radical hysterectomy remains one of the most effective treatments for early-stage but clinically significant cervical cancer, offering excellent survival outcomes when clear surgical margins and negative nodes are achieved.

When it's used:

- For early but invasive cervical cancer (IA2, IB1, some IB2 depending on guidelines)
- When fertility preservation is not desired or not safe
- When a wider margin of surrounding tissue (parametrium + upper vagina) is needed for cure
- Sometimes for recurrent cervical cancer if radiation was not previously used

Hospital stay averages 3-5 days for minimally invasive procedures and up to 7 days for open abdominal surgery. Early mobilization begins within 24 hours to prevent clots and promote bowel function. During the first two weeks at home, movement should focus on short, frequent walks of 5-10 minutes on level ground, gradually increasing as tolerated. The abdominal wall, pelvic floor, and internal tissues are highly vulnerable at this point, so lifting more than 10 pounds, deep core exercises, and any straining should be avoided. Gentle breathing exercises, light mobility for the spine and shoulders and very small-range hip movements are appropriate if comfortable.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace, with rests as needed. Strength work should remain extremely light and non-straining. Core training should focus on reconnecting with deep abdominal and pelvic support through pelvic tilts, diaphragmatic breathing, and modified dead bug without leg load.

After six weeks, exercise can be expanded cautiously. Low-impact cardiovascular activity such as longer walks, stationary cycling, or swimming is appropriate. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Core work can progress as long as there is no abdominal bulging or pelvic pressure. Pelvic floor coordination remains important even though the uterus has been removed, as the surgery alters support structures and can initially weaken the pelvic base. Mobility and stretching should continue consistently to prevent compensatory patterns in the hips and low back.

Throughout all stages, increases in bleeding, abdominal or pelvic heaviness, urinary changes, leg swelling, or sharp pain indicate the need to reduce activity and reassess with the care team.

Potential Side-effects of all Hysterectomies:

- Pain and soreness
- Bleeding and spotting
- Fatigue
- Gas pain and bloating
- Constipation
- Urinary symptoms
- Blood clots
- Changes in bowel or bladder habits
- Pelvic floor dysfunction
- Temporary numbness or soreness in the inner thighs
- Adhesion formation
- Hormonal changes (if ovaries are removed)
- Chronic pelvic or abdominal pain
- Risk of lymphedema (if pelvic lymph nodes are removed)
- Loss of fertility

- **Radical Trachelectomy (fertility-preserving) –** a radical trachelectomy is a fertility-preserving surgery for early-stage cervical cancer that removes the cervix while keeping the uterus intact. During the procedure, the surgeon removes the cervix, the surrounding parametrial tissues, and the upper portion of the vagina. Pelvic lymph nodes are also taken out and examined first; if cancer is found in the nodes, the procedure is usually stopped because preserving the uterus would no longer be considered safe. If the nodes are clear, the surgeon continues by removing the cervix with adequate margins and then reconnects the lower part of the uterus to the remaining vagina. This new connection is called a cervico-isthmic anastomosis. Because the cervix is gone, a permanent stitch or band called a cerclage is typically placed around the base of the uterus to help support future pregnancies. This functions like an artificial cervix, helping the uterus stay closed during gestation. A temporary catheter may be placed in the uterus or vagina during early healing to keep the new opening unobstructed.

The procedure is generally offered only to those with small, early-stage tumor, typically stage IA2 or IB1 under two centimeters, because the goal is to remove all cancer while still allowing the possibility of pregnancy later. Radical trachelectomy can be performed through the vagina, abdomen, laparoscopy, or robotic surgery depending on surgeon expertise.

Recovery involves healing both the internal surgical site and the lymph node removal area. Light bleeding, pelvic soreness, and fatigue are common for several weeks. Sexual activity, heavy lifting, and strenuous exercise are restricted during the early healing period to protect the new uterine-vaginal connection. Many people who undergo this surgery later achieve pregnancy, although the risk of miscarriage and preterm birth is higher, and delivery is usually planned by cesarean section.

When it's used:

- For early-stage cervical cancer in those who wish to keep fertility
- Typically for stage IA2 or small IB1 tumors <2 cm
- When imaging shows the cancer is confined to the cervix with no nodal spread
- When clear margins are achievable without needing a hysterectomy

Hospital stays average 3-5 days. The first two weeks focus on rest, wound care, and gentle walking. Heavy lifting, squatting, or abdominal pressure must be avoided to protect the cervical sutures and prevent bleeding. Between weeks 4-8, stamina improves, and walking can increase in duration, but pelvic floor engagement exercises are postponed until cleared. Sexual activity, tampon use, and vigorous movement are avoided for 8-10 weeks. By three months, most patients resume regular activity, though fertility follow-up and pelvic assessments continue for several months.

Most patients stay in the hospital for 1-2 nights so the care team can monitor bleeding, bladder function, pain control, and mobility. A urinary catheter is often left in place for several days after discharge, and light bleeding or watery discharge is common early on.

Exercise recovery over the first three months must be extremely gradual and highly individualized. In the first 2-4 weeks after discharge, the main goal is gentle mobility and basic functional independence. Walking is the primary mode of activity, starting with a few minutes at a time several times a day, and avoiding strain. Any activity that increases intra-abdominal pressure - such as lifting more than 5-10 pounds, climbing steep stairs, or engaging the core forcefully - should be avoided. Breathing work, gentle seated mobility for the upper body, ankle pumps, and light hip movements help circulation without stressing surgical repairs or abdominal closures.

From weeks 2-6, walking can gradually increase to fifteen to thirty minutes per day as long as there is no increase in bleeding or pelvic pressure. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Core training centers on pelvic tilts, diaphragmatic breathing, and very gentle transverse abdominis activation without leg loading.

After six weeks, exercise can be expanded cautiously. Low-impact cardiovascular activity such as longer walks, stationary cycling, or swimming is appropriate. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Core work can progress as long as there is no abdominal bulging or pelvic pressure. Pelvic floor coordination remains important even though the uterus has been removed, as the surgery alters support structures and can initially weaken the pelvic base.

Mobility and stretching should continue consistently to prevent compensatory patterns in the hips and low back.

Throughout all stages, increases in bleeding, abdominal or pelvic heaviness, urinary changes, leg swelling, or sharp pain indicate the need to reduce activity and reassess with the care team.

Potential Side-effects for Radical Trachelectomy:

- Pain and soreness
- Bleeding and spotting
- Fatigue
- Gas pain and bloating
- Constipation
- Urinary symptoms
- Blood clots
- Changes in bowel or bladder habits
- Pelvic floor dysfunction
- Temporary numbness or soreness in the inner thighs
- Adhesion formation
- Reduced fertility

- **Pelvic Exenteration (anterior, posterior, or total) –** a pelvic exenteration is one of the most extensive operations performed for advanced or recurrent cervical cancer, used when the disease is confined to the pelvis but cannot be controlled with standard treatments like hysterectomy, radiation, or chemotherapy. The goal is to remove all cancerous tissue by taking out not only the reproductive organs but also additional pelvic structures that the tumor has invaded. Because every case is different, the exact organs removed vary, but the surgery is always major, technically complex, and life-altering.

  In a typical pelvic exenteration, the uterus, cervix, ovaries, fallopian tubes, upper vagina, and surrounding tissues are removed. If the cancer involves the bladder, rectum, or both, these organs are removed as well. When the bladder is taken out, the surgeon creates a urinary diversion such as an ileal conduit or continent reservoir. When the rectum is removed, a colostomy is created so stool can exit through an abdominal opening. Some patients require reconstruction of the vagina using tissue from the abdomen, thigh, or bowel, depending on their goals for recovery and sexual function. Lymph nodes are often removed to assess the spread of disease, and portions of the pelvic wall may also be resected if the tumor has extended into those structures.

  Pelvic exenteration is generally reserved for patients whose cancer has returned after radiation or whose initial tumor is too locally advanced to treat with less invasive options. The surgery is performed only when imaging shows no spread outside the pelvis, because the benefits are meaningful only when complete removal of all visible disease is possible. Although it is a radical approach, it can offer the possibility of cure in situations where other therapies cannot.

  When it's used:

  - For recurrent cervical cancer after radiation or chemoradiation when the recurrence is confined to the pelvis
  - For very locally advanced disease invading bladder, rectum, or pelvic sidewall when cure is still possible with surgery
  - When no metastasis is present outside the pelvis and complete surgical removal of disease appears achievable
  - As a last-resort curative surgery when all other treatments have failed or are not possible

  Following a pelvic exenteration, recovery is extensive and requires a multidisciplinary approach to address both the physical and emotional challenges of such a major operation. Hospital stays typically range from 10-21 days, depending on the extent of the surgery and whether it involved removal of adjacent organs such as the bladder, reproductive organs, or part of the bony pelvis. The immediate postoperative focus is on pain management, infection prevention, and monitoring for complications such as bleeding, wound breakdown, or abscess formation. Patients are closely observed in a high-dependency or intensive care unit during the first few days, as multiple surgical sites and drains require careful management. Nutrition is reintroduced slowly - usually starting with clear fluids and progressing to soft foods once bowel activity resumes. Patients often have one or more stomas (colostomy, ileostomy, or urostomy), and stoma education begins as soon as they are stable enough to participate. Gentle assisted walking usually starts within 48-72 hours to improve circulation, reduce stiffness, and prevent clots.

  During the first month at home, recovery remains slow and focused on wound care, energy conservation, and learning to manage new bodily functions. Patients often experience fatigue, abdominal and pelvic tenderness, and significant adjustments to body image and daily routines, especially if permanent stomas are present. Physical activity should be minimal and limited to short, gentle walks several times a day, gradually increasing in duration as tolerated. Lifting, bending, twisting, or carrying objects heavier than 5-10 pounds should be strictly avoided to prevent wound separation or hernia formation. Hydration and nutrition are essential for healing, and small, frequent meals are often better tolerated. Emotional and psychological support are equally important during this phase, as patients adapt to major lifestyle changes.

  Between weeks 5-8, energy levels begin to improve, and walking distances can be increased at a slow, steady pace. Light household activities may be resumed if they do not involve strain or fatigue. Some patients begin gentle stretching or physical therapy to restore mobility and prevent stiffness in the hips and lower back. Any exercise involving the abdominal or pelvic region should be avoided, as deep tissue healing continues. Wound sites, particularly perineal or pelvic incisions, often take several months to fully close and must be kept clean and dry to prevent infection.

By weeks 9-12, most individuals experience gradual increases in stamina and a greater ability to perform daily activities. Low-impact exercises such as walking, light stationary cycling, or gentle range-of-motion exercises can usually be performed without discomfort. However, heavy resistance training, running, or any movement that increases intra-abdominal pressure should be postponed until at least 12-16 weeks post-surgery and only after medical clearance. Adaptation to stoma care and urinary diversion continues during this period, with support from wound and ostomy care nurses. Full recovery following a pelvic exenteration can take 6 months to a year, depending on surgical complexity, reconstruction, and the patient's baseline health. Many patients benefit from ongoing physical therapy, nutritional counseling, and psychological support.

Potential Side-effects of a Pelvic Exenteration:

- Pain and soreness
- Heavy postoperative bleeding and drainage from surgical sites
- Fatigue
- Bowel paralysis (ileus) or difficulty restarting normal bowel function
- Urinary retention or difficulty adjusting to a urinary diversion
- Nausea and loss of appetite
- Blood clots
- Risk of wound separation, especially in the perineal closure
- Challenges learning to manage a colostomy, urostomy, or both
- Phantom sensations or altered pelvic pressure as organs heal
- Pelvic or abdominal fluid collections (seromas or abscesses)
- Bladder or bowel cramps, depending on reconstruction type
- Hernias at incision or stoma sites
- Adhesions
- Immediate menopause if ovaries were removed

- **Pelvic Lymphadenectomy (performed alone or with hysterectomy) –** is a surgical procedure in which lymph nodes in the pelvic region are removed so they can be examined for cancer cells. It is commonly performed in cervical, endometrial, prostate, bladder, and ovarian cancers to determine whether the disease has spread beyond the primary tumor.

The operation can be performed through an open abdominal incision, laparoscopically, or with robotic assistance. Minimally invasive approaches allow for smaller incisions and quicker early recovery, though the goals of surgery are the same regardless of technique.

When it's used:

- To determine lymph node involvement in cervical, endometrial, ovarian, prostate, and bladder cancers
- As the first step in surgeries where future decisions depend on nodal status (e.g., radical trachelectomy, radical hysterectomy)
- When staging information will guide the need for radiation or chemotherapy
- Sometimes as part of debulking for gynecologic cancers

Typically there will be a short hospital stay unless it is performed as part of a larger cancer surgery. When done on its own, most patients stay in the hospital for one night, though some go home the same day if the procedure is laparoscopic or robotic and recovery is uncomplicated.

Exercise recovery during the first three months centers on protecting the pelvic tissues, restoring mobility, and minimizing lymphedema risk. In the first two weeks, walking is the main recommended activity. Short, frequent walks of 5-10 minutes help maintain circulation without stressing the surgical area. Heavy lifting, straining, and high-impact exercise should be avoided. Gentle breathing work, ankle pumps, light hip mobility, and comfortable upper-body stretching can reduce stiffness while keeping pressure low on the pelvic region.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace. If there is no groin pain or swelling, strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells. Because lymph node removal increases the risk of lymphedema, it is essential to incorporate lymphatic drainage exercises and monitor for swelling.

Between 6-12 weeks, most patients can begin low-impact cardiovascular exercise and slightly more structured strength training. Walking can progress to longer, more continuous sessions, and low-resistance cycling or swimming may be added. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Flexibility and mobility work remain important to counteract stiffness in the hips and groin, which can occur after lymph node removal.

Throughout recovery, any signs of swelling in the legs or groin, heaviness, sudden pain, warmth, or tightness should be taken seriously, as these may indicate lymphedema or vascular complications. This should prompt immediate reduction in activity and referral to physician.

Potential Side-effects of a Pelvic Lymphadenectomy:

- Pain and soreness
- Bleeding and oozing from incisions
- Fatigue
- Persistent bowel or bladder changes depending on reconstruction
- Difficulty adjusting to a colostomy or urinary diversion
- Blood clots
- Nausea, loss of appetite, and weight loss
- Fluid collections such as seromas or abscesses
- Adhesion formation
- Hernias at incision or stoma sites
- Phantom pelvic sensations or pressure changes
- Lymphedema if lymph nodes were removed

- **Cone Biopsy (Conization) –** is a procedure in which a cone-shaped piece of tissue is removed from the cervix to diagnose or treat high-grade precancerous changes or very early cervical cancer. The removed tissue includes the transformation zone - where abnormal cells most commonly develop - and a portion of the endocervical canal, allowing pathologists to assess both the surface and deeper glandular areas. The goal is to remove all abnormal cells with clear margins while preserving as much healthy cervical tissue as possible.

  The procedure can be performed using different techniques. Cold-knife conization, done with a scalpel, provides the most precise specimen and is preferred when invasive cancer is suspected. LEEP or LLETZ uses a heated wire loop and is widely used because it is efficient and accessible. Laser conization uses a CO_2 laser for precise cutting but is less commonly available. Regardless of the method, the tissue is examined under a microscope to determine the extent of disease and whether further treatment is needed.

  Cone biopsy is almost always done as outpatient surgery under local anesthesia, sedation, or general anesthesia. Most patients go home the same day after a short recovery period. Cramping, spotting, or light discharge is typical for several days to a few weeks. During healing, patients are usually advised to avoid heavy lifting, intercourse, tampons, and strenuous exercise for about 4-6 weeks to prevent bleeding or disruption of the healing cervix.

  Cone biopsy serves both as a diagnostic tool and, in many cases, a curative treatment. When margins are clear and disease is limited, no additional surgery may be needed. If margins are positive or deeper invasion is found, additional treatment may be recommended. Overall, the procedure is a targeted, fertility-preserving approach that allows effective removal and evaluation of early cervical disease.

  When it's used:
  - To diagnose or treat high-grade precancerous lesions (CIN 2–3)
  - For adenocarcinoma in situ
  - For very early microinvasive cervical cancer (stage IA1, some IA2)
  - When fertility preservation is desired/disease is limited
  - When prior tests (colposcopy/ECC) show abnormalities extending into the canal
  - When margin status will determine whether additional surgery is needed

Most patients will go home the same day as the procedure. During the first two weeks after a cone biopsy, exercise should be limited to gentle walking for five to fifteen minutes at a relaxed pace, 1-2 times per day. The goal is simply to promote circulation without increasing pelvic blood flow or intra-abdominal pressure. Heavy lifting, running, cycling, core exercises, and anything that causes straining should be avoided. Gentle breathing exercises, light upper-body stretching, and small-range hip mobility can help reduce stiffness without stressing the surgical site.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace. If there is no groin pain or swelling, strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells. Because lymph node removal increases the risk of lymphedema, it is essential to incorporate lymphatic drainage exercises and monitor for swelling.

Between 6-12 weeks, most patients can begin low-impact cardiovascular exercise and slightly more structured strength training. Walking can progress to longer, more continuous sessions, and low-resistance cycling or swimming may be added. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Flexibility and mobility work remain important to counteract stiffness in the hips and groin, which can occur after lymph node removal.

At all stages, new or increased bleeding, pelvic pressure, sharp pain, or unusual fatigue should prompt immediate reduction in activity and referral to physician.

Potential Side-effects of a Cone Biopsy:

- Mild to moderate cramping for several days
- Light bleeding or spotting that may last 2-4 weeks
- Delayed bleeding around 7-14 days when the cervical scab separates
- Fatigue
- Cervical stenosis (narrowing of the cervical canal) in some cases

Types of Treatment Used:

- External beam radiation
- Brachytherapy (internal radiation
- Concurrent chemoradiation (radiation + weekly cisplatin)
- Chemotherapy
- Targeted therapy
- Immunotherapy
- Combination immunotherapy and chemotherapy
- Hormonal therapy (rarely used)

CANCER OF THE UTERUS/ENDOMETRIUM

Globally, endometrial cancer is the sixth most common cancer in women and ranks 14th among causes of cancer-related deaths worldwide. There were 420,368 new cases and 97,704 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Disease incidence has increased by 132% over the last 30 years and continues to rise globally, driven by an aging population and increasing rates of obesity and diabetes (Guo et al., Cancers, 2025). Incidence rates are substantially higher in women aged 50 and older than in women under 50, with 11.6% of US cases now occurring in women under 50 (EBioMedicine, 2024).

Unlike cervical cancer, there is no noninvasive stage with endometrial cancer. In atypical uterine hyperplasia, normal endometrial cells multiply out of control, causing the uterine wall to thicken. Depending on the degree of hyperplasia, a woman has a 5-30% chance of developing endometrial cancer over 5-10 years (WCRF International, Endometrial Cancer, 2024). Although atypical hyperplasia is not cancer, it is treated as a precancerous condition - through either surgery or hormonal therapy - depending on whether the patient wishes to preserve fertility or has completed child-bearing. Endometrial cancer most commonly affects postmenopausal women; approximately 75% of all cases occur after the age of 50 and only 4% occur before the age of 40 (WCRF International, Endometrial Cancer, 2024).

There is currently no standard population-wide screening test for endometrial cancer. Routine Pap testing, used to detect cervical cancer, does not detect endometrial cancer. Patients are typically diagnosed after presenting with symptoms - most commonly abnormal postmenopausal bleeding - and approximately 68% of cases are diagnosed at an early stage as a result of this symptom prompting timely evaluation (ACS, Key Statistics for Endometrial Cancer, 2024). Early-stage diagnosis is associated with a favorable five-year overall survival rate of approximately 81%, while the five-year survival rate for advanced-stage disease falls sharply to approximately 17% for locally advanced disease and 15% for distant metastatic disease (NCI, SEER Cancer Statistics: Uterine Cancer, 2024). Transvaginal ultrasound and endometrial biopsy remain the primary diagnostic tools when endometrial cancer is suspected.

The most common symptoms are abnormal vaginal bleeding or spotting, particularly in postmenopausal women. Pain during urination, intercourse, or in the pelvic area may also occur. Any postmenopausal bleeding should be evaluated promptly, as it is the earliest and most actionable warning sign of this disease.

Obesity is the most significant modifiable risk factor for endometrial cancer, primarily by elevating circulating estrogen levels through the conversion of androgens to estrogens in adipose tissue. Other factors associated with increased estrogen exposure and elevated risk include late menopause, estrogen-only hormone therapy without progesterone, nulliparity, a history of polycystic ovary syndrome (PCOS), and long-standing type 2 diabetes. Use of tamoxifen for breast cancer treatment modestly increases endometrial cancer risk due to its estrogen-like effects on the uterine lining. Lynch syndrome - a hereditary condition caused by mismatch repair gene mutations - is the most significant genetic risk factor, conferring a lifetime endometrial cancer risk of 40-60%. Conversely, pregnancy, use of combined oral contraceptives, and intrauterine devices (IUDs) appear to reduce the risk of endometrial cancer (ACS, Endometrial Cancer Risk Factors, 2024).

Procedures:

- **Simple (Total) Hysterectomy with Bilateral Salpingo-Oophorectomy (TH-BSO) –** removes the uterus and cervix while preserving the parametrial tissues and upper vagina. It is most often combined with bilateral salpingo-oophorectomy (removal of both fallopian tubes and ovaries) for complete disease management and hormonal control. The surgery can be performed abdominally, laparoscopically, robotically, or occasionally vaginally, depending on patient anatomy, comorbidities, and surgeon expertise. Minimally invasive approaches are preferred worldwide for early-stage disease because they offer less blood loss, faster recovery, and similar oncologic outcomes to open surgery.

For aggressive variants such as serous carcinoma, carcino-sarcoma, or undifferentiated tumors, the procedure includes an infracolicomentectomy and peritoneal washings or biopsies to detect occult metastases. These additional steps provide more accurate staging and guide adjuvant treatment decisions.

When it's used:

- For stage I endometrial carcinoma limited to the uterine corpus (confined to the endometrium or myometrium)
- As part of standard staging surgery (total hysterectomy with BSO ± sentinel lymph-node mapping)
- For atypical endometrial hyperplasia or endometrial intraepithelial neoplasia when childbearing is complete
- For benign uterine conditions (fibroids, adenomyosis, prolapse, or abnormal uterine bleeding) when cancer risk is also a concern

Hospital stays are typically 1-3 days, sometimes performed as same-day discharge if laparoscopic. Light bleeding and abdominal or pelvic soreness are expected during the initial recovery phase, and fatigue is common for the first several days. During the first two weeks, the priority is gentle movement that promotes circulation without straining the abdominal wall or pelvic floor. Walking for 5-10 minutes at a relaxed pace can be done several times per day. Deep core engagement, heavy lifting, and high-impact activities should be avoided.

Weeks 2-6, activity can increase gradually as long as no new pain, bleeding, or pelvic pressure develops. Walking can be extended to 20-30 minutes per day, along with body-weight lower body exercises and upper-body exercises with light dumbbells. Core exercise should remain low intensity and avoid anything that causes abdominal bulging or strain.

After six weeks most individuals can transition to a more structured and progressive exercise program. Low-impact cardiovascular options such as brisk walking, stationary cycling, and swimming can be added gradually. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Pelvic floor and deep core coordination remain important even after the uterus has been removed, because the pelvic support system has been altered.

- **Radical Hysterectomy (open, laparoscopic, or robotic) –** is a more extensive surgical procedure reserved for cases where the tumor has extended beyond the uterine body into the cervix or adjacent tissues but remains potentially curable with surgery. Unlike a simple hysterectomy, which removes only the uterus and cervix, a radical hysterectomy removes a wider margin of surrounding structures that may contain mi croscopic spread, including the parametrial tissues, upper va- gina, and uterosacral ligaments. Pelvic and often para-aortic lymph nodes are removed at the same time to assess whether the cancer has spread, and the fallopian tubes and ovaries are typically taken as part of the procedure.

The procedure can be performed through an open abdominal incision or using minimally invasive laparoscopic or robotic techniques, depending on tumor characteristics and surgical expertise. Because more tissue and ligaments are removed, this surgery has a longer recovery period and a higher risk of affecting bladder and bowel function, as the nerves that control these organs run through the parametrial tissues. The most common early side effects include pelvic pain, fatigue, bladder retention or urgency, constipation, and reduced stamina. Long-term effects may include sexual discomfort due to vaginal shortening, pelvic floor weakness, complications related to nerve disruption, and, rarely, lymphedema if lymph nodes are removed. Despite these risks, a radical hysterectomy remains one of the most effective treatments for early-stage but clinically significant cervical cancer, offering excellent survival outcomes when clear surgical margins and negative nodes are achieved.

When it's used:

- When the disease extends beyond the uterine body but remains surgically resectable
- Stage II endometrial carcinoma, where the cancer has invaded the cervical stroma but not spread beyond the uterus
- Select stage IIB cases with limited parametrial invasion that can still be completely removed surgically
- Recurrent disease confined to the central pelvis, particularly when prior radiation was given and com- plete resection is feasible
- High-grade tumors (such as serous or carcinosarcoma) with suspected cervical or parametrial involvement requiring wider margins for local control.

Hospital stay averages 3-5 days for minimally invasive procedures and up to 7 days for open abdominal surgery. Early mobilization begins within 24 hours to prevent clots and promote bowel function. During the first two weeks at home, movement should focus on short, frequent walks of 5-10 minutes on level ground, gradually increasing as tolerated. The abdominal wall, pelvic floor, and internal tissues are highly vulnerable at this point, so lifting more than 10 pounds, deep core exercises, and any straining should be avoided. Gentle breathing exercises, light mobility for the spine and shoulders and very small-range hip movements are appropriate if comfortable.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace, with rests as needed. Strength work should remain extremely light and non-straining. Core training should focus on reconnecting with deep abdominal and pelvic support through pelvic tilts, diaphragmatic breathing, and modified dead bug without leg load.

After six weeks, exercise can be expanded cautiously. Low-impact cardiovascular activity such as longer walks, stationary cycling, or swimming is appropriate. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Core work can progress as long as there is no abdominal bulging or pelvic pressure. Pelvic floor coordination remains important even though the uterus has been removed, as the surgery alters support structures and can initially weaken the pelvic base. Mobility and stretching should continue consistently to prevent compensatory patterns in the hips and low back.

Throughout all stages, increases in bleeding, abdominal or pelvic heaviness, urinary changes, leg swelling, or sharp pain indicate the need to reduce activity and reassess with the care team.

Potential Side-effects of all Hysterectomies:

- Pain and soreness
- Bleeding and spotting
- Fatigue
- Gas pain and bloating
- Constipation
- Urinary symptoms
- Blood clots
- Changes in bowel or bladder habits
- Pelvic floor dysfunction
- Temporary numbness or soreness in the inner thighs
- Adhesion formation
- Hormonal changes (if ovaries are removed)
- Chronic pelvic or abdominal pain
- Risk of lymphedema (if pelvic lymph nodes are removed)
- Loss of fertility

- **Omentectomy and Peritoneal Washings/Biopsies –** this procedure is used when the tumor type or imaging suggests a higher likelihood of spread beyond the uterus, even if the disease appears confined at the time of surgery. It is most often performed for high-risk or aggressive histologic subtypes such as serous carcinoma, carcinosarcoma, undifferentiated, and clear cell endometrial cancers. These tumors tend to behave more like ovarian cancers, with a greater tendency to spread microscopically to the peritoneum and omentum. Removing the infracolic omentum allows for both diagnostic staging and therapeutic removal of potential microscopic disease. Peritoneal washings and biopsies are taken to check for cancer cells that may have detached and implanted on the peritoneal surfaces. This information helps determine the stage, guide the need for adjuvant therapy, and improve prognosis accuracy. Omentectomy is not typically necessary for low-grade endometrioid tumors, as they have a much lower risk of peritoneal spread.

When it's used:

- High-risk histologies or when imaging suggests extra-uterine disease risk despite apparent uterine confinement

After an omentectomy with peritoneal washings and biopsies for endometrial cancer, the typical hospital stay ranges from 2-5 days, depending on the surgical approach and whether other procedures, such as hysterectomy or lymph-node removal, were performed at the same time. Minimally invasive laparoscopic or robotic surgeries often allow discharge within two to three days, while open abdominal procedures may require up to a week for pain control and bowel recovery.

Throughout recovery, attention to incision healing, bowel function, and fatigue levels is important. If abdominal swelling, pain, or new drainage occurs, activity should be reduced until evaluated by the surgical team. The overall goal during the first three months is gradual restoration of mobility, endurance, and core control while protecting surgical repairs and preventing lymphedema or hernia formation.

During the first two weeks the focus is rest, short indoor walks, and breathing or ankle-pump exercises to prevent clots. Nothing heavier than about 5 pounds should be lifted, and all straining, twisting, or bending at the waist should be avoided.

From weeks 2-6, walking duration can be increased gradually, aiming for 10-20 minutes several times a day. Gentle mobility and posture exercises may begin, but no core or abdominal work yet. Continue avoiding lifting, vacuuming, or other tasks that raise abdominal pressure.

From weeks 6-12, low-impact aerobic work such as a stationary bike, slow treadmill walking, or water walking combined with light resistance (bands or 5-10 pound weights) should be added to the routine. Emphasize posture, breathing control, and, if lymph nodes were removed, lymph-drainage routines to prevent swelling. Activities that strain the abdomen (sit-ups, planks, heavy lifting) should still wait until at least the three-month mark or until the abdominal wall is fully healed.

Potential Side-effects of Omentectomy & Peritoneal Washings/Biopsies:

- Abdominal or pelvic pain and tenderness after surgery
- Temporary bloating or delayed return of bowel function
- Fatigue and weakness during early recovery
- Risk of infection at the incision site or within the abdomen
- Bleeding or formation of hematoma
- Development of adhesions that may cause future abdominal discomfort or bowel obstruction
- Changes in appetite or digestion due to alteration of abdominal anatomy
- Fluid buildup or seroma formation near the surgical area
- Hernia formation at incision sites, particularly after open surgery
- Rare injury to surrounding organs such as bowel, bladder, or blood vessels
- Longer-term changes in lymphatic drainage that may contribute to abdominal or lower extremity swelling

- **Sentinel Lymph-Node Mapping and/or Lymphadenectomy –** this procedure is used to determine whether cancer has spread beyond the uterus through the lymphatic system, which is an important part of staging and treatment planning. Sentinel lymph-node mapping identifies and removes only the first few lymph nodes that directly drain the uterus, as these are the most likely sites for early metastasis. A dye such as indocyanine green is injected into the cervix, allowing the surgeon to trace the drainage pathways and locate the sentinel nodes using fluorescence imaging. These nodes are then removed and examined under a microscope with special staining (ultrastaging) to detect even small clusters of cancer cells. If mapping fails on one or both sides, or if any nodes appear enlarged or suspicious during surgery, a complete pelvic or para-aortic lymphadenectomy may be performed for accurate staging. This approach helps balance the need for diagnostic precision with the goal of minimizing surgical complications such as lymphedema or nerve injury. Sentinel lymph-node mapping is now the preferred technique for most intermediate and high-risk endometrial cancers, as it provides highly reliable staging information while reducing postoperative morbidity.

When it's used:

- In intermediate - to high-risk cases, where there is a higher likelihood of lymphatic involvement
- For grade 2 or 3 tumors, deep myometrial invasion (greater than 50%), non-endometrioid histologies such as serous or clear cell carcinoma, and tumors with lymphovascular space invasion
- It may also be used in apparent early-stage disease to confirm that lymph nodes are negative before deciding on adjuvant therapy

Typically there will be a short hospital stay unless it is performed as part of a larger cancer surgery. When done on its own, most patients stay in the hospital for one night, though some go home the same day if the procedure is laparoscopic or robotic and recovery is uncomplicated.

Exercise recovery during the first three months centers on protecting the pelvic tissues, restoring mobility, and minimizing lymphedema risk. In the first two weeks, walking is the main recommended activity. Short, frequent walks of 5-10 minutes help maintain circulation without stressing the surgical area. Heavy lifting, straining, and high-impact exercise should be avoided. Gentle breathing work, ankle pumps, light hip mobility, and comfortable upper-body stretching can reduce stiffness while keeping pressure low on the pelvic region.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace. If there is no groin pain or swelling, strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells. Because lymph node removal increases the risk of lymphedema, it is essential to incorporate lymphatic drainage exercises and monitor for swelling.

Between 6-12 weeks, most patients can begin low-impact cardiovascular exercise and slightly more structured strength training. Walking can progress to longer, more continuous sessions, and low-resistance cycling or swimming may be added. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Flexibility and mobility work remain important to counteract stiffness in the hips and groin, which can occur after lymph node removal.

Throughout recovery, any signs of swelling in the legs or groin, heaviness, sudden pain, warmth, or tightness should be taken seriously, as these may indicate lymphedema or vascular complications. This should prompt immediate reduction in activity and referral to physician.

Potential Side- effects of Sentinel Lymph-Node Mapping and/or Lymphadenectomy:

- Temporary pelvic or leg pain and tenderness
- Mild swelling or heaviness in the legs or groin
- Bruising or fluid buildup (seroma) at incision or node removal sites
- Numbness, tingling, or altered sensation in the upper thigh or groin from nerve irritation
- Risk of infection at incision sites or within the lymphatic channels
- Bleeding or minor hematoma formation
- Fatigue or soreness during early recovery
- Limited range of motion or stiffness in the hips or lower abdomen
- Lymphedema (persistent swelling of legs or lower abdomen) in rare cases, more common after full lymphadenectomy
- Development of scar tissue or adhesions that may cause discomfort
- Very rare risk of lymphocele (fluid collection in the pelvis) requiring drainage

- **Cytoreductive ("Debulking") Surgery –** this procedure is used when endometrial cancer has spread beyond the uterus but complete removal of visible disease is still possible. The main goal is to remove as much of the tumor burden as possible, since studies show that the amount of residual disease after surgery is a major predictor of survival. This type of surgery often involves removing visible tumor implants throughout the abdomen and pelvis, which may include resection of portions of the omentum, bowel, bladder, or other affected organs if the disease has spread to those areas. In some cases, peritoneal surfaces or diaphragmatic implants are also removed. It is most often used for advanced-stage disease, particularly stages III and IV, or for isolated pelvic or abdominal recurrences when other treatments alone are unlikely to control the disease. In recurrent settings, it may be considered for patients who previously received radiation or systemic therapy but whose disease has returned in a localized, resectable area. The purpose of debulking surgery is both therapeutic and palliative - it can prolong survival, improve the effectiveness of subsequent chemotherapy or radiation, and relieve symptoms such as pain, bleeding, or bowel obstruction caused by tumor pressure. The extent of surgery depends on the distribution of disease and the patient's overall health, as this is a complex and physically demanding procedure requiring multidisciplinary surgical expertise.

When it's used:

- In cases of advanced or recurrent endometrial cancer when the disease has spread beyond the uterus but can still be safely and effectively removed
- For stage III or IV disease, where cancer involves the ovaries, omentum, or peritoneal surfaces, or when isolated metastases are present in the abdomen or pelvis
- It may also be used for localized recurrences after prior treatment, particularly if radiation or systemic therapy has already been given and complete surgical removal is feasible.
- To relieve symptoms such as pain, obstruction, or bleeding in cases where full cure is not possible but quality of life can be improved.

The typical hospital stay is 7-14 days, depending on the extent of tumor removal, whether multiple organs were resected, and how quickly bowel and urinary function recover. Patients undergoing minimally invasive debulking may be discharged sooner, but most require a longer stay for close monitoring, pain control, and nutritional management.

Recovery begins in the hospital with assisted walking, deep breathing, and gentle circulation exercises to prevent blood clots. During the first two weeks, walking is continued several times a day for short durations, avoiding stairs and lifting more than 5 pounds. Core engagement, twisting, or bending should be completely avoided. Rest periods are essential between short bouts of movement.

From weeks 2-6, gradual mobility progression focuses on posture, gentle walking, and flexibility work for shoulders, ankles, and hips. Fatigue is typically high, so sessions should be brief with frequent breaks. If lymph nodes were removed, lymph-drainage routines to prevent swelling. No abdominal exercises, resistance work, or lifting beyond 8-10 pounds should occur during this phase.

From weeks 6-12, low-impact activity can begin, such as light resistance bands, slow cycling, or short aquatic therapy sessions. Strengthening focuses on breathing mechanics, pelvic floor awareness, and gentle postural reconditioning. High-impact activities, heavy lifting, and exercises that significantly raise intra-abdominal pressure - such as planks, crunches, or loaded squats - should still be avoided.

Recovery after debulking surgery is slower and more variable than after hysterectomy or omentectomy. It often takes three months or longer before moderate-intensity exercise is tolerated. Throughout this period, exercise should prioritize energy conservation, circulation, and progressive mobility, while closely monitoring for pain, swelling, shortness of breath, or changes in incision healing.

Potential Side-effects of Cytoreductive ("Debulking") Surgery:

- Significant abdominal pain, bloating, or discomfort after surgery
- Prolonged fatigue and weakness during recovery
- Risk of infection at incision sites or within the abdomen
- Bleeding or formation of hematoma
- Temporary or prolonged bowel dysfunction, including constipation, diarrhea, or obstruction
- Risk of injury to nearby organs such as the bladder, bowel, ureters, or major blood vessels
- Delayed wound healing, particularly after large incisions or combined organ resections
- Formation of adhesions that may cause chronic pain or bowel obstruction
- Fluid buildup in the abdomen (ascites or seroma) requiring drainage
- Hernia formation at incision or stoma sites
- Nutritional challenges if portions of bowel or omentum are removed
- Lymphedema in the legs or pelvis if lymph nodes are also removed
- Emotional distress or decreased energy due to the magnitude of surgery and slower recovery process

Types of Treatment Used:

- External beam radiation therapy.
- Vaginal brachytherapy (intracavitary radiation) either alone or combined with EBRT for adjuvant therapy in intermediate-risk cases.
- Chemotherapy
- Immunotherapy
- Targeted therapy
- Hormonal therapy
- Palliative radiation for symptom control

CANCER OF THE OVARIES

Ovarian cancer is the eighth most commonly diagnosed cancer in women worldwide and the most lethal gynecological malignancy. There were approximately 324,603 new cases and 206,956 deaths globally in 2022, with ovarian cancer accounting for approximately 4.3% of global female cancer deaths and surpassing all other gynecologic cancers in mortality (Hang et al., Journal of Cancer Research and Clinical Oncology, 2025). Usually by the time ovarian cancer is detected, it has already spread to other organs within the pelvis.Incidence rates have been declining in many higher-income countries; age-adjusted rates for new cases have fallen on average 1.4% per year over 2014-2023, and death rates have declined an average of 2.9% per year over 2015-2024 in the United States (NCI, SEER Cancer Statistics: Ovarian Cancer, 2025).

Ovarian tumors are never biopsied with a needle or cut into, because doing so could allow cancerous cells to escape and spread. Most ovarian cancer patients are past menopause, making a hysterectomy a viable surgical option when necessary. As with pancreatic cancer, ovarian cancer is considered silent and deadly. Often there are no symptoms in early ovarian cancer, which makes it extremely difficult to detect at the stage when the greatest chance for cure exists. An ovarian tumor can grow for some time before pressure or pain is felt. Symptoms, when they do occur, can include abdominal swelling or bloating, discomfort in the lower abdomen, feeling full after a light meal, nausea or vomiting, lack of appetite, gas or indigestion, unexplained weight loss, diarrhea, constipation, frequent urination, shortness of breath, and bleeding that is not part of a regular menstrual cycle.

A strong family history of breast or ovarian cancer is among the most important risk factors. Women who test positive for mutations in the BRCA1 gene have an estimated lifetime risk of ovarian cancer between 35% and 70%, while those with BRCA2 mutations face a lifetime risk of approximately 10-30% by age 70 (ACS, Ovarian Cancer Risk Factors, 2024). Those with pelvic inflammatory disease and Lynch syndrome are also at increased risk. Several large studies have linked an increased risk of ovarian cancer to the use of estrogen-only hormone replacement therapy. Smoking cigarettes increases the risk of mucinous ovarian cancer specifically. Conversely, pregnancy and long-term use of oral contraceptives appear to reduce risk - women who use oral contraceptives for five or more years have approximately a 50% lower risk of developing ovarian cancer compared to women who have never used them (ACS, Ovarian Cancer Risk Factors, 2024).

Procedures:

- **Laparotomy –** is an open surgical procedure involving a large incision through the abdominal wall to access the organs within the abdominal cavity. In ovarian cancer, it remains a cornerstone approach for both diagnostic and therapeutic purposes, particularly when comprehensive staging or extensive cytoreduction is required. During a laparotomy, the surgeon typically makes a midline vertical incision from just below the sternum to the pubic bone, allowing wide exposure of the abdomen and pelvis. Once the abdomen is opened, the peritoneal cavity is inspected for visible disease, and peritoneal washings may be taken for cytology. The omentum, diaphragm, bowel surfaces, peritoneal folds, liver capsule, and pelvic organs are examined for tumor spread. If cancer is confirmed, staging and debulking are performed in the same session. This can include removal of the ovaries and fallopian tubes (bilateral salpingo-oophorectomy), uterus (hysterectomy), omentum (omentectomy), and any visible tumor deposits on peritoneal or visceral surfaces. Lymph nodes in the pelvis and para-aortic region may also be dissected for staging.

The goal of a laparotomy in ovarian cancer is to achieve optimal cytoreduction - removal of all visible tumor tissue, ideally leaving no residual lesions larger than 1 cm. Achieving complete gross resection is strongly associated with improved survival outcomes. Because this approach allows direct tactile assessment and access to deep or complex disease sites, it remains the preferred technique for advanced disease or when minimally invasive access is inadequate.

When it's used:

- For advanced-stage ovarian cancer (Stage III-IV) requiring extensive cytoreductive surgery to remove all visible tumor tissue
- When imaging or diagnostic laparoscopy reveals widespread peritoneal or omental disease that cannot be adequately addressed through minimally invasive methods
- For primary debulking surgery when complete tumor removal is the goal, including in cases involving bowel, diaphragm, or upper abdominal metastases
- During interval debulking surgery after neoadjuvant chemotherapy when disease burden is reduced but still requires broad abdominal access
- When diagnostic uncertainty exists and direct visualization and biopsy of multiple abdominal organs are needed
- In emergency situations such as bowel obstruction, internal bleeding, or tumor rupture caused by advanced disease

Following a laparotomy for ovarian cancer, the hospital stay typically lasts 5-10 days, depending on the extent of surgery, whether bowel resection was performed, and the patient's overall condition. During this time, pain management, bowel recovery, and prevention of complications such as infection, deep vein thrombosis, or ileus are the primary goals. Walking is usually encouraged within 24 hours of surgery to improve circulation, enhance lung function, and prevent clot formation.

For the first two weeks after discharge, activity should focus on rest and gentle mobility - short, frequent walks around the home, avoiding lifting more than 5 pounds, bending, or straining the abdomen.

Between weeks 3-6, walking distance can gradually increase, along with light stretching and postural exercises to promote flexibility and reduce stiffness. Heavy lifting,vacuuming, or core exercises should still be avoided.

From weeks 6-12, most patients can progress to low-impact activities such as stationary cycling or gentle yoga, depending on surgical healing and energy levels. Light resistance bands or small weights may be added, focusing on maintaining posture and avoiding abdominal strain. Persistent fatigue is common, and daily rest remains essential. Full return to moderate or higher intensity activity, including abdominal strengthening or resistance training, should wait until at least twelve weeks postoperatively or until surgical clearance confirms complete healing of the incision and internal tissues.

Potential Side-effects of Laparotomy:

- Abdominal pain and tenderness at the incision site
- Fatigue and low energy during early recovery
- Temporary loss of appetite, bloating, or delayed bowel function
- Nausea or constipation related to anesthesia and pain medication
- Wound infection or bleeding at the incision site
- Hematoma or fluid buildup (seroma) in the surgical area
- Adhesion formation leading to future abdominal pain or bowel obstruction
- Hernia at the incision site if lifting or strain occurs too early
- Urinary retention or bladder irritation
- Lymphedema
- Deep vein thrombosis (DVT) or pulmonary embolism from limited mobility
- Injury to nearby organs such as bowel, bladder, or blood vessels (rare)
- Persistent fatigue or reduced core strength for several weeks
- Changes in digestion or bowel habits as healing progresses

- **Unilateral and Bilateral Salpingo-Oophorectomy –** involves the surgical removal of one or both ovaries and their corresponding fallopian tubes. In a unilateral procedure, only one ovary and fallopian tube are removed, preserving the uterus and the other ovary. This is often performed for early-stage ovarian cancer confined to one ovary, benign cysts, or borderline tumors - especially in younger women who wish to maintain fertility and natural hormone production. The surgeon carefully inspects the opposite ovary and surrounding tissues to confirm there is no spread before limiting the surgery to one side.

A bilateral salpingo-oophorectomy, in contrast, removes both ovaries and both fallopian tubes and is the standard approach for most ovarian cancers because the disease frequently spreads or arises bilaterally. It may also be performed prophylactically in women at high genetic risk for ovarian or breast cancer (such as those with BRCA1/2 mutations). This procedure eliminates ovarian hormone production, inducing immediate menopause in premenopausal women and resulting in permanent infertility. It can be performed alone or with a hysterectomy or staging procedures such as omentectomy or lymph node sampling. Both surgeries may be completed through laparoscopic, robotic, or open abdominal techniques.

When it's used:

- Unilateral salpingo-oophorectomy is used when disease is confined to a single ovary and fertility preservation is desired. This includes early-stage epithelial ovarian cancer (stage IA, grade 1), borderline ovarian tumors, benign cystadenomas, or germ cell tumors limited to one ovary. It is also performed for diagnostic or preventive purposes when a single ovary shows suspicious findings but the other appears healthy

- Bilateral salpingo-oophorectomy is used when both ovaries are affected, when the cancer has a high risk of bilateral or microscopic spread, or as part of a complete staging operation for epithelial ovarian carcinoma. It is also the standard procedure in postmenopausal women, those with advanced disease, or individuals with hereditary cancer syndromes such as BRCA1 or BRCA2 mutations or Lynch syndrome. In these cases, removing both ovaries reduces recurrence risk and eliminates the hormonal source that may fuel certain tumors

Following a unilateral or bilateral salpingo-oophorectomy without hysterectomy, hospital stays are typically short ranging from 1-3 days for laparoscopic or robotic procedures and up to five days for open abdominal surgery. Common postoperative effects include abdominal tenderness, fatigue, and temporary bloating. In bilateral cases, menopausal symptoms such as hot flashes, mood changes, and sleep disturbances often begin within days of surgery. Most patients can begin walking within 24 hours, and oral intake usually resumes the next day once bowel activity returns.

During the first month, activity should remain limited to gentle walking, breathing exercises, and short periods of standing to reduce stiffness and promote circulation. Lifting, pushing, or pulling anything over 5-10 pounds should be avoided to protect abdominal incisions and internal healing. Driving, sexual activity, and work may typically resume after two to four weeks, depending on the individual's comfort and surgical approach.

Between weeks 5-8, most patients experience steady improvements in strength and energy. Walking distances can gradually increase, and light stretching or mobility exercises may begin, but abdominal strain and core workouts should still be avoided. Women who underwent bilateral oophorectomy may begin to experience menopausal symptoms due to hormonal changes, such as hot flashes or mood fluctuations, which can affect energy and sleep. Hydration, balanced nutrition, and slow increases in movement help support recovery.

By weeks 9-12, most individuals return to normal daily activities with minimal discomfort. Low-impact exercise, such as stationary cycling, gentle yoga, or light resistance bands, may be added as tolerated. High-impact activity, abdominal exercises, and heavy lifting should wait until at least three months post-surgery or until cleared by the surgeon. Full internal healing generally occurs by 10-12 weeks, allowing a gradual return to unrestricted physical activity.

Potential Side-effects of Unilateral & Bilateral Salpingo-Oophorectomy:

- Abdominal or pelvic pain and tenderness following surgery
- Fatigue and general weakness from anesthesia and blood loss
- Temporary bloating, constipation, or changes in bowel habits
- Nausea and reduced appetite during early recovery
- Infection at the incision site or within the abdomen
- Bleeding or hematoma formation near the surgical area
- Formation of adhesions that can lead to chronic pelvic pain or bowel obstruction
- Risk of injury to nearby structures such as the bladder, bowel, or blood vessels
- Hernia formation at incision sites, especially after open surgery
- Hormonal changes including hot flashes, mood swings, and sleep disturbances (more pronounced after bilateral removal)
- Vaginal dryness, decreased libido, and accelerated bone loss in premenopausal women after bilateral surgery
- Rare risk of lymphedema if performed in conjunction with pelvic lymph node dissection

- **Simple (Total) Hysterectomy with Bilateral Salpingo-Oophorectomy (TH-BSO) –** removes the uterus and cervix while preserving the parametrial tissues and upper vagina. It is most often combined with bilateral salpingo-oophorectomy (removal of both fallopian tubes and ovaries) for complete disease management and hormonal control. The surgery can be performed abdominally, laparoscopically, robotically, or occasionally vaginally, depending on patient anatomy, comorbidities, and surgeon expertise. Minimally invasive approaches are preferred worldwide for early-stage disease because they offer less blood loss, faster recovery, and similar oncologic outcomes to open surgery.

For aggressive variants such as serous carcinoma, carcino sarcoma, or undifferentiated tumors, the procedure includes an infracolicomentectomy and peritoneal washings or biopsies to detect occult metastases. These additional steps provide more accurate staging and guide adjuvant treatment decisions.

When it's used:

- For early-stage epithelial ovarian cancer confined to one or both ovaries
- As part of full surgical staging for apparent stage I or II disease
- For prophylactic removal in high-risk genetic carriers (BRCA1/2) after childbearing
- When combined with omentectomy and peritoneal biopsies to complete staging for borderline or low-grade tumors

Hospital stays are typically 1-3 days, sometimes performed as same-day discharge if laparoscopic. Light bleeding and abdominal or pelvic soreness are expected during the initial recovery phase, and fatigue is common for the first several days. During the first two weeks, the priority is gentle movement that promotes circulation without straining the abdominal wall or pelvic floor. Walking for 5-10 minutes at a relaxed pace can be done several times per day. Deep core engagement, heavy lifting, and high-impact activities should be avoided.

Weeks 2-6, activity can increase gradually as long as no new pain, bleeding, or pelvic pressure develops. Walking can be extended to 20-30 minutes per day, along with body-weight lower body exercises and upper-body exercises with light dumbbells. Core exercise should remain low intensity and avoid anything that causes abdominal bulging or strain.

After six weeks most individuals can transition to a more structured and progressive exercise program. Low-impact cardiovascular options such as brisk walking, stationary cycling, and swimming can be added gradually. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Pelvic floor and deep core coordination remain important even after the uterus has been removed, because the pelvic support system has been altered.

- **Radical Hysterectomy (open, laparoscopic, or robotic) –** a radical hysterectomy is a more extensive surgical procedure reserved for cases where the tumor has extended beyond the uterine body into the cervix or adjacent tissues but remains potentially curable with surgery. Unlike a simple hysterectomy, which removes only the uterus and cervix, a radical hysterectomy removes a wider margin of surrounding structures that may contain microscopic spread, including the parametrial tissues, upper vagina, and uterosacral ligaments. Pelvic and often para-aortic lymph nodes are removed at the same time to assess whether the cancer has spread, and the fallopian tubes and ovaries are typically taken as part of the procedure. The surgery can be performed through an open abdominal incision, laparoscopically, or robotically, with the choice depending on tumor size, stage, patient health, and surgical expertise. Because it involves removal of more supportive and connective tissue, recovery is longer and functional side effects are more common. Early postoperative effects may include pelvic ain, fatigue, bladder or bowel disturbances, and reduced stamina. Long-term effects can involve pelvic floor weakness, urinary urgency or retention, sexual discomfort due to vaginal shortening, and a small risk of lymphedema if lymph nodes are removed. Despite its complexity, a radical hysterectomy remains an important treatment for select cases of stage II or locally advanced endometrial cancer, offering the potential for complete disease control when negative margins and clear nodal status are achieved.

When it's used:

- When ovarian cancer has extended locally to involve the uterus, cervix, or upper vagina but remains operable and potentially curable with complete resection
- In advanced epithelial ovarian cancer where disease is confined to the pelvis and a radical resection is necessary to achieve no gross residual disease
- For select cases of fallopian tube or primary peritoneal carcinoma involving contiguous reproductive organs
- In recurrent ovarian cancer limited to the central pelvis, where previous treatment has controlled distant disease and surgical removal may offer prolonged remission
- When high-grade serous or clear cell carcinomas involve the uterus or parametrial tissues, requiring wider surgical margins for optimal cytoreduction

Hospital stay averages 3-5 days for minimally invasive procedures and up to 7 days for open abdominal surgery. Early mobilization begins within 24 hours to prevent clots and promote bowel function. During the first two weeks at home, movement should focus on short, frequent walks of 5-10 minutes on level ground, gradually increasing as tolerated. The abdominal wall, pelvic floor, and internal tissues are highly vulnerable at this point, so lifting more than ten pounds, deep core exercises, and any straining should be avoided. Gentle breathing exercises, light mobility for the spine and shoulders, and very small-range hip movements are appropriate if comfortable.

From weeks 2-6, walking can gradually increase to 15-30 minutes per day at an easy pace, with rests as needed. Strength work should remain extremely light and non-straining. Core training should focus on reconnecting with deep abdominal and pelvic support through pelvic tilts, and diaphragmatic breathing. If lymph nodes were removed, lymph-drainage routines to prevent swelling.

After six weeks, exercise can be expanded cautiously. Low-impact cardiovascular activity such as longer walks, stationary cycling, or swimming is appropriate. Strength training can progress modestly along with body-weight lower body exercises and upper-body exercises with light dumbbells or bands. Core work can progress as long as there is no abdominal bulging or pelvic pressure. Pelvic floor coordination remains important even though the uterus has been removed, as the surgery alters support structures and can initially weaken the pelvic base. Mobility and stretching should continue consistently to prevent compensatory patterns in the hips and low back.

Throughout all stages, increases in bleeding, abdominal or pelvic heaviness, urinary changes, leg swelling, or sharp pain indicate the need to reduce activity and reassess with the care team.

Potential Side-effects for all Hysterectomies:

- Pain and soreness
- Bleeding and spotting
- Fatigue
- Gas pain and bloating
- Constipation
- Urinary symptoms
- Blood clots
- Changes in bowel or bladder habits
- Pelvic floor dysfunction
- Temporary numbness or soreness in the inner thighs
- Adhesion formation
- Hormonal changes (if ovaries are removed)
- Chronic pelvic or abdominal pain
- Risk of lymphedema (if pelvic lymph nodes are removed)
- Loss of fertility



- **Omentectomy and Peritoneal Washing –** this procedure is routinely performed during ovarian cancer surgery because the omentum and peritoneum are frequent sites of microscopic or early metastatic spread, even when imaging suggests that the disease is localized. The omentum serves as a "filter" where free-floating cancer cells often implant and grow, especially in epithelial ovarian carcinomas such as serous, endometrioid, clear cell, or carcinosarcoma subtypes. Removing the infracolic omentum allows for both staging and therapeutic purposes by eliminating potential microscopic disease. Peritoneal washings and biopsies are taken at the beginning of surgery to detect any free-floating malignant cells and to identify small tumor deposits not visible to the eye. This information helps determine the FIGO stage, guide postoperative chemotherapy decisions, and improve overall prognosis accuracy. The procedure is typically performed as part of a comprehensive staging or cytoreductive operation and is standard of care in both early- and advanced-stage ovarian cancer.

When it's used:

- As part of initial staging for all suspected or confirmed epithelial ovarian cancers
- In high-grade or aggressive subtypes likely to spread microscopically (serous, clear cell, carcinosarcoma)
- When imaging or intraoperative findings suggest possible peritoneal or omental involvement
- During interval or secondary debulking to remove residual omental disease

The average hospital stay ranges from 3-7 days, depending on whether it is performed laparoscopically, robotically, or as part of a larger open debulking procedure. Minimally invasive surgeries often allow discharge within 3-4 days, while open operations - particularly when other organs are resected - may require longer stays for pain control and bowel recovery. During the first several weeks, patients may experience abdominal discomfort, bloating, and fatigue, which improve as bowel function normalizes and incisions heal. Early ambulation is encouraged to prevent blood clots and promote recovery, but lifting, twisting, and straining should be avoided.

For the first two weeks, activity should be limited to rest, gentle breathing, and short indoor walks. Nothing heavier than 5 pounds should be lifted, and abdominal strain must be avoided.

From weeks 2-6, walking time can increase gradually, aiming for several short sessions daily to build endurance. Gentle stretching and mobility work can begin, but no abdominal or resistance exercises should be introduced yet.

By weeks 6-12, patients can progress to low-impact aerobic activities such as slow walking, stationary cycling, or aquatic therapy. Light resistance bands or 5-10 pound weights may be added cautiously. Any activity that causes abdominal pressure, such as planks or heavy lifting, should wait until at least the three-month mark or until the abdominal wall has fully healed and the surgeon provides clearance.

Potential Side-effects of Omentectomy and Peritoneal Washings/Biopsies:

- Abdominal or pelvic pain and tenderness following surgery
- Temporary bloating or delayed bowel movement return
- Fatigue and weakness during the early recovery phase
- Risk of infection at incision sites or within the abdominal cavity
- Postoperative bleeding or hematoma formation
- Adhesion development that may cause future discomfort or bowel obstruction
- Loss of appetite or digestive changes due to altered abdominal anatomy
- Seroma or fluid buildup near the surgical site
- Hernia formation at incision sites, particularly after open surgery
- Rare injury to adjacent organs such as the bowel, bladder, or blood vessels
- Lymphedema

- **Cytoreductive (Debulking) Surgery for Advanced Ovarian Cancer –** is the cornerstone of treatment for advanced ovarian cancer, aiming to remove all visible tumor deposits within the abdomen and pelvis. The procedure often includes removal of the uterus, both ovaries, fallopian tubes, omentum, and affected peritoneal surfaces. Depending on disease spread, portions of the bowel, spleen, liver capsule, diaphragm, or bladder may also be removed or reconstructed. The goal is to achieve no visible residual disease, as survival outcomes improve significantly when complete cytoreduction is achieved. These surgeries are performed through open abdominal incisions by specialized gynecologic oncology teams.

When it's used:

- For advanced-stage (III–IV) ovarian cancer where complete tumor removal appears feasible
- For isolated recurrences confined to the pelvis or abdomen
- After neoadjuvant chemotherapy as an interval debulking procedure in patients who respond to treatment

Hospitalization typically lasts 7-14 days, depending on surgical complexity, bowel involvement, and postoperative recovery speed. In the hospital, patients begin walking within 24-48 hours with assistance, focusing on short sessions to restore circulation and lung expansion.

The first two weeks at home prioritize rest, slow walking, and deep breathing to prevent complications. Lifting is limited to less than five pounds, and abdominal strain is strictly avoided.

Between weeks 2-6, mobility exercises for the hips, shoulders, and spine can be added gradually. Walking tolerance increases to several short sessions per day, emphasizing energy conservation and posture. If lymph nodes or large portions of the omentum were removed, lymphatic drainage exercises and leg elevation are essential to prevent lymphedema. Strength work and abdominal activity remain restricted during this phase.

From 6-12 weeks, low-impact aerobic exercises such as stationary cycling, gentle yoga, or water walking may begin once cleared by the surgical team. Light resistance work under 8-10 pounds can be reintroduced gradually, focusing on breathing control and proper core alignment. Fatigue, bloating, or abdominal discomfort signal the need to reduce intensity. Recovery after debulking surgery varies widely, and full return to baseline strength and endurance may take several months.

Potential side effects of Cytoreductive ("Debulking") Surgery:

- Significant abdominal pain, bloating, or discomfort after surgery
- Prolonged fatigue and weakness during recovery
- Risk of infection at incision sites or within the abdomen
- Bleeding or formation of hematoma
- Temporary or prolonged bowel dysfunction, including constipation, diarrhea, or obstruction
- Risk of injury to nearby organs such as the bladder, bowel, ureters, or major blood vessels
- Delayed wound healing, particularly after large incisions or combined organ resections
- Formation of adhesions that may cause chronic pain or bowel obstruction
- Fluid buildup in the abdomen (ascites or seroma) requiring drainage
- Hernia formation at incision or stoma sites
- Nutritional challenges if portions of bowel or omentum are removed
- Lymphedema in the legs or pelvis if lymph nodes are also removed
- Emotional distress or decreased energy due to the magnitude of surgery and slower recovery process

Types of Treatment Used:

- Chemotherapy
- Targeted therapy
- Anti-angiogenic therapy
- Immunotherapy
- Hormonal therapy

STOMACH CANCER

Stomach cancer is the fifth most commonly diagnosed cancer worldwide and the fifth leading cause of cancer-related mortality, with 968,784 new cases and 659,853 deaths in 2022. It is the fourth most common cancer in men and the seventh most common in women (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Although global age-standardized incidence and death rates have declined significantly over recent decades - attributed to reductions in H. pylori infection, tobacco smoking, and consumption of salt-preserved foods - the absolute number of cases remains high due to population growth and aging, and obesity may drive an increase in cardia cancer particularly in Western populations (Inoue, Cancers, 2024).

Stomach cancer was the leading cause of cancer death in the United States for much of the early 20th century. The decline has been attributed to the widespread adoption of refrigeration, which increased availability of fresh fruits and vegetables and reduced reliance on salted and smoked foods, as well as the increased use of antibiotics, which can eradicate Helicobacter pylori (H. pylori) - a bacterium now recognized as a major causative factor in stomach cancer (ACS, Stomach Cancer Key Statistics, updated 2025).Almost all gastric cancers are adenocarcinomas, arising in the mucus-producing cells of the stomach lining. Other types include gastrointestinal neuroendocrine tumors, gastrointestinal stromal tumors, and lymphomas. The average age at diagnosis is 68, with approximately 6 out of every 10 people diagnosed being 65 or older. The lifetime risk of developing stomach cancer is approximately 1 in 104 for men and 1 in 153 for women (ACS, Stomach Cancer Key Statistics, updated 2025).

Stomach cancer is more common in East Asia, Eastern Europe, and parts of South and Central America, and less common in North America, Northern and Western Africa, and South Central Asia (Bray et al., CA: A Cancer Journal for Clinicians, 2024). In the United States, it is more common in Hispanic Americans, African Americans, and Asian and Pacific Islanders than in non-Hispanic whites (ACS, Stomach Cancer Key Statistics, updated 2025).

The most significant risk factors include long-term H. pylori infection, which leads to chronic inflammation and precancerous changes in the stomach lining; a diet high in smoked, salted, pickled, or processed foods; tobacco smoking, which approximately doubles the risk particularly for cancers in the upper stomach near the esophagus (ACS, Stomach Cancer Risk Factors, 2024; Inoue, Cancers, 2024).

Procedures:

- **Endoscopic Resection (Endoscopic Mucosal Resection – EMR / Endoscopic Submucosal Dissection - ESD) –** these are organ-preserving techniques performed entirely through an endoscope inserted via the mouth. EMR removes superficial lesions by lifting and snaring them, while ESD uses a fine dissecting knife to remove larger or ulcerated lesions in one piece. ESD allows en bloc resection for more accurate pathological assessment and lower recurrence rates.

When it's used:

- For very early gastric cancers (T1a) confined to the mucosa without lymphovascular invasion
- Lesions typically ≤2 cm, well-differentiated, and without ulceration

Gastrectomy Procedures:

1. Function-Preserving or Limited Resections (early-stage, curative)

- Endoscopic Resection (EMR / ESD) - removes superficial mucosal or submucosal tumors without external incisions
- Pylorus-Preserving Gastrectomy (PPG) - removes the middle portion of the stomach but preserves the pylorus to reduce dumping and reflux
- Proximal Gastrectomy - removes only the upper part of the stomach for small, early proximal tumors while preserving digestive function

When it's used:

- Cancer is early (T1a–T1b), well-differentiated, and confined
- Lymph-node risk is minimal

2. Standard Gastrectomies (localized–advanced, curative)

- Distal (Subtotal) Gastrectomy - removes the antrum and lower two-thirds of the stomach, commonly for distal or mid-body tumors
- Total Gastrectomy - removes the entire stomach with reconstruction (Roux-en-Y esophagojejunostomy)
- Lymphadenectomy (D1 or D2) - accompanies both operations; D2 is now global standard for adequate staging and control

When it's used:

- Stage I-III resectable tumors needing full oncologic margins and node dissection

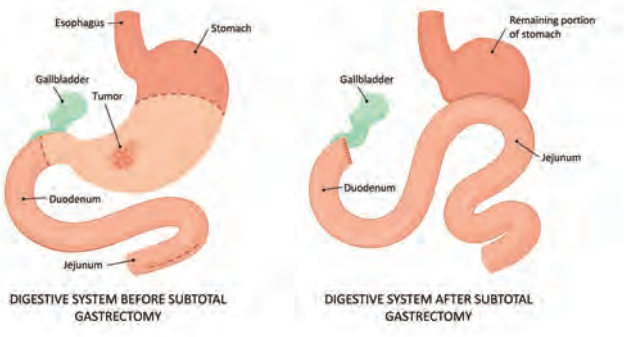
3. Extended or Multivisceral Resections (locally advanced, curative intent)

- Extended Gastrectomy / En Bloc Resection - removes stomach plus directly invaded adjacent organs (e.g., spleen, pancreas, colon, diaphragm)
- Cytoreductive Surgery ± HIPEC - in select peritoneal metastasis cases to remove macroscopic disease and treat residual microscopic disease with heated intraperitoneal chemotherapy

When it's used:

- Locally advanced (T4b) tumors invade nearby organs, but complete resection (R0) is feasible

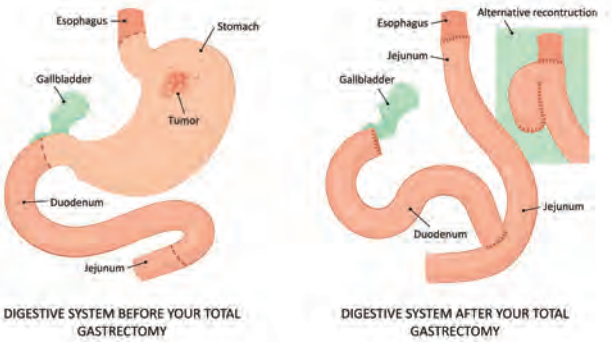
PARTIAL GASTRECTOMY



DIGESTIVE SYSTEM BEFORE SUBTOTAL GASTRECTOMY

DIGESTIVE SYSTEM AFTER SUBTOTAL GASTRECTOMY

TOTAL GASTRECTOMY



DIGESTIVE SYSTEM BEFORE YOUR TOTAL GASTRECTOMY

DIGESTIVE SYSTEM AFTER YOUR TOTAL GASTRECTOMY

4. Minimally Invasive Approaches (applied across stages I-III when feasible)

- Laparoscopic or Robotic Gastrectomy - same oncologic resection performed through small incisions, offering faster recovery and reduced blood loss

When it's used:

- Early or moderately advanced disease and surgical expertise are available

5. Palliative and Conversion Procedures (advanced or metastatic disease)

- Conversion Surgery - curative resection after major response to systemic therapy in initially unresectable disease

- Palliative Surgery (Bypass, Stent, Jejunostomy) - symptom control for obstruction, bleeding, or nutritional support

When it's used:

- Systemic therapy has downstaged disease or surgery improves quality of life

The typical hospital stay after gastrectomy ranges from 5-7 days for minimally invasive procedures and up to two weeks following open subtotal or total resections, depending on recovery progress and postoperative stability. During the first few days, patients begin gentle mobility under supervision, sitting upright and walking short distances within 24-48 hours to promote circulation and lung expansion. Breathing exercises are emphasized several times a day to prevent pneumonia, while posture awareness and light upper-body mobility help reduce stiffness from protective guarding. During this period, no lifting, bending, twisting, or abdominal strain is permitted, and activity should remain limited to slow, deliberate movements and short bouts of assisted walking.

Over the next several weeks, walking is gradually increased, beginning with 5-10 minutes several times daily and extending to 20-30 minutes by the end of week six as energy improves.Gentle stretching of the shoulders, spine, and hips helps restore alignment and mobility, while light breathing and postural control exercises support circulation and core stability without creating intra-abdominal pressure. Activities involving resistance, rapid changes in position, or high exertion should still be avoided. Lifting more than ten pounds is generally contraindicated, and any movement that causes pulling or pain near the incision should be stopped immediately.

Between 6-12 weeks, most individuals can expand to low-impact cardiovascular exercise such as stationary cycling or brisk walking and begin very light resistance work under supervision, focusing on controlled range of motion and proper breathing rather than intensity. Deep core engagement and pelvic floor coordination can be reintroduced at this stage, but traditional abdominal exercises and twisting motions remain off-limits until the abdominal wall and internal tissues are fully healed.

By three months, most patients have regained steady endurance and functional mobility, though fatigue and deconditioning may still limit stamina. Any sharp pain, abdominal swelling, or new discomfort should prompt activity reduction and review with the medical team.

Potential Side-effects of all Gastrectomies:

- Pain, abdominal discomfort, and fatigue
- Nausea, vomiting, or intolerance to oral intake during reintroduction of food
- Anastomotic leak (leakage from surgical connection between stomach and intestine or esophagus)
- Bleeding (internal or at incision site)
- Infection (wound, intra-abdominal, or respiratory)
- Ileus (temporary paralysis of the intestines causing bloating and nausea)
- Pulmonary complications (atelectasis, pneumonia due to shallow breathing post-surgery)
- Deep vein thrombosis (DVT) or pulmonary embolism due to reduced mobility
- Bile reflux or gastritis, especially after partial or pylorus-preserving gastrectomy
- Pancreatic fistula or injury (if extended resection near pancreas)
- Dumping syndrome
- Delayed gastric emptying, particularly after pylorus-preserving procedures
- Weight loss and muscle wasting
- Diarrhea or steatorrhea (fat malabsorption)
- Anastomotic stricture (narrowing at surgical junction leading to difficulty swallowing or obstruction)
- Reflux esophagitis, especially after proximal gastrectomy
- Lymphatic leakage or chyle leak after extensive lymph node dissection
- Abdominal bloating or gas discomfort
- Nutritional deficiencies (especially in total or near-total gastrectomy):
    - Vitamin B12 deficiency (due to loss of intrinsic factor)
    - Iron deficiency anemia
    - Folate, calcium, and vitamin D deficiencies

- **D1 and D2 Lymphadenectomy –** lymph-node dissection is crucial for staging and cure. D1 removes perigastric nodes (stations 1-6), while D2 includes second-tier nodes along major arteries (celiac, splenic, hepatic, left gastric).

When it's used:

- D1: in early-stage, node-negative cancers treated by minimally invasive surgery
- D2: global standard for curative surgery in resectable stage IB-III cancers

Potential Side-effects of D1 and D2 Lymphadenectomy:

- Lymphedema in the legs or lower abdomen due to lymphatic disruption

If a stomach tumor is blocking the stomach and can't be removed completely, prophylactic surgery may be done to help patients eat normally. Procedures include:

- **Gastrojejunostomy (Bypass Surgery) –** creates a new connection between the stomach and the small intestine to bypass the obstructed portion of the stomach. This allows food to pass normally when the tumor blocks the pylorus or duodenum.
- **Endoscopic Stent Placement –** a metal or plastic stent is inserted through an endoscope to hold the blocked area open, allowing liquid and soft foods to pass without open surgery.
- **Feeding Jejunostomy –** a small feeding tube is placed directly into the jejunum (part of the small intestine) to ensure adequate nutrition when swallowing or gastric emptying is severely impaired.
- **Partial Palliative Gastrectomy –** removes the portion of the stomach containing the tumor to relieve obstruction or bleeding, even when complete cancer removal isn't possible.
- **Laser or Argon Plasma Coagulation –** used endoscopically to reduce tumor bulk or control bleeding from the tumor surface.

Your client should discuss yoga, Pilates, and other exercises that target the abdominal area with their doctor. Contact sports are not recommended because they can dislodge a tube or irritate the stoma site. Swimming is a great form of exercise, but should also be discussed with their doctor.

Eating after a Gastrectomy:

- After this surgery, the stomach won't be able to hold as much as it did before surgery. Your client will need to have 6 or more small meals a day instead of 3 main meals. This will help them eat the proper amount of food, although the stomach is smaller or completely removed.

- If your client is losing weight inadvertently, they should see their doctor and/or registered dietitian

- Suggest that they start with 6 or more small meals daily. When they first start eating, they may only be able to comfortably eat a ½ to 1 cup portion (serving) of food at a time. Over time, they may be able to have larger portion sizes and eat fewer meals per day. This may take several months. Some individuals may need to keep following a 6-small-meal diet.

- Recommend that they chew food throughly. This makes it easier for te body to digest the food. Eating slowly will help them to stop eating before they get too full and feel uncomfortable.

- Recommend that they sit upright during meals and have their last meal of the day at least 2 hours before bedtime. They should not have more than 4 ounces (½ cup) of liquid with meals. This will allow them to eat enough solid food, getting the nutrients that they need, without getting too full. It will also keep the food from moving into the small intestine too quickly.

- Let them know that soup and protein shakes count as liquids

- They should include protein with each meal. Good protein sources include eggs, lean meat, poultry, fish, nuts, milk, yogurt, cottage cheese, cheese, almond butter, and tofu.

- They should avoid spicy and peppery foods soon after their surgery as well as fatty and sugary foods if they cause discomfort



Drinking after a Gastrectomy:

- Recommend that they drink about 8-10 (8-ounce) glasses of liquid each day and avoid carbonated drinks if they make them feel full
- They should drink most of liquids at least 1 hour before or 1 hour after meals rather than accompanying them. This will help them to avoid feeling too full while preventing dehydration.
- If they must have a drink with their meals, they should have no more than about 4 ounces (½ cup) of liquids
- If a large part of their stomach was removed during surgery, they may need to take extra vitamin B12 as well as other vitamin and mineral supplements. They should discuss this with their doctor and/or registered dietitian first.

Potential Side-effects of all Gastrectomies:

- Increased heartburn and regurgitation
- Weight loss
- Abdominal pain and cramping
- Ulcers
- Nausea, vomiting and diarrhea
- Vitamin deficiencies
- Dumping syndrome
- Risk of overwhelming infection with splenectomy

Types of Treatment Used:

- Chemotherapy
- Targeted therapy
- Immunotherapy
- External beam radiation
- Chemoradiation
- CAR-T and TCR-T therapy
- Cancer vaccines and dendritic cell immunotherapy
- Liquid biopsy-guided precision therapy

DUMPING SYNDROME

Dumping syndrome occurs when food moves too quickly from the stomach into the small intestine. It most commonly develops after gastric surgery such as gastric bypass or gastrectomy, though it can occasionally occur without a surgical history.

- **Early Dumping Syndrome –** occurs within 10-30 minutes after eating. When food enters the small intestine too rapidly, it draws large amounts of fluid out of the bloodstream and into the gut. This fluid shift, combined with the sudden release of gut hormones, produces both gastrointestinal and cardiovascular symptoms.

Symptoms:

- Nausea and vomiting
- Abdominal cramping and bloating
- Diarrhea
- Flushing and excessive sweating
- Rapid or pounding heartbeat (tachycardia)
- Dizziness and lightheadedness
- Low blood pressure (hypotension)
- Fatigue and general weakness

- **Late Dumping Syndrome –** occurs 1-3 hours after eating and is driven by reactive hypoglycemia. Rapid absorption of carbohydrates causes a sharp spike in blood glucose, prompting the pancreas to release a large surge of insulin. Blood sugar then drops below normal, producing primarily neurological and hypoglycemic symptoms.

Symptoms:

- Shakiness and trembling
- Profuse sweating
- Weakness and fatigue
- Rapid heartbeat
- Difficulty concentrating or mental confusion
- Hunger shortly after eating
- Anxiety and irritability
- Fainting (syncope) in severe cases

> One of the most practical steps a person with dumping syndrome can take is to allow sufficient time between eating and exercising. Waiting at least 2-3 hours after a meal before engaging in any physical activity gives the stomach and small intestine adequate time to process food at a controlled pace. During this window, gastric emptying is most active and the body is most vulnerable to the fluid shifts and hormonal surges that trigger early dumping symptoms. Jumping into exercise too soon compresses this critical period, accelerating gut motility further and dramatically increasing the likelihood of cramping, nausea, dizziness, and cardiovascular instability.
>
> Closely related to this is the importance of avoiding high-intensity exercise during the late postprandial window, roughly 1-3 hours after eating. This is precisely the period when reactive hypoglycemia is most likely to develop in late dumping syndrome. During intense physical activity, muscles demand glucose at a rapid rate, which compounds the blood sugar drop already being driven by the excess insulin response.

The result can be a dangerously sharp fall in blood glucose that leaves the person feeling shaky, confused, weak, and at risk of fainting - all while their body is already under the physiological stress of exertion. Even moderate-intensity activity during this window should be approached with caution and awareness.

Because hypoglycemic episodes can arise unpredictably, it is strongly advisable to keep a fast-acting carbohydrate source on hand at all times during exercise. Options such as fruit juice, glucose tablets, regular soda, or small glucose gels are ideal because they are absorbed rapidly into the bloodstream and can reverse a hypoglycemic episode within minutes. This is not merely a precaution - for individuals prone to late dumping, it is a genuine safety measure. Exercising alone without access to a carbohydrate source, particularly in remote areas or without a phone, carries real risk. Informing a workout partner or gym staff about the condition is also a sensible precaution so that help can be provided quickly if symptoms escalate.

When it comes to the type of exercise chosen, light to moderate activity is far better tolerated than intense or high-impact exercise. Activities such as walking, gentle cycling, swimming, yoga, or low-resistance strength training place manageable demands on the cardiovascular system without dramatically altering blood flow away from the gut or spiking hormonal responses.

High-impact activities like running, interval training, or heavy weightlifting, by contrast, cause rapid shifts in heart rate, blood pressure, and blood glucose that overlap with and worsen the physiological instability already present in dumping syndrome. Building an exercise routine around lower-intensity options does not mean sacrificing fitness - consistent, moderate activity still delivers meaningful cardiovascular, musculoskeletal, and metabolic benefits while keeping symptoms under control.

Scheduling exercise in the early morning before the first meal of the day, or in a clearly defined gap between meals, is one of the most effective structural strategies available. Exercising in a fasted or semi-fasted state - provided blood sugar is stable at baseline - removes the postprandial risk window entirely. Alternatively, identifying a consistent 2-3 hour gap between a small, low-carbohydrate meal and a planned workout can allow for more flexibility throughout the day. The key principle is predictability: establishing a routine that respects the body's digestive timeline reduces the guesswork and lowers the chance of being caught mid-workout by a symptomatic episode.

Finally, hydration requires particular care in the context of dumping syndrome. While staying well hydrated throughout the day is essential for overall health and exercise performance, consuming large amounts of fluid immediately before or during a workout can accelerate gastric emptying and worsen symptoms significantly. Fluids move through the stomach quickly and, when combined with the physical motion of exercise, can push intestinal contents into the small bowel at an even faster rate than food alone. The recommended approach is to hydrate steadily in the hours between meals and exercise rather than in concentrated doses around workout time. Small sips of water during exercise are generally well tolerated, but gulping large quantities should be avoided. Sports drinks containing sugar should also be used with caution, as their carbohydrate content can trigger a late dumping response in susceptible individuals.

Signs to stop exercising immediately:

- Sudden dizziness or near-fainting
- Heart palpitations
- Profuse unexpected sweating
- Confusion or inability to focus
- Severe abdominal cramping

LIVER CANCER

The liver regulates most chemical levels in the blood and excretes a product called bile - a clear green or yellow fluid that helps break down fats and carries away waste products during digestion. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down, balances, and creates nutrients, and metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic (Johns Hopkins Medicine, Liver: Anatomy and Functions, 2024).

The liver holds about one pint (13%) of the body's blood supply at any given moment. The liver consists of 2 main lobes, both of which are made up of 8 segments that consist of 1,000 lobules (small lobes). These lobules are connected to small ducts (tubes) that connect with larger ducts to form the common hepatic duct. The common hepatic duct transports the bile made by the liver cells to the gallbladder and duodenum (the first part of the small intestine) via the common bile duct (Johns Hopkins Medicine, Liver: Anatomy and Functions, 2024).

Liver cancer is the sixth most commonly diagnosed cancer and the third leading cause of cancer-related deaths worldwide. There were 866,136 new cases and 758,725 deaths worldwide in 2022, with men bearing a disproportionately higher burden than women across all regions (Li et al., Chinese Medical Journal, 2024). The number of new cases and deaths from liver cancer is expected to increase by more than 55% by 2040, meaning that approximately 1.4 million people could be diagnosed and 1.3 million could die from the disease in that year (Rumgay, Arnold, Ferlay, et al., Journal of Hepatology, 2022).

Often the disease has been preceded by years of chronic liver disease, including cirrhosis and/or viral hepatitis. There are many people with cirrhosis and decompensated liver disease, but not all are appropriate candidates for liver transplantation. A patient must be able to survive the operation and potential postoperative complications, reliably take medications that prevent rejection and opportunistic infections, comply with frequent clinic visits and laboratory tests, and refrain from activities that would injure the liver, such as drinking alcohol. The conditions listed below are generally considered to be absolute contraindications to liver transplantation (EASL, Clinical Practice Guidelines on Liver Transplantation, 2024):

- Severe, irreversible medical illness that limits short-term life expectancy
- Severe pulmonary hypertension (a mean pulmonary artery pressure greater than 35 mmHg requiring vasomodulator therapy before transplant consideration, with mPAP >45 mmHg despite treatment considered an absolute contraindication
- Cancer that has spread outside of the liver
- Systemic or uncontrollable infection
- Active substance abuse (drugs and/or alcohol)
- Unacceptable risk for substance abuse (drugs and/or alcohol)
- History of non-compliance, or inability to adhere to a strict medical regimen
- Severe, uncontrolled psychiatric disease

Symptoms of liver cancer may include pain in the right side of the upper abdomen or around the right shoulder blade, a hard lump below the ribs on the right side, abdominal swelling, swollen veins on the abdomen, unexplained weight loss, weakness, loss of appetite, jaundice, fatigue, and fever. Unfortunately, symptoms of liver cancer often do not appear until the disease is in a more advanced stage, which is why regular screening is especially important in patients living with chronic liver disease

The main types of primary liver cancer are:

- **Hepatocellular Carcinoma (HCC) –** is the most common primary liver cancer, accounting for approximately 85-90% of all primary liver cancers (Llovet et al., JHEP Reports, 2025). HCC typically arises in the context of cirrhosis or chronic liver disease - approximately 80-90% of cases arise in patients with underlying cirrhosis, most commonly due to chronic hepatitis B or C infection, alcohol-related liver disease, and increasingly metabolic dysfunction-associated steatotic liver disease (MASLD/NAFLD) (Petrick et al., StatPearls, updated 2023).

- **Bile Duct Cancer (Cholangiocarcinoma) –** accounts for approximately 10-20% of all primary liver cancers and is classified by anatomical location into three distinct subtypes: intrahepatic (arising within the liver), perihilar (occurring at the junction of the left and right hepatic ducts, also known as Klatskin tumors), and distal (arising in the common bile duct closer to the small intestine). It is the second most common primary liver malignancy after hepatocellular carcinoma and carries a poor prognosis due to its typically late presentation, aggressive biological behavior, and limited response to systemic therapies (Moris et al., CA: A Cancer Journal for Clinicians, 2023)

- **Angiosarcoma (Hemangiosarcoma) –** is an exceptionally rare and highly aggressive malignancy arising from the endothelial cells lining the hepatic blood vessels, accounting for approximately 0.1-2% of all primary liver cancers and representing the most common primary malignant mesenchymal tumor of the liver in adults - predominantly affects older men in their 60-70s (Rojas et al., Annals of Medicine and Surgery, 2024).

- **Hepatoblastoma –** the most common primary malignant liver tumor in the pediatric population, accounting for approximately 1% of all childhood cancer diagnoses and occurring at an incidence of approximately 1.5 cases per million children under 15 years of age worldwide (Czauderna and Haeberle, StatPearls, updated 2024).

- **Fibrolamellar HCC –** is a rare subtype representing less than 1% of all malignant liver neoplasms, typically affecting adolescents and young adults without the underlying cirrhosis associated with conventional HCC. FL-HCC is plagued by high recurrence rates and poor long-term outcomes, related in part to the absence of effective treatment for advanced and recurrent disease (Glavas et al., 2023, Journal of Gastrointestinal Surgery).

The liver is a common place where cancer spreads. Its large size and high blood flow make it a prime target for tumor cells moving through the bloodstream. Colorectal, breast and lung cancers are the most common sources of metastatic liver cancer. [177]

Liver tumors are classified in one of four ways:

1. Localized and operable tumors are found in one place and can be removed

2. Localized and inoperable tumors are found in one area but cannot be totally removed safely

3. In advanced cases, cancer has spread throughout the liver and/or to other parts of the body

4. In recurrent cases, the cancer has returned to the liver or another part of the body after initial treatment

Procedures:

- **Hepatic Resection –** is the cornerstone surgical treatment for primary and some secondary liver cancers, aimed at removing all visible disease while preserving enough healthy liver for recovery and function. The procedure involves excising part of the liver containing the tumor along with a margin of normal tissue to ensure negative (cancer-free) margins. Resections are categorized anatomically according to Couinaud's segments, which divide the liver into functional units with their own vascular and biliary systems.

    1. **Wedge Resection (non-anatomic resection) –** removes only the tumor and a cuff of surrounding parenchyma without regard to segmental boundaries. It is typically used for small, peripherally located tumors, particularly in patients with limited liver reserve or prior resections.

    2. **Segmentectomy or Sectionectomy (anatomic resection) –** follows the natural vascular and biliary divisions, removing one or more entire liver segments supplied by a specific portal triad. This method reduces recurrence risk by removing potential microscopic disease spread through the segment's portal branches.

    3. **Lobectomy or Hemihepatectomy –** removes an entire lobe - either the right (segments 5-8) or left (segments 2-4) - and is used for larger or centrally located tumors where a smaller resection would not achieve clear margins.

    4. **Extended Hepatectomy –** involves resection of one lobe plus part of the opposite lobe for extensive but still resectable disease. This approach may require complex vascular or biliary reconstruction when tumors involve major vessels or ducts.

During a resection, surgeons often employ intraoperative ultrasound to map tumor location and guide precise cuts while preserving critical vasculature. Advanced centers may use vascular occlusion techniques (Pringle maneuver) to minimize blood loss and ensure hemostasis. When the expected future liver remnant (FLR) is small, preoperative strategies can be used to induce hypertrophy of the remaining liver (Llovet et al., JHEP Reports, 2025).

The procedure can be performed via open, laparoscopic, or robotic approaches. Open surgery remains standard for complex or large resections, while minimally invasive techniques are increasingly adopted for peripheral and smaller lesions, offering less pain, reduced blood loss, and shorter hospital stays.

Hepatic resection is most successful in patients with preserved liver function, no uncontrolled portal hypertension, and disease confined to the liver without extensive vascular invasion or metastases. Contraindications include decompensated cirrhosis, multifocal disease not amenable to clear margins, and inadequate FLR despite optimization.

Overall, hepatic resection provides one of the best chances for long-term survival or cure in carefully selected patients. For hepatocellular carcinoma, modern 5-year survival rates following resection range from 50-70% in non-cirrhotic patients with early-stage, single tumors, though rates are lower in the setting of underlying cirrhosis or advanced disease (Llovet et al., JHEP Reports, 2025, Hepatocellular Carcinoma Clinical Practice Guidelines, Version 2.2024).

When it's used:

- For liver cancers that can be completely removed while leaving enough healthy tissue for normal function

- Typically indicated for hepatocellular carcinoma (HCC) or intrahepatic cholangiocarcinoma (ICC) that is confined to one region of the liver, with good liver function (Child-Pugh A), no significant portal hypertension, and no spread beyond the liver

- Resection may also be performed for select patients with colorectal or neuroendocrine metastases limited to the liver, or after successful downstaging therapy that converts an unresectable tumor into a resectable one

Recovery after hepatic resection (wedge, segmentectomy, lobectomy, or extended hepatectomy) progresses in carefully staged phases over the first three months. The process is influenced by the extent of resection, whether the approach was open or minimally invasive, and the patient's baseline liver function and conditioning before surgery.

The typical hospital stay is 5-7 days after minimally invasive procedures and 7-14 days after open hepatectomy. During the first 2-3 days, patients remain in a monitored setting to manage pain, prevent bleeding, and ensure stable liver and kidney function. Early ambulation begins within 24-48 hours, usually with assistance. Breathing exercises (incentive spirometry and diaphragmatic breathing) are performed several times daily to prevent pneumonia, while gentle leg and help maintain circulation and reduce the risk of blood clots. Drain output and liver enzyme levels are monitored closely to detect bile leaks or infection. During this time, no lifting, twisting, or abdominal strain is permitted, and movement should remain slow, upright, and deliberate. Over weeks 2-6, walking becomes the primary exercise focus. Patients are encouraged to walk short distances multiple times per day, gradually increasing duration to 20-30 minutes as tolerated. Light stretching for the shoulders, chest, and upper back helps restore posture and prevent stiffness from the surgical position. Gentle seated or standing mobility work for the hips and knees can be added, avoiding any direct abdominal pressure. Fatigue is common, and pacing is essential - activity should stop at the first signs of - lightheadedness, pain, or swelling around the incision. Lifting more than ten pounds is contraindicated during this phase, as are core or resistance exercises that increase intra-abdominal pressure.

Between weeks 6-12, healing and strength begins to improve. Once incisions are fully closed and pain-free mobility returns, low-impact aerobic activity such as brisk walking, stationary cycling, or gentle pool walking may be introduced under medical clearance. Light resistance training with elastic bands or 1-3 pound weights can begin, emphasizing slow, controlled motion and proper breathing - never holding the breath or straining. Gentle core retraining can start with diaphragmatic breathing and pelvic tilts, but traditional abdominal exercises and twisting motions remain off-limits until three months or more, depending on healing progress.

Throughout this period, activity should build gradually, with close attention to fatigue, swelling, or pain, which indicate the need to scale back. Vigorous exercise, contact sports,or heavy lifting remain contraindicated until the surgeon confirms full recovery and adequate liver regeneration, typically after 12-16 weeks. By the end of three months, most patients have regained steady mobility, improved endurance, and sufficient strength for daily tasks, but continued pacing and careful self-monitoring remain essential to prevent complications or delayed healing.

Potential Side-effects of all Hepatic Resections:

- Pain and tenderness at the incision or port sites
- Fatigue, weakness, and reduced stamina
- Nausea or vomiting from anesthesia or narcotic use
- Temporary loss of appetite
- Bleeding or hematoma at the surgical site
- Bile leak from the cut surface of the liver or bile ducts
- Infection (wound, intra-abdominal abscess, or bile collection)
- Pleural effusion (fluid accumulation around the lungs)
- Pneumonia or atelectasis from shallow breathing
- Blood clots (deep vein thrombosis or pulmonary embolism)
- Ileus (temporary slowing or paralysis of bowel function)
- Temporary changes in liver function tests due to surgical stress
- Persistent right upper quadrant discomfort or pulling sensation
- Nutritional deficiencies if bile production or absorption is reduced

- **Liver Transplantation (Orthotopic or Living Donor Liver Transplantation) –** replaces a diseased or cancer-bearing liver with a healthy one from a donor. It serves as both a curative and restorative treatment for selected patients with hepatocellular carcinoma (HCC) or end-stage liver disease. The goal is to completely remove the diseased organ and restore normal hepatic function by implanting a new liver that can regenerate and sustain the body's metabolic and detoxification needs.

There are two main types of transplantation performed worldwide:

- **Deceased Donor Liver Transplantation (DDLT) –** the entire liver is removed from a brain-dead donor and implanted into the recipient.

- **Living Donor Liver Transplantation (LDLT) –** a portion of the liver (usually the right or left lobe) is removed from a healthy living donor and transplanted into the recipient. The liver's unique regenerative capacity allows both the donor and recipient segments to regrow to functional size within weeks.



The operation involves removing the diseased liver through a major upper abdominal incision. Surgeons then connect the donor liver's blood vessels - the hepatic artery, portal vein, and hepatic veins - to the recipient's circulation, followed by reconstruction of the bile duct to restore bile flow. The procedure can last eight to twelve hours and requires precise coordination of surgical, anesthetic, and transplant teams. After surgery, the patient is monitored in an intensive care unit for several days to stabilize vital functions and ensure the new liver is working properly. Blood flow to the graft is continuously assessed with Doppler ultrasound.

Immunosuppressive medications are started immediately to prevent the immune system from rejecting the new organ. Modern liver transplantation offers excellent long-term survival with five-year survival rates that now exceed 75-85% in well-selected patients with early-stage HCC - and dramatically improves quality of life for those with cirrhosis or end-stage liver disease.

When it's used:

- HCC within transplant criteria

- Patients with cirrhosis who are poor resection candidates due to limited reserve or portal hypertension

- "Down-staged" HCC successfully brought within criteria

Most patients remain hospitalized for 10-14 days after liver transplantation, beginning in the intensive care unit for close monitoring. The first 48-72 hours are critical for ensuring the new liver functions properly, maintaining stable blood flow, and preventing rejection or infection. Patients are encouraged to begin gentle breathing exercises and ankle or leg movements within the first 24 hours to prevent pneumonia and blood clots. Once breathing tubes and lines are removed, sitting up and short, assisted walks begin - usually within the first three days. Abdominal discomfort, fatigue, and muscle weakness are common but managed with progressive mobilization. Heavy lifting, twisting, and abdominal strain are strictly contraindicated.

During the first 2-6 weeks, energy levels slowly improve, but patients still tire easily. Walking becomes the primary form of exercise and should be performed several times daily in short bouts, gradually extending to 20-30 minutes as tolerated. Breathing and postural exercises remain essential to rebuild lung capacity and counteract the tendency to hunch forward after abdominal surgery. Gentle upper-body mobility, such as shoulder rolls and arm raises, can begin if pain-free. No lifting heavier than 5-10 pounds is allowed, and activities that involve bending, twisting, or core contraction should be avoided to protect the healing incision and internal sutures. Immunosuppressive medications can cause muscle weakness and joint stiffness, so flexibility and light stretching are encouraged under supervision.

By 6-8 weeks, most patients have regained steadier energy and can begin more structured physical activity. Daily walking continues, and low-impact aerobic options like stationary cycling or gentle pool walking can be added once incisions are fully healed and cleared by the transplant team. Light resistance exercises using elastic bands or 1-3 pound hand weights may be introduced, focusing on slow, controlled movements that maintain breathing throughout. Gentle core retraining can begin with diaphragmatic breathing and pelvic tilts, avoiding any crunching or straining motions. Patients should still avoid abdominal pressure, contact sports, or activities that risk falls.

Throughout this three-month period, fatigue and mild muscle wasting are common due to prolonged preoperative illness, medication effects, and reduced activity.

Progress must be gradual - overexertion can elevate liver enzymes, increase hernia risk, or strain the healing vascular and biliary connections. Warning signs such as new abdominal pain, swelling, shortness of breath, jaundice, or unexplained fatigue require immediate medical evaluation.

By the end of the third month, most individuals can walk or perform light aerobic activity comfortably, manage normal daily tasks, and begin building endurance under a structured exercise plan. Strength training, higher-intensity cardiovascular work, and abdominal loading are typically delayed until after 3-4 months, once healing is confirmed and the transplant team approves progression.

Potential Side-effects of Liver Transplant:

- Pain, swelling, and tenderness around the incision
- Fatigue and generalized weakness
- Nausea or vomiting from anesthesia or medications
- Bleeding or hematoma formation around the surgical site
- Bile leakage from the bile duct connection (anastomosis)
- Infection (wound, lungs, urinary tract, or within the abdomen)
- Fluid accumulation in the abdomen (ascites) or around the lungs (pleural effusion)
- Graft dysfunction or delayed graft function)
- Rejection of the transplanted liver (acute cellular rejection)
- Abnormal liver enzyme elevations in blood tests
- Blood clots (deep vein thrombosis or pulmonary embolism)
- Chronic rejection (slow, long-term damage to the transplanted liver)
- Biliary strictures (narrowing of bile ducts leading to jaundice or infection)
- Recurrent primary liver disease (e.g., hepatitis B or C, autoimmune hepatitis, or NASH)
- Kidney damage from long-term use of immunosuppressants
- Osteoporosis or bone thinning from corticosteroid use
- Diabetes or high cholesterol related to medications
- Hypertension (from immunosuppressive therapy)
- Weight gain and metabolic syndrome
- Increased risk of certain cancers (especially skin cancer and lymphoma) due to immunosuppression

Drug/Class	Common Agents	Mechanism of Action	Indications/Clinical Use
Calcineurin Inhibitors (CNI)	Tacrolimus (Prograf, Envarsus XR), Cyclosporine (Neoral, Gengraf)	Inhibit calcineurin enzyme in T-cells → block IL-2 transcription → suppress T-cell activation and proliferation	Cornerstone of maintenance immunosuppression. Used as primary long-term therapy to prevent acute cellular rejection. Tacrolimus is preferred for its lower rejection rates; cyclosporine used when tacrolimus causes neurotoxicity or intolerance.
Antiproliferative Agents (Antimetabolites)	Mycophenolate mofetil (CellCept), Mycophenolic acid (Myfortic), Azathioprine	Inhibit inosine monophosphate dehydrogenase → block lymphocyte DNA synthesis → reduce T and B cell proliferation	Used in combination with CNI to provide additive immunosuppression and allow lower CNI dosing. Often continued long-term. Azathioprine is used when mycophenolate causes GI intolerance or cytopenia.
Corticosteroids (Glucocorticoids)	Prednisone, Methylprednisolone	Broad immunosuppressive effect: inhibit cytokine production, reduce inflammation, and suppress macrophage and lymphocyte activity	Used in early postoperative phase and during acute rejection episodes. Typically tapered over 3-6 months in stable recipients to minimize long-term side effects.
mTOR Inhibitors (Mammalian Target of Rapamycin Inhibitors)	Sirolimus (Rapamune), Everolimus (Zortress)	Block mTOR pathway → inhibit T-cell response to IL-2 → suppress proliferation and angiogenesis	Used when CNIs cause nephrotoxicity or neurotoxicity; also for patients at high risk of renal dysfunction, metabolic syndrome, or post-transplant malignancy. May be combined with low-dose CNI or used as CNI-sparing therapy.
Co-stimulation Blocker	Belatacept	Binds CD80/86 on antigen-presenting cells → blocks CD28-mediated T-cell activation	Used experimentally or in select patients intolerant to CNIs. Limited use in liver transplant due to higher rejection risk compared to kidney transplant.
Monoclonal Antibodies (Induction / Rejection Rescue)	Basiliximab (Simulect), Daclizumab (rarely used), Alemtuzumab (Campath), Rituximab	Target specific immune cell receptors (e.g., IL-2 receptor, CD52, CD20) → block T/B cell activation or deplete lymphocytes	Used perioperatively for induction therapy to reduce early rejection, or for rescue therapy during severe or steroid-resistant rejection. Basiliximab commonly used in induction protocols with lower steroid and CNI exposure.
Polyclonal Antibodies	Antithymocyte globulin (ATG, Thymoglobulin)	Broadly depletes circulating T-lymphocytes	Used in severe or steroid-resistant rejection or as induction in high-risk patients. Requires close monitoring for infection and cytopenia.
Adjunctive / Supportive Agents	Trimethoprim-sulfamethoxazole (Bactrim), Valganciclovir, Fluconazole	Anti-infective prophylaxis against opportunistic pathogens (Pneumocystis, CMV, fungal infections)	Not immunosuppressive per se but essential to safely maintain immunosuppression by preventing infection-related graft loss

Potential Side-effects of Calcineurin Inhibitors (CNI) Drugs: Tacrolimus, Cyclosporine:

- Tremors or fine hand shaking
- Headache and insomnia
- Nausea, diarrhea, or stomach upset
- High blood pressure (hypertension)
- Increased blood sugar or new-onset diabetes after transplant (NODAT)
- Kidney toxicity (nephrotoxicity) - elevated creatinine and reduced GFR
- Magnesium loss and potassium retention
- Hair loss (tacrolimus) or excessive hair growth (cyclosporine)
- Gum overgrowth (gingival hyperplasia, especially with cyclosporine)
- Fatigue and mild mood changes
- Chronic kidney disease
- Neurotoxicity (confusion, seizures in high levels)
- Severe hypertension requiring multiple agents
- Liver enzyme elevation

Potential Side-effects of Antiproliferative (Antimetabolite) Agents Drugs: Mycophenolate mofetil (CellCept), Mycophenolic acid (Myfortic), Azathioprine:

- Nausea, vomiting, and diarrhea
- Abdominal pain or bloating
- Headache or dizziness
- Mild anemia and fatigue
- Susceptibility to infections
- Bone marrow suppression → low white cells (leukopenia), platelets (thrombocytopenia), and red cells (anemia)
- Increased bleeding or bruising tendency
- Gastrointestinal ulceration or bleeding
- Birth defects if taken during pregnancy
- Liver toxicity
- Rare risk of lymphoma or skin cancer with prolonged use

Potential Side-effects of Corticosteroids (Glucocorticoids) Drugs: Prednisone, Methylprednisolone:

- Weight gain and fluid retention
- Mood swings, anxiety, or insomnia
- Facial rounding ("moon face") and fat redistribution
- Increased appetite
- Elevated blood sugar (steroid-induced diabetes)
- High blood pressure
- Osteoporosis and bone fractures
- Muscle weakness (steroid myopathy)
- Gastric ulcers or reflux
- Thinning skin and delayed wound healing
- Increased infection risk
- Cataracts and glaucoma
- Suppressed adrenal function

Potential Side-effects of mTOR Inhibitors (Sirolimus, Everolimus):

- Mouth sores or ulcers (aphthous lesions)
- Delayed wound healing
- Fatigue and mild anemia
- High cholesterol and triglycerides
- Swelling in legs or ankles
- Skin rash or acne-like eruptions
- Joint or muscle pain
- Lung inflammation (non-infectious pneumonitis)
- Kidney dysfunction (especially if combined with CNIs)
- Proteinuria (protein leakage in urine)
- Increased risk of infection
- Rare risk of vascular thrombosis in early postoperative period

Potential Side-effects of Co-Stimulation Blocker (Belatacept):

- Fatigue, headache, and mild flu-like symptoms
- High blood pressure
- Mild anemia or low white cell counts
- Edema (especially in lower limbs)
- Increased risk of post-transplant lymphoproliferative disorder (PTLD), especially in Epstein-Barr virus (EBV)-negative recipients
- Opportunistic infections (CMV, BK virus, fungal)
- Anemia or leukopenia requiring dose modification
- Rare acute rejection episodes if underdosed

Potential Side-effects of Monoclonal & Polyclonal Antibodies Drugs: Basiliximab, Alemtuzumab, Rituximab, Antithymocyte Globulin (ATG):

- Fever and chills during infusion (cytokine release symptoms)
- Nausea and fatigue
- Temporary rash or redness
- Mild hypotension or headache
- Severe infusion reactions or anaphylaxis (especially with ATG)
- Profound immune suppression → risk of bacterial, viral, and fungal infections
- Cytopenias (low white cells, red cells, and platelets)
- Serum sickness
- Increased cancer risk with long-term lymphocyte depletion
- Post-transplant lymphoproliferative disorder (especially with Alemtuzumab or Rituximab)

Types of Treatment Used:

Radiofrequency Ablation (RFA)

- Microwave Ablation (MWA)
- Cryoablation
- Irreversible Electroporation (IRE)
- Transarterial Chemoembolization (TACE)
- Transarterial Radioembolization (TARE / Selective Internal Radiation Therapy - SIRT)
- Targeted therapy
- Immunotherapy
- Anti-VEGF/Anti-Angiogenic Agents
- Chemotherapy
- External Beam and Stereotactic Radiotherapy

KAPOSI SARCOMA

Kaposi's Sarcoma (KS) is a vascular tumor caused by Human Herpesvirus 8 (HHV-8), also known as Kaposi's sarcoma - associated herpesvirus (KSHV). It is characterized by the abnormal proliferation of spindle-shaped endothelial cells that form blood-filled vascular spaces. These lead to red, purple, or brown lesions on the skin, mucous membranes, or internal organs. KS is unique among cancers in that it develops in the context of immune dysregulation - most commonly HIV/AIDS, organ transplantation, or chronic immunosuppression (Bettuzzi, Lebbe, and Grolleau, Journal of Medical Virology, 2025).

KS arises when viral oncogenes and inflammatory cytokines such as IL-6 and VEGF stimulate angiogenesis and endothelial proliferation. Clinically, lesions begin as flat, painless macules or patches that may progress to nodules or plaques. They commonly occur on the legs, face, oral mucosa, or genitals but can also appear in the lungs, lymph nodes, or gastrointestinal tract, leading to bleeding, cough, or obstruction depending on location. KS can cause serious problems or even become life threatening when the lesions are in the lungs, liver, or digestive tract. KS in the digestive tract, for example, can cause bleeding, while tumors in the lungs may cause trouble breathing.

There are four main types of KS:

1. **Classic (Mediterranean) Kaposi's Sarcoma –** classic Kaposi's sarcoma (KS) is a slow-growing, indolent form of the disease most commonly seen in older men of Mediterranean, Eastern European, or Middle Eastern descent. It is associated with chronic HHV-8 infection but usually arises in the absence of HIV or overt immunosuppression. The disease typically begins as reddish-purple macules or patches on the lower legs, ankles, or feet that gradually progress to firm nodules or plaques over years. Lesions are often bilateral and symmetric but rarely ulcerate or cause pain unless traumatized. Internal organ involvement is uncommon, and lymph node or visceral spread tends to occur late, if at all. The disease may remain confined to the skin for decades, progressing slowly and intermittently. Histologically, lesions contain spindle cells and vascular channels interspersed with inflammatory cells, but systemic immune compromise is minimal. Because it is indolent, classic KS is often treated with local therapies such as cryotherapy, intralesional vinblastine, or low-dose radiation. Systemic chemotherapy is rarely equired. The overall prognosis is excellent, with most patients maintaining a normal lifespan and good quality of life once lesions are controlled.

2. **Endemic (African) Kaposi's Sarcoma –** endemic, or African, KS is prevalent throughout sub-Saharan Africa, where HHV-8 infection rates are high. This form occurs in both HIV-negative and HIV-positive individuals and represents a broad clinical spectrum ranging from chronic cutaneous disease to fulminant systemic involvement. Four main subtypes have been recognized: nodular (chronic), florid (aggressive), infiltrative, and lymphadenopathic. The nodular type resembles classic KS, affecting adults with indolent skin lesions that progress slowly. In contrast, the lymphadenopathic subtype, seen primarily in children, is highly aggressive and often fatal without treatment, as it rapidly spreads to lymph nodes, liver, spleen, and other internal organs. Endemic KS can present with swelling of the legs due to lymphatic obstruction, and lesions may ulcerate or become secondarily infected in humid climates. Environmental factors, co-infections such as malaria, and chronic immune activation may contribute to its development. Management varies by subtype and disease burden - local radiation or chemotherapy is used for limited disease, while systemic therapy (such as liposomal anthracyclines or paclitaxel) is required for disseminated cases. Prognosis is variable, with chronic forms responding well to local treatment but lymphadenopathic KS carrying a poor outcome in resource-limited settings.

3. **Iatrogenic (Immunosuppression-Associated) Kaposi's Sarcoma –** develops in individuals receiving long-term immunosuppressive therapy, most commonly organ transplant recipients - especially those who have received kidney transplants. The reduction of immune surveillance allows HHV-8 reactivation and angiogenic proliferation, resulting in the formation of KS lesions. Clinically, these patients present with violaceous macules, papules, or nodules that may appear months to years after transplantation. Lesions frequently occur on the skin, oral mucosa, or genitals, and internal organ involvement can occur in more advanced cases. Unlike the epidemic form, iatrogenic KS is typically reversible. Reducing or discontinuing immunosuppressive drugs often leads to regression of lesions, particularly when calcineurin inhibitors like cyclosporine or tacrolimus are replaced with mTOR inhibitors such as sirolimus or everolimus, which possess both immunosuppressive and antiangiogenic properties. In patients who cannot safely reduce immunosuppression, localized radiation or systemic chemotherapy may be necessary to control the disease. Prognosis is generally favorable if the immune system can be partially restored, though recurrence is possible if immunosuppressive therapy must be resumed at high doses. Iatrogenic KS highlights the delicate balance between immune control and graft preservation in transplant medicine.

4. **Epidemic (AIDS-Related) Kaposi's Sarcoma –** the most aggressive and globally significant form, occurs in individuals with advanced HIV infection. It was one of the earliest AIDS-defining illnesses recognized in the early 1980s and remains common in areas with limited access to antiretroviral therapy (ART). HHV-8 and HIV act synergistically: HIV infection enhances KS progression by increasing cytokine production, particularly IL-6 and VEGF, and through the effects of the HIV Tat protein, which promotes angiogenesis and viral replication. Clinically, epidemic KS presents with multiple, widespread lesions on the skin, oral cavity, and genitals and often involves visceral organs such as the lungs and gastrointestinal tract. Patients may experience cough, shortness of breath, hemoptysis, gastrointestinal bleeding, or lymphadenopathy. Without ART, the disease can progress rapidly and become life-threatening. The cornerstone of treatment is immediate initiation of combination ART, which restores immune function and leads to regression in many cases. However, rapid immune recovery may trigger immune reconstitution inflammatory syndrome (IRIS), causing temporary lesion flare-ups. Advanced or visceral KS typically requires systemic chemotherapy with agents such as pegylated liposomal doxorubicin or paclitaxel. With modern therapy, prognosis has improved substantially, and most patients can achieve durable remission when ART is maintained and opportunistic infections are controlled.

The treatment for Kaposi's sarcoma varies, depending on these factors:

A. Type of disease – historically, AIDS-related Kaposi's sarcoma has been more serious than classic or transplant-related disease. Thanks to increasingly effective antiviral drug combinations and improved prevention of other AIDS-related infections, Kaposi's sarcoma has become less common and less severe in people with AIDS.

B. Number and location of lesions – widespread skin lesions and internal lesions require different treatment from isolated lesions

C. Effects of the lesions – lesions in the mouth and throat make eating difficult, while lesions in the lung can cause shortness of breath. Large lesions, particularly on the upper legs, can lead to painful swelling and difficulty moving around.

D. General health – the immune system impairment that makes someone vulnerable to Kaposi's sarcoma also makes certain treatments, such as chemotherapy drugs, too risky to try.

For AIDS-related Kaposi's sarcoma, the first step is to start/switch to an antiviral drug combination that will reduce the amount of the virus that causes HIV/AIDS and increase the number of immune cells in the patient's body. Sometimes, this is the only treatment needed. When possible, people with transplant-related Kaposi's sarcoma may be able to stop taking immune system-suppressing medication. Sometimes this allows the immune system to eliminate the cancer on its own. Switching to a different immunosuppressive medication can also bring improvement.

Procedures:

- **Local Surgical Excision –** is reserved for cases where disease is limited. It involves removing a single or small number of lesions with a margin of normal tissue. This approach is most beneficial for classic KS, where lesions grow slowly and remain localized, or for cosmetically or functionally significant lesions - such as those on the face, genitals, or hands. Excision can also be considered for isolated nodules that bleed, ulcerate, or interfere with clothing or mobility. While it provides immediate removal, recurrence is common because KS lesions often arise from multiple microscopic foci in surrounding tissue. The procedure is typically outpatient and maybe combined with other local therapies such as cryotherapy or radiation to improve control.

When it's used:

- For solitary or limited lesions
- Cosmetically visible or symptomatic areas
- When histologic confirmation is required

- **Electrosurgical Procedures (Curettage and Electrodesiccation) –** electrosurgery combines curettage (scraping the lesion) with electrical cauterization to remove and seal superficial KS lesions. This technique is effective for small, raised lesions, particularly in areas such as the oral cavity, lips, or extremities where bleeding control is essential. It is minimally invasive, inexpensive, and can be performed in an outpatient or clinic setting. Healing is generally rapid, and recurrence rates are moderate. Because it targets superficial tissue, it is not suitable for nodular or deep subcutaneous lesions. The resulting cosmetic outcomes are often good, though minor scarring or pigment changes can occur.

When it's used:

- For small, superficial cutaneous or mucosal KS lesions where bleeding control is important
- When quick recovery and minimal equipment are priorities

- **Laser Surgery (co_2 or pulsed dye laser) –** laser therapy is a precise and cosmetically favorable method for treating small or superficial KS lesions, especially in cosmetically sensitive regions such as the face, lips, eyelids, or oral cavity. CO_2 lasers ablate tissue by vaporizing lesion surfaces, while pulsed dye lasers coagulate the blood vessels within the lesion to cause regression. Both methods minimize bleeding and scarring and can be repeated as needed. Laser therapy is most beneficial for patients with limited, flat, or mucosal KS, and is often combined with topical or systemic therapies to maintain remission. Limitations include higher cost, specialized training requirements, and limited depth of penetration.

  When it's used:
  - For flat, superficial, or mucosal KS lesions, particularly in visible areas where cosmetic outcomes matter
  - For patients with few, localized lesions

- **Palliative Surgical Procedures (advanced or obstructive disease) –** in advanced KS, surgery is occasionally used not to remove the cancer itself but to relieve complications caused by tumor growth. Palliative procedures may include tracheostomy or airway debulking for upper airway obstruction, gastrointestinal bypass or resection for severe bleeding or obstruction from intestinal KS, or decompressive operations for massive, painful lymphedema. These procedures are performed only when non-surgical measures have failed and are aimed at improving comfort, maintaining nutrition, or preventing life-threatening complications. Recovery and prognosis depend heavily on the underlying disease state and concurrent systemic therapy.

  When it's used:
  - For life-threatening obstruction (airway, bowel)
  - Uncontrollable bleeding
  - Severe pain and swelling not responsive to other therapies.

Recovery after surgical or local procedures for Kaposi's sarcoma is typically brief, though activity should be adjusted based on the extent of treatment and lesion location. Minor procedures such as cryotherapy, electrosurgery, or laser ablation usually require only a few days of downtime, with patients resuming light movement or walking almost immediately and returning to full activity within a week once scabs or crusts have healed. Local surgical excision of larger or deeper lesions involves a slightly longer recovery, typically 1-2 weeks - during which heavy lifting, high-impact exercise, and stretching around the incision should be avoided to prevent bleeding or wound disruption. For lower-extremity procedures, swelling can be managed with leg elevation and gradual walking, while friction, heat, or moisture over treated areas should be minimized until the skin has fully recovered. Major palliative operations for airway or gastrointestinal complications demand more prolonged recovery - often several weeks - with a gradual return to mobility under medical supervision. In general, light activity and circulation-promoting movement are encouraged early on, while strenuous exercise, swimming, or resistance training should be avoided until complete wound closure and physician clearance.

HIV can be spread by:

- Unprotected sexual contact (vaginal, anal, or oral sex) with an infected partner when one of these fluids enters another person's body. Anal sex carries the highest risk, followed by vaginal sex.
- Sharing needles, syringes, or drug injection equipment, which allows infected blood to pass directly into the bloodstream.
- Mother-to-child transmission (perinatal transmission) during pregnancy, childbirth, or breastfeeding if the mother is not on anti-retroviral therapy.
- Blood transfusions or organ transplants from an infected donor (extremely rare today in countries where all blood and organs are screened).
- Occupational exposure, such as needle-stick injuries in healthcare workers involving contaminated blood.

Types of Treatment Used:

- Antiretroviral therapy (ART / HAART)
- Radiation therapy (external-beam or electron-beam)
- Cryotherapy (freezing)
- Intralesional chemotherapy (e.g. vinblastine injected directly into lesions)
- Systemic chemotherapy
- Immunotherapy
- Topical agents (e.g. retinoid gels such as alitretinoin)
- Photodynamic therapy (PDT)

Key Training Considerations for Clients with Kaposi's Sarcoma or AIDS

1. Medical clearance and communication are essential before initiating or advancing any exercise program for clients with KS or AIDS. Trainers should ensure that the client's physician or healthcare provider approves the exercise plan and be aware of current medications, treatment side effects, and any activity restrictions. Maintaining open communication with the healthcare team helps guide safe progression and adjustments based on health status or treatment response.

2. Because of immune suppression, strict hygiene must be followed to reduce infection risk. Equipment should be disinfected before and after sessions, and open lesions or wounds should be covered. Public gyms should be avoided if the client's CD4 count is below 200 cells/μL or if they are receiving chemotherapy or radiation. Training should be postponed if either the trainer or client shows signs of illness.

3. For clients with KS, it is important to avoid pressure, friction, or impact on areas with lesions. Equipment straps, resistance bands, or cuffs should not be placed over affected tissue. Aquatic exercise should be avoided if lesions are open or ulcerated, as water exposure can increase infection risk. Compression garments may help with swelling in the limbs, but exercises that worsen lymphedema should be avoided. Any new swelling, bleeding, or changes in lesion appearance warrant medical reassessment.

4. Fatigue management is critical, as clients often experience low energy, muscle wasting, or deconditioning. Sessions should start at a low intensity for short durations, emphasizing form and consistency over intensity. Movement-based exercise, such as light resistance bands, stretching, and gentle walking, offers significant benefit. Intensity should be guided by perceived exertion rather than heart rate, as medications and anemia may affect cardiovascular response.

5. Exercise selection must also consider medical conditions like anemia or neuropathy. High-impact or contact activities should be avoided in clients with low platelet counts to prevent bruising or bleeding. Balance exercises and stability training are beneficial when neuropathy affects coordination. For those with anemia, sessions should be brief, low-intensity, and include rest periods. Exercise should stop immediately for symptoms such as fever, chest pain, or excessive fatigue.

6. Emotional support is an important part of training. Clients with KS or AIDS may face stigma, body image challenges, or anxiety about their condition. Trainers should provide a safe and supportive environment, celebrate small improvements, and maintain empathy and confidentiality. Encouraging participation and progress within the client's limits promotes both psychological and physical well-being.

CANCER OF THE BRAIN AND NERVOUS SYSTEM

There were 321,624 new cases and approximately 248,403 deaths from brain and central nervous system (CNS) cancers worldwide in 2022 (Kim et al., Journal of Neuro-Oncology, 2025). Nearly one-third (27.9%) of brain and CNS tumors are malignant, meaning approximately 72% are benign or non-malignant in nature (Ostrom et al., Neuro-Oncology, 2023). Notably, brain and CNS tumors are the leading cause of cancer-related death in children aged 0-14 in the United States and rank second globally for cancer incidence in this age group (ABTA, Brain Tumor Facts, 2024; Kim et al., Journal of Neuro-Oncology, 2025).

While a non-cancerous lesion would not be alarming in most parts of the body, the skull provides no room to accommodate any additional mass. Therefore, even benign growths can cause life-threatening neurological damage depending on their location. The tumor can interfere with whatever functions that area of the brain controls - speech, movement, and cognitive abilities, just to name a few. If the tumor puts enough pressure on one of the intracranial blood vessels, blood flow to the brain could be blocked, triggering the equivalent of a stroke. The location of the tumor will determine whether it can be removed surgically.

Symptoms of brain cancer include new onset or change in the pattern of headaches; headaches that gradually become more frequent and severe; unexplained nausea or vomiting; vision problems; loss of sensation or movement in an arm or leg; difficulty with balance; difficulty with speech; confusion; personality changes; seizures; and hearing problems (ACS, Brain and Spinal Cord Tumors in Adults, 2024).

There are two main types of brain tumors: those that originate in the brain, and those that spread to the brain from cancer elsewhere in the body. Those that originate in the brain are referred to as primary brain tumors, while those that spread from another site are referred to as secondary, or metastatic, brain tumors. Metastatic brain tumors are actually more common than primary brain tumors. Primary brain tumors may spread to other parts of the brain or spine but rarely spread to other parts of the body (ACS, Brain and Spinal Cord Tumors in Adults, 2024).

The best-known environmental risk factor for brain tumors is radiation exposure, most often from radiation therapy used to treat another condition. Other than radiation, no known lifestyle-related or environmental factors are clearly linked to brain tumors, and many of the gene changes found in brain tumor cells may simply be random events that occur inside a cell without any outside cause. Most radiation-induced brain tumors result from radiation to the head given to treat other cancers, and they occur most often in people who received cranial radiation as children - most commonly as part of treatment for leukemia (ACS, Brain and Spinal Cord Tumors in Adults, 2024).

Several inherited genetic syndromes also significantly increase the risk of brain tumors. Neurofibromatosis type 1 (NF1), also known as von Recklinghausen disease, is the most common syndrome linked to brain or spinal cord tumors. People with this condition have higher risks of schwannomas, meningiomas, certain types of gliomas, and neurofibromas - benign tumors of the peripheral nerves. Changes in the NF1 gene cause this disorder, and these changes are inherited from a parent in about half of all cases; in the other half, the gene changes occur before birth in people whose parents did not have the condition (ACS, Brain and Spinal Cord Tumors in Adults, 2024).

People with Von Hippel-Lindau (VHL) disease - a rare autosomal dominant disorder affecting approximately 1 in 36,000 individuals - develop benign and malignant tumors across multiple organ systems (Gómez-Virgilio et al., Diagnostics, 2024). The condition is caused by germline mutations in the VHL tumor suppressor gene on chromosome 3, most commonly inherited in an autosomal dominant pattern, though de novo mutations in individuals with no family history are also recognized.

Li-Fraumeni syndrome (LFS) is a rare autosomal dominant hereditary cancer predisposition syndrome caused by germline pathogenic variants in the TP53 tumor suppressor gene, which encodes the p53 protein responsible for regulating cell growth and preventing tumor formation. The lifetime cancer risk is exceptionally high, with most affected individuals developing cancer - often at an early age or in childhood.

Types of Adult Cancerous Brain Tumors:

- **Adult Pineal Parenchymal Tumors –** rare primary neuroepithelial tumors arising from pineocytes within the pineal gland - a small endocrine organ deep within the brain responsible for melatonin production and circadian rhythm regulation. Pineal region tumors constitute approximately 1% of all intracranial tumors in adults and up to 8% in children, and their deep central location adjacent to the cerebral aqueduct, third ventricle, and brainstem makes surgical access technically demanding. Compression of the cerebral aqueduct frequently results in obstructive hydrocephalus at presentation (Hall and Karsonovich, StatPearls, updated December 2025).

- **Astrocytomas –** tumors arising from astrocytes - the star-shaped glial cells that provide structural and metabolic support to neurons throughout the brain and spinal cord. Constituting approximately 60% of all brain tumors, glial tumors include astrocytoma as the most prevalent form of glioma, and while primarily impacting the brain, they can also affect the spinal cord (Ostrom et al., Neuro-Oncology, 2025).

- **Brain-stem Gliomas –** rare tumors arising from glial cells within the brainstem, representing a clinically significant subset of central nervous system tumors. While brainstem gliomas occur at any age, they are predominantly considered a pediatric disease - the majority of cases occur in children between ages 5-9 years, and brainstem tumors account for approximately 10-20% of all pediatric brain tumors (Ostrom et al., Neuro-Oncology, 2025; Hall and Karsonovich, StatPearls, updated December 2025).

- **Chordomas –** rare, slow-growing malignant tumors arising from remnants of the embryological notochord, most commonly occurring at the base of the skull or the sacrococcygeal spine, and accounting for approximately 1-4% of all primary bone tumors. With an estimated incidence of approximately 350 cases per year in the United States and a worldwide annual incidence of 0.08 per 100,000, chordoma occurs primarily in the fifth and sixth decades of life and affects males approximately twice as often as females (Taghavi Pourianazar, International Journal of Molecular Sciences, 2026).

- **Craniopharyngiomas –** rare, slow-growing, histologically benign (WHO Grade 1) brain tumors arising from epithelial remnants of the craniopharyngeal duct near the pituitary gland and hypothalamus in the sellar and suprasellar region. They constitute approximately 1-3% of all primary intracranial tumors and 5-11% of brain tumors in children, with an incidence of approximately 0.5-2 cases per million people annually and a bimodal age distribution, primarily affecting children aged 5-14 years and adults aged 50-74 years (Rao et al., StatPearls, updated 2025).

- **Ependymomas –** rare primary central nervous system tumors arising from ependymal cells lining the ventricles of the brain and the central canal of the spinal cord. They account for less than 2% of all brain and CNS tumors overall, approximately 9% of all childhood CNS tumors, and about 2% of adult CNS tumors, with an estimated annual incidence of 0.29-0.6 cases per 100,000 individuals in the United States (American Brain Tumor Association, 2024).

- **Gangliomas –** rare brain tumors composed of both neurons and glial cells, accounting for less than 2% of all brain and CNS tumors overall, approximately 9% of all childhood CNS tumors, and about 2% of adult CNS tumors (Ostrom et al., Neuro-Oncology, 2025).

- **Gliomas –** the most common primary malignant brain tumors in adults, accounting for approximately 22-33% of all primary brain and CNS tumors and representing the majority of malignant cases - with glioblastoma alone accounting for approximately 53% of all malignant brain tumors and 13.7% of all primary brain tumors combined (Ostrom et al., Neuro-Oncology, 2025).

- **Glioblastoma –** the most common and most aggressive primary malignant brain tumor in adults, accounting for approximately 52% of all primary malignant brain and CNS tumors, with an age-adjusted annual incidence rate of 3.28 per 100,000 persons and an estimated 10,000 deaths in the United States each year (Ostrom et al., Neuro-Oncology, 2025).

- **Medulloblastomas –** develop from neuroectodermal cells (early forms of nerve cells) in the cerebellum. They are fast-growing (grade IV) tumors and often spread throughout the CSF pathways, but they can be treated by surgery, radiation therapy, and chemotherapy. Medulloblastoma represents the most common malignant brain tumor in children, accounting for approximately 20-25% of all pediatric CNS tumors, with approximately 500 new cases diagnosed in children annually in the United States (American Brain Tumor Association, 2024).

- **Meningiomas –** the most common primary brain tumor in adults, accounting for approximately 37-42% of all primary brain and CNS tumors, representing approximately 50% of all benign brain tumors (Ostrom et al., Neuro-Oncology, 2025).

- **Mixed gliomas –** tumors containing two or more distinct types of glial cells, most commonly a combination of oligodendroglial and astrocytic components, accounting for approximately 2.3% of all reported brain tumors, with a median age of diagnosis of about 42 years (Ostrom et al., Neuro-Oncology, 2025).

- **Oligodendroglioma –** diffusely infiltrating glial tumors arising from oligodendrocytes - the cells responsible for producing the myelin sheath that insulates and supports nerve fibers throughout the central nervous system. They are rare tumors, accounting for approximately 2-3% of all primary CNS tumors, with a US incidence of approximately 0.43 per 100,000 and a slight male predominance (Ostrom et al., Neuro-Oncology, 2025).

- **Pineal Region Tumors –** occur in or around the pineal gland, a small organ located in the center of the brain. The pineal gland produces melatonin, a hormone that plays an important role in the sleep-wake cycle. They can be slow growing (pineocytoma) or fast growing (pineoblastoma). Since the pineal region is very difficult to reach, it requires a high level of surgical expertise to remove these tumors. They account for less than 1% of all adult intracranial tumor lesions, yet represent a disproportionately higher percentage of pediatric brain tumors (Hall and Karsonovich, StatPearls, updated December 2025).

- **Pituitary tumors –** among the most common intracranial tumors, accounting for approximately 10-20% of all primary brain tumors and with a prevalence reported as high as 14-23% (PMC, 2022). The vast majority are benign adenomas arising from the anterior pituitary gland. They are classified by size into microadenomas (less than 1 cm) and macroadenomas (greater than 1 cm), and by hormonal activity into functioning (hormone-secreting) and non-functioning tumors. The median age at diagnosis is approximately 39-41 years; in younger adults, tumors are more common in females, while in older adults incidence equalizes between sexes (Giraldi, Allen, and Ioachimescu, Endocrine Practice, 2023).

Procedures:

- **Craniotomy –** is the most common and fundamental surgical approach used to remove brain tumors that can be safely accessed. The procedure begins under general anesthesia, with the patient's head secured in a fixed position to prevent movement. Using detailed preoperative imaging such as MRI or CT scans, the neurosurgical team plans a precise entry route to the tumor, taking care to avoid critical structures like blood vessels and functional brain areas responsible for movement, language, or sensation.

  Once the scalp is incised and the bone flap is temporarily removed, the dura mater - the tough outer covering of the brain - is opened to expose the underlying tissue. Through this opening, the surgeon visualizes the tumor under high magnification using an operating microscope. Modern craniotomies incorporate technologies such as neuronavigation, intraoperative MRI or ultrasound for confirmation of tumor margins, and fluorescence-guided resection, allowing more complete yet precise removal.

  The tumor is carefully dissected and removed piece by piece using microsurgical instruments and suction. Throughout the operation, neuromonitoring tools track brain function, particularly when the tumor is near eloquent areas. In select cases, the patient may remain awake for portions of the procedure (an awake craniotomy) to allow direct testing of speech, movement, or sensation, ensuring these functions are preserved. Once the resection is complete, the surgical field is irrigated, the dura is closed, and the bone flap is re attached with small plates and screws. The scalp is then sutured or stapled closed.

  The primary objective of a craniotomy for brain cancer is maximal safe resection - to remove as much tumor tissue as possible while maintaining neurological integrity. Postoperative imaging is typically performed within 24-48 hours to evaluate the extent of resection and rule out complications such as bleeding or swelling.

  When it's used:
  - Tumors are localized, accessible, and resectable

Types of Craniotomies:

1. **Standard (Microsurgical) Craniotomy –** this is the most common form of craniotomy. Using an operating microscope and navigation tools, the surgeon removes the tumor through a tailored skull opening. Intraoperative monitoring may be used to preserve motor, sensory, or visual pathways.

   When it's used:
   - Lesions are well-defined and in non-eloquent or surgically accessible areas

2. **Awake Craniotomy with Cortical and Subcortical Mapping –** the patient remains awake and responsive during part of the operation, allowing the surgical team to map and preserve critical brain areas responsible for speech, movement, and sensation. Electrical stimulation identifies functional zones, guiding resection boundaries.

   When it's used:
   - Tumors are near or within eloquent regions such as motor, language, or sensory cortex

3. **Keyhole or Minimally Invasive Craniotomy –** this approach uses small, targeted skull openings and tubular retractors to access tumors through natural corridors, minimizing brain retraction and trauma. Endoscopes may assist visualization.

   When it's used:
   - Tumors are deep but focal (thalamic, insular, or periventricular)
   - When cosmetic or recovery concerns favor a smaller exposure

4. **Endoscopic Endonasal Craniotomy (Transsphenoidal Approach) –** this minimally invasive procedure uses the nasal passages as a corridor to reach midline skull-base tumors. A neurosurgeon and ENT surgeon operate collaboratively using an endoscope for visualization.

   When it's used:
   - Tumors are located in or near the sella or midline base

5. **Posterior Fossa and Skull Base Craniotomy –** this approach provides access to tumors in the cerebellum, brainstem, or foramen magnum. It may involve suboccipital or far-lateral skull-base openings and microsurgical dissection near cranial nerves.

   When it's used:
   - Tumors compressing the brainstem or cerebellum

6. **Stereotactic or Needle Biopsy (Minimally Invasive Craniotomy Variant) –** involves inserting a small needle through a burr hole using image guidance to obtain tissue samples for diagnosis and genetic profiling.

   When it's used:
   - Deep, multifocal, or unresectable lesions
   - Diagnostic uncertainty (e.g., primary CNS lymphoma)



7. Laser Interstitial Thermal Therapy (LITT) – a minimally invasive stereotactic procedure using a fiberoptic laser probe to ablate tumor tissue with controlled heat under MRI thermography.

When it's used:

- Small (<3-4 cm), deep, or recurrent tumors; radiation necrosis after prior therapy
- Tumors near eloquent regions unsuitable for open resection

8. Intraoperative Brachytherapy and Wafer Implantation – after tumor resection, localized therapy such as carmustine (BCNU) wafers or radioactive seeds can be implanted into the cavity to deliver direct radiation to residual cells.

When it's used:

- High-grade gliomas with residual disease after resection
- Recurrent tumors requiring local control

9. CSF Diversion Procedures (Adjunct to Craniotomy) – these include external ventricular drains (EVD), ventriculoperitoneal (VP) shunts, and endoscopic third ventriculostomy (ETV) to manage hydrocephalus caused by tumor obstruction.

When it's used:

- Tumors obstruct normal CSF flow

Hospital stay after a craniotomy typically lasts between 3-7 days, depending on the tumor type, surgical approach, and individual recovery. Minimally invasive and endoscopic procedures often allow discharge within 2-3 days, while more extensive or posterior fossa surgeries may require longer monitoring for swelling, infection, or neurological changes. During the hospital phase, the focus is on early mobilization, respiratory exercises, and gradual reintroduction of sitting, standing, and short walks under supervision. Patients are monitored for headaches, nausea, dizziness, or neurological deficits, and energy expenditure should remain low to prevent spikes in intracranial pressure.

The first month of recovery emphasizes rest, wound healing, and prevention of complications such as blood clots or infection. Exercise should be limited to gentle walking and basic range-of-motion movements, with no lifting above five to ten pounds and no bending, straining, or Valsalva-type effort. Headaches and fatigue are common; therefore, activity must follow an "energy-in, energy-out" principle - light movement balanced with ample rest. Patients who have undergone posterior fossa or awake mapping procedures may also benefit from early balance and coordination drills under supervision, focusing on posture and controlled transitions from sitting to standing.

Between 4-8 weeks, as incisions heal and swelling subsides, low-intensity aerobic activity can be expanded. Walking duration can gradually increase to 20-30 minutes per day at an easy pace, and light upper-body resistance bands or body-weight exercises may be introduced if cleared by the neurosurgical team. Deep breathing, gentle stretching, and shoulder or neck mobility work help restore alignment and circulation without straining healing tissues. Those recovering from endoscopic endonasal surgery should still avoid heavy exertion or nose-blowing to prevent cerebrospinal fluid leaks.

By 2-3 months post-surgery, most individuals can resume light-to-moderate exercise as tolerated. Low-impact cardiovascular activities such as stationary cycling, elliptical, or swimming (once incisions are fully healed) can be added, along with gentle strengthening for the core and extremities. However, activities that involve impact, inversion, or heavy resistance remain contraindicated until cleared by the physician. The overall goal during this phase is restoring stamina, mobility, and independence - never pushing through neurological or pressure-related warning signs. With steady, progressive exercise and proper medical supervision, most craniotomy patients can return to functional daily activity and structured exercise within 12 weeks, adjusting intensity to their recovery pace and individual neurological outcomes.

Potential Side-effects for all Craniotomies:

- Headache, scalp tenderness, or incision site pain
- Fatigue, low energy, or prolonged drowsiness
- Swelling or bruising around the eyes and face
- Nausea or vomiting due to anesthesia or increased intracranial pressure
- Temporary confusion, memory issues, or difficulty concentrating
- Dizziness or imbalance, especially after posterior fossa surgery
- Weakness, numbness, or coordination changes depending on surgical site
- Speech or language difficulties (after dominant hemisphere surgery)
- Seizures due to cortical irritation or swelling
- Fluid accumulation under the scalp (pseudomeningocele)
- Cerebrospinal fluid (CSF) leak from incision or nose (in skull-base cases)
- Infection of incision, bone flap, or meninges (meningitis)
- Blood clot formation (deep vein thrombosis or pulmonary embolism)
- Hydrocephalus requiring CSF diversion
- Visual disturbances, including double vision or blurred sight
- Hormonal imbalance if pituitary region was involved
- Emotional changes, anxiety, or depression related to surgery or tumor effects
- Delayed wound healing or scar sensitivity
- Hearing loss or facial nerve weakness (particularly after posterior fossa or skull-base surgery)

- **Ommaya Reservoir Placement –** involves surgically implanting a small, dome-shaped device beneath the scalp that connects via a thin catheter into one of the brain's ventricles or a cystic cavity. It provides long-term access for the direct delivery of chemotherapy or other medications into the cerebrospinal fluid (CSF), bypassing the blood-brain barrier that often limits systemic drug penetration. This method allows for more effective treatment of cancers that spread to the brain or meninges, such as leptomeningeal metastases, central nervous system (CNS) lymphoma, leukemia, or certain metastatic solid tumors. The procedure is typically performed under general anesthesia and may be completed as a standalone operation or in conjunction with other neurosurgical procedures.

  During placement, a small incision is made in the scalp, and a burr hole is drilled in the skull. The catheter is guided into a lateral ventricle or tumor cyst using neuro-navigation to ensure accurate positioning. The dome of the reservoir, typically made of silicone, is then secured under the scalp for accessibility. After surgery, oncology teams use the system to administer chemotherapy, antibiotics, or to obtain CSF samples directly through the skin into the port using a fine needle. This eliminates the need for repeated spinal taps and provides a safe, sterile, and efficient route for ongoing therapy.

  When it's used:
  - For leptomeningeal carcinomatosis, where cancer cells have spread through the meninges and require intrathecal therapy
  - In primary CNS lymphoma or leukemia with meningeal involvement
  - To drain recurrent cystic lesions or abscesses that require periodic aspiration
  - In patients who need repeated CSF sampling for monitoring tumor markers or treatment response

Potential Side-effects of Ommaya Reservoir:

- Headache
- Scalp tenderness, or swelling at the incision site
- Local infection or meningitis, often presenting with fever, neck stiffness, or altered mental status
- Catheter blockage or displacement that disrupts medication flow
- Bleeding or hematoma at the surgical site or within the ventricle
- Cerebrospinal fluid leakage around the incision
- Over-drainage or pressure-related symptoms such as dizziness or nausea
- Rare allergic or inflammatory reactions to the device material
- Neurological changes if infection, bleeding, or swelling occur

Recovery after Ommaya reservoir placement is generally straightforward, with most patients discharged within 1-2 days. During the first two weeks, exercise should be limited to gentle walking and range-of-motion movements to promote circulation and prevent stiffness. Straining, heavy lifting above 10 pounds, bending forward, or any activity that increases intracranial pressure should be avoided. Direct pressure on the reservoir site, such as from helmets, tight headbands, or lying face-down, should also be avoided. From weeks 3-6, light cardiovascular exercise such as walking or stationary cycling can be resumed as long as there is no discomfort, dizziness, or incision irritation. Light resistance training may begin gradually, ensuring steady breathing and avoiding Valsalva maneuvers. Clients receiving ongoing intrathecal chemotherapy may experience fatigue or mild balance issues, so rest intervals should be flexible, and any new symptoms monitored closely. After 6-12 weeks, most individuals can return to normal activity if healing is complete and no infection or neurological symptoms are present. Contact sports should be avoided for a minimum of 6 weeks while the device site heals; thereafter, patients should consult their neurosurgical team regarding individual activity clearance."

- **Shunt Surgery –** is a common neurosurgical procedure designed to divert excess cerebrospinal fluid (CSF) from the brain's ventricles to another part of the body, where it can be absorbed, helping to relieve hydrocephalus - a condition where fluid buildup increases intracranial pressure. This buildup can result from brain tumors, hemorrhage, infection, or congenital abnormalities. In cancer patients, shunts are often placed when tumors obstruct normal CSF flow, particularly in the ventricles or posterior fossa.

  The procedure is typically performed under general anesthesia. A small incision is made in the scalp, and a burr hole is created in the skull to access a ventricle. A flexible catheter is inserted into the ventricle and connected to a valve system that regulates CSF flow. The distal end of the catheter is tunneled under the skin and directed to a drainage site, most commonly the peritoneal cavity (ventriculoperitoneal shunt), but occasionally to the right atrium of the heart (ventriculoatrial shunt) or the pleural cavity (ventriculopleural shunt). The valve system ensures one-way flow and helps prevent backflow or over-drainage.

  Once in place, the shunt continuously diverts fluid, reducing intracranial pressure and alleviating symptoms such as headache, nausea, vomiting, balance issues, and cognitive changes. Modern shunts may have programmable valves that allow clinicians to adjust flow resistance noninvasively with a magnetic device.

  When It's Used:

  - To treat hydrocephalus caused by brain tumors obstructing CSF flow
  - After tumor surgery if swelling or scarring blocks normal CSF circulation
  - For communicating hydrocephalus secondary to meningitis, hemorrhage, or leptomeningeal disease
  - To relieve symptoms of increased intracranial pressure not controlled by medication or temporary drainage

Potential Side-effects of Shunt Surgery:

- Headache or neck pain due to pressure changes
- Infection at the incision, valve, or catheter site (can progress to meningitis or ventriculitis)
- Shunt blockage or mechanical failure, causing recurrent symptoms of hydrocephalus
- Over-drainage, leading to subdural hematoma, dizziness, or positional headaches
- Catheter disconnection, migration, or kinking
- Seizures or neurological changes after surgery
- Abdominal complications such as peritonitis or pseudocyst formation (in ventriculoperitoneal shunts)
- Shunt dependency - where the brain becomes reliant on the system for CSF regulation

Hospital stay typically lasts 2-5 days, depending on the patient's condition and whether the shunt was placed during another operation. During the first two weeks, activity should focus on rest and gentle movement, such as short, frequent walks to promote circulation and prevent deconditioning. Heavy lifting, straining, or bending forward should be avoided, as these actions can alter intracranial pressure or strain the neck where the catheter passes. The scalp and abdominal incisions must be kept clean and free from pressure.

By weeks 3-6, light aerobic activity such as walking, recumbent cycling, or seated mobility drills can resume if the patient is symptom-free. Any recurrence of headache, nausea, dizziness, or visual disturbances during activity warrants immediate rest and medical review. Strength training should be introduced slowly, avoiding the Valsalva maneuver, deep bending, or exercises that place tension on the neck and torso.

After 6-12 weeks, most patients can return to moderate exercise, including low-impact cardio and controlled resistance training, as long as balance and coordination are stable. High-impact activities, contact sports, or rapid changes in position (such as inversions, headstands, or heavy over-head lifting) should be avoided indefinitely, as they can cause pressure fluctuations or mechanical stress on the shunt. Clients with programmable valves should avoid strong magnetic fields (such as in MRI or industrial equipment) unless cleared by their neurosurgeon, as these can alter valve settings.

In summary, shunt surgery provides a vital solution for managing hydrocephalus and intracranial pressure related to brain tumors or other causes. With gradual, closely monitored exercise progression and attention to postural and pressure precautions, most individuals can regain mobility and strength safely while protecting shunt function and neurological stability.

- **Gamma Knife Radiosurgery –** is a non-invasive, highly precise form of stereotactic radiation therapy used to treat brain tumors and other intracranial abnormalities without the need for an open incision. Despite its name, no surgical cutting occurs. The "knife" refers to the accuracy with which multiple beams of gamma radiation converge on a single target deep within the brain. Each beam on its own is too weak to harm surrounding tissue, but at the focal point where all beams intersect, the cumulative dose is powerful enough to destroy tumor cells or disrupt abnormal blood vessels. The goal is to halt tumor growth, shrink existing lesions, or prevent recurrence, while preserving the surrounding healthy brain.

  The procedure begins with detailed imaging and treatment planning. The patient's head is immobilized using either a stereotactic frame secured with small pins or a frameless mask system. MRI, CT, or angiography scans are obtained to locate the exact tumor coordinates and define its shape in three dimensions. A multidisciplinary team - including a neurosurgeon, radiation oncologist, and medical physicist - uses advanced software to map the dose distribution, adjusting the beam angles and intensity to cover the tumor while minimizing radiation exposure to nearby structures such as the optic nerves, brainstem, or motor cortex. Once the plan is finalized, the patient is positioned on the Gamma Knife treatment couch, which moves precisely so that the machine's multiple cobalt-60 radiation sources can deliver beams from hundreds of angles that converge at the target. The treatment itself lasts 30 minutes to two hours, depending on the number and size of lesions. The patient remains awake throughout but feels no pain; mild head pressure or fatigue may occur from lying still. After completion, the head frame or mask is removed, and most patients go home the same day without any hospital stay.

  Gamma Knife radiosurgery is used worldwide to treat small, well-defined brain tumors, both benign and malignant, including metastatic lesions, meningiomas, vestibular schwannomas, and certain low-grade gliomas. It is particularly valuable for tumors in deep or eloquent areas - such as the thalamus, basal ganglia, or brainstem - where open surgery would risk significant neurological deficits. It is also used for recurrent or residual disease after prior surgery or radiation and for patients medically unfit for craniotomy. The best outcomes occur in tumors less than 3-4 cm in diameter with minimal swelling. Gamma Knife is not appropriate for large masses causing brain compression, diffuse infiltrative gliomas (like glioblastoma multiforme), or lesions adjacent to highly radiation-sensitive structures unless dose can be safely limited.

Recovery after Gamma Knife is typically rapid, and most individuals can resume light daily activity within 24-48 hours. Walking and gentle stretching are encouraged the same day to reduce fatigue and support circulation. However, for the first week, strenuous exercise, bending, or heavy lifting should be avoided to minimize the risk of headache or intracranial pressure spikes. If corticosteroids are prescribed for swelling, trainers should monitor for muscle weakness, mood changes, or elevated blood pressure during exercise. Clients who experience balance issues, dizziness, or fatigue should focus on low-impact movement - such as stationary cycling, gentle yoga, or supervised strength training - at low intensity until cleared by their physician. High-impact activities, inversions, or resistance movements that increase head pressure should be postponed for at least two weeks or until follow-up imaging confirms stability. For those with residual or recurrent tumors, exercise should emphasize mobility, posture, and endurance while avoiding excessive strain.

Potential Side-effects of Gamma Knife:

- Fatigue, mild headache, or lightheadedness for one to three days after treatment.
- Temporary scalp soreness or pin-site tenderness if a head frame was used.
- Local swelling or edema around the treated lesion, which can cause transient neurological symptoms such as weakness, speech changes, or imbalance; these usually resolve with short-term corticosteroids.
- Nausea or vomiting related to increased intracranial pressure from swelling.
- Temporary hair thinning or loss in a small patch overlying the treatment area.
- Delayed radiation necrosis or scar tissue formation months later, occasionally causing new symptoms that may require medication or, rarely, surgery.
- Very rare complications include seizures or cranial nerve injury if treatment is near sensitive structures.

Following any brain cancer procedure - whether open surgery, minimally invasive intervention, or radiosurgery - patients should contact their doctor or seek emergency care immediately if any of the following symptoms occur. These can indicate infection, bleeding, swelling, or complications involving the brain, surgical site, or implanted device.

- Sudden or worsening confusion, disorientation, or memory loss
- New or increasing difficulty with speech, understanding, or forming words
- Sudden weakness, numbness, or tingling on one side of the body
- Loss of coordination, balance, or ability to walk
- Seizures (new onset or worsening frequency/intensity)
- Vision changes such as double vision, loss of vision, or new blurriness
- Persistent or severe dizziness or vertigo
- New or worsening headaches, especially if severe, throbbing, or different from baseline

Signs of increased Intracranial Pressure (ICP):

- Persistent nausea or vomiting, particularly when not related to medication or food
- Headaches that worsen when lying down, coughing, or bending forward
- Unusual drowsiness, lethargy, or difficulty staying awake
- Behavioral or personality changes, irritability, or emotional instability
- Pupillary changes (unequal size or poor light response)

Signs of infection or wound problems:

- Fever over 100.4°F (38°C)
- Redness, swelling, or warmth around the incision site or scalp
- Drainage of pus, fluid, or blood from the wound
- Increasing pain, tenderness, or swelling near the incision or device site (e.g., shunt or Ommaya reservoir)
- Stiff neck or sensitivity to light (possible meningitis)

Signs of bleeding or fluid accumulation:

- Sudden severe headache different from typical post-op pain
- Clear fluid (cerebrospinal fluid) leaking from the nose, incision, or ear
- Rapid swelling under the scalp or around the surgical site
- Worsening neurological function after initial improvement

Device or Shunt-related Complications (if applicable):

- **For shunt patients:** increasing headache, nausea, vomiting, or gait changes suggesting blockage or over-drainage
- **For Ommaya reservoir:** pain, redness, or swelling at the dome site, or fever following medication administration
- **For programmable shunts:** exposure to a strong magnet (e.g., MRI) without prior valve adjustment

Other concerning signs:

- New or worsening neck stiffness
- Shortness of breath, chest pain, or leg swelling (possible blood clot or embolism)
- Any sudden or unexplained decline in physical or cognitive function

Types of Treatment used:

- External Beam Radiation Therapy
- Intensity-Modulated Radiation Therapy
- Stereotactic Radiosurgery
- Proton Beam Therapy
- Whole-Brain Radiation Therapy
- Systemic chemotherapy
- Intrathecal Chemotherapy
- Targeted therapy

Balance and Coordination

Balance plays a central role in recovery after any brain cancer treatment, especially surgical procedures such as craniotomy, posterior fossa resections, or treatments involving the cerebellum, brainstem, or vestibular pathways. These regions control coordination, spatial awareness, and postural stability - so when they are disrupted, patients often experience dizziness, gait instability, or vertigo. Even in non-surgical cases (like radiation or chemotherapy), neurological fatigue, muscle weakness, or sensory loss can reduce balance and increase fall risk. Rebuilding balance is, therefore, not just a rehabilitation goal - it's a prerequisite for restoring safe mobility, independence, and overall function.

How Balance Is Affected

Damage or swelling in the brain can alter:

- **Vestibular processing –** affecting equilibrium, spatial orientation, and eye-head coordination.
- **Proprioception –** disrupting how the body senses joint position and movement.
- **Muscle tone and coordination –** particularly after cerebellar or motor cortex involvement.
- **Vision and depth perception –** impacting balance confidence.
- **Fatigue and cognition –** reducing focus and postural control during movement.

These effects may appear as unsteady gait, difficulty with quick directional changes, slower reaction time, or a widened stance when walking.



Balance Training in Exercise Programming

Balance training should start early in recovery - often within the first few weeks - once cleared for mobility and stability by the neurosurgical or oncology team. The program should progress gradually from static stability to dynamic and functional control, integrating posture, coordination, and strength.

Phase 1: Early Recovery (weeks 1-4)

Goals: restore posture, stimulate the vestibular system gently, and promote safe mobility.

Activities:

- Seated or supported standing balance (wide base of support)
- Weight shifting side-to-side and front-to-back
- Gaze stabilization exercises (focusing on a fixed object while moving the head)
- Gentle walking in a controlled environment (using assistive devices if needed)

Precautions: avoid sudden head movements, fatigue, or overstimulation; use stable support surfaces and supervision.

Phase 2: Foundational Strength and Static Balance (weeks 4-8)

Goals: improve lower-body strength and trunk stability to enhance postural control.

Activities:

- Supported single-leg stance and heel-to-toe walking
- Standing marches or mini-squats near a wall or rail
- Seated or standing core activation (pelvic tilts, gentle rotations)
- Slow transitions (sit-to-stand)

Progression: reduce hand support and increase duration or repetitions gradually.

Precautions: no closed-eye balance or unstable surfaces yet; avoid overexertion or dizziness.

Phase 3: Dynamic Balance and Coordination (weeks 8-12)

Goals: reinforce stability during movement and integrate balance into daily and functional tasks.

Activities:

- Step-ups, light direction changes, or tandem gait on firm surfaces
- Balance board or foam pad work under supervision
- Reaching, twisting, or light upper-body resistance while standing
- Controlled multidirectional walking drills and obstacle navigation

Progression: narrow stance, increase movement speed slightly, or incorporate light resistance bands.

Precautions: avoid dual-tasking (balance + cognitive challenge) until balance alone is consistent.

Phase 4: Integrated Functional Training (beyond 12 weeks)

Goals: rebuild full proprioceptive and vestibular integration for daily life or athletic activity.

Activities:

- Dynamic stability drills (lateral steps, walking lunges, cone taps)
- Dual-task exercises (balance while counting, turning, or carrying light objects)
- Low-impact cardiovascular options like elliptical, stationary cycling, or pool work

Progression: introduce gentle agility or reactive drills for higher-level recovery

Precautions:high-impact, plyometric, or contact activities until cleared by neurosurgery.

Additional Recommendations

- **Monitor fatigue closely:** balance performance drops with neurological or general fatigue; rest periods are essential.
- **Emphasize posture and alignment:** gentle cues to maintain neutral spine and upright stance help reestablish body awareness.
- **Integrate vision and vestibular retraining:** for patients with dizziness, combine slow head turns, eye tracking, and gaze stabilization exercises.
- **Encourage barefoot or minimal footwear work:** only when safe, to improve sensory feedback.
- **Cross-train:** pool walking or aquatic balance drills reduce fall risk while improving coordination. Make sure that your client is not immunocompromised before recommending exercise in a public pool.

Key Progression Principles

1. Start simple, build complexity: Move from stable to unstable, supported to unsupported, static to dynamic.
2. Challenge safely: Use parallel bars, walls, or sturdy objects for support.
3. Focus on quality, not quantity: Controlled, deliberate movement retrains neural pathways more effectively than repetition under fatigue.
4. Integrate cognitive tasks gradually: Once balance improves, add mild multitasking to restore brain–body coordination.



CANCER OF THE TESTICLE

There were approximately 72,000 new cases and 9,056 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Testicular cancer is the most common malignancy in men aged 15-44 years, though it is not restricted to that age group, with peak incidence in the 20-34 year age range. About 95% of testicular cancers arise from germ cells, and the highest incidence rates globally are found in Europe, while Africa has the lowest (Bray et al., CA: A Cancer Journal for Clinicians, 2024).One of the main risk factors for testicular cancer is a condition called cryptorchidism, or undescended testicle(s) - meaning that one or both testicles fail to move from the abdomen into the scrotum before birth. Males with cryptorchidism have a relative risk of developing testicular cancer approximately 2.75-8 times higher than males with normally descended testicles, making it the most unanimously recognized risk factor for the disease (Feretti et al., UroCancer Clinics of India, 2024; McHugh, Taza, and Feldman, CA: A Cancer Journal for Clinicians, 2024).

Testicular cancer carries an excellent prognosis with effective management, with a greater than 90% cure rate and greater than 95% five-year survival rate. If diagnosed early, the cure rate is nearly 99%. Even when the tumor has metastasized, the majority of patients can be cured with modern treatment (ACS, Testicular Cancer Survival Rates, 2024; McHugh et al., CA: A Cancer Journal for Clinicians, 2024). Symptoms of testicular cancer may include a lump in the testicle, painless enlargement of the testicle, a dull ache in the lower abdomen or groin, a feeling of heaviness in the scrotum, sudden collection of fluid in the scrotum, a dragging sensation in the scrotum, fatigue, and tenderness or enlargement of the breasts.

There are many types of testicular tumors:

- **Germ Cell Tumors** - account for more than 95% of all testicular cancers, arising from the sperm-producing germ cells of the testicle (ACS, What Is Testicular Cancer?, 2024). There are two main types: seminomas and non-seminomas, which occur in roughly equal proportions. Some tumors contain both cell types and are classified and treated as non-seminomas, as they grow and spread in the same manner.

- **Seminomas** - develop from the sperm-producing germ cells of the testicle. The two main subtypes of these tumors are classical seminomas and spermatocytic seminomas.

- **Classical Seminoma** - accounts for more than 95% of all seminomas and typically occurs in men between the ages of 25-45. It is generally slow-growing, highly sensitive to radiation and chemotherapy, and carries an excellent prognosis even when diagnosed at a more advanced stage (ACS, What Is Testicular Cancer?, 2024).

- **Spermatocytic Seminoma** - is now recognized as a distinct tumor type separate from classical seminoma. It is a very rare disease, accounting for approximately 1% of testicular cancers. It usually affects men aged 50 and older, and is mostly considered benign, though the tumor tends to be larger than classical seminoma tumors. It grows slowly and rarely spreads to other areas of the body. Standard treatment is surgical removal of the affected testicle (orchiectomy) (ACS, What Is Testicular Cancer?, 2024).

- **Non-Seminomas –** are germ cell tumors that typically occur in men between their late teens and early 30s. They tend to grow and spread more quickly than seminomas. There are four main types (ACS, What Is Testicular Cancer?, 2024; McHugh et al., CA: A Cancer Journal for Clinicians, 2024):

  - **Choriocarcinomas –** a very rare and fast-growing type of testicular cancer in adults. Pure choriocarcinoma, which occurs in less than 1% of non-seminomas, is likely to spread rapidly to the lungs, bones, and brain. More often, choriocarcinoma cells appear as a component of mixed germ cell tumors. This type significantly elevates hCG levels.

  - **Teratomas –** composed of multiple tissue types derived from the three embryonic germ layers; in adults, testicular teratomas are generally considered malignant regardless of appearance, and pure teratomas do not secrete Alpha-Fetoprotein or hCG.

  - **Yolk Sac Carcinomas (also known as Endodermal Sinus Tumor) –** named because its cells resemble the yolk sac of an early human embryo. This is the most common testicular tumor type in children, in whom it responds very well to treatment. In adults it is typically seen as a component of mixed tumors. This type almost always elevates AFP levels.

  - **Embryonal Carcinomas –** cells are found in approximately 40% of all testicular tumors, though pure embryonal carcinomas account for only 3-4% of cases. This subtype tends to grow rapidly and spread outside the testicle. It can elevate blood levels of alpha-fetoprotein (AFP) and human chorionic gonadotropin (hCG).

- **Carcinoma in Situ (CIS) –** testicular germ cell cancers may begin as a non-invasive form of the disease or intratubular germ cell neoplasia. Carcinoma in situ may not always progress to invasive cancer and when it does, it is estimated that it can take about 5 years to progress to the invasive form of germ cell cancer. Because it generally causes no symptoms and often does not form palpable lump, it is difficult to diagnose it before it turns into an invasive cancer. Because CIS doesn't always become an invasive cancer, many doctors recommend observation (watchful waiting). When a testicular tumor like CIS becomes invasive, its cells are no longer just in the seminiferous tubules (where sperm cells are formed) but have grown into other structures of the testicle. These cancer cells can then metastasize either to the lymph nodes or through the blood circulation.

- **Stromal Tumors –** can also develop in the supportive and hormone-producing tissues, or stroma, of the testicles. Sex cord-stromal tumors account for approximately 5% of all testicular neoplasms in adults and a proportionally higher percentage in children, where they represent a clinically important subset (Kapoor and Leslie, StatPearls, updated June 2024). The vast majority are benign - malignant transformation occurs in fewer than 10% of cases overall and most are curable with surgery alone. The two principal subtypes are Leydig cell tumors and Sertoli cell tumors, though granulosa cell tumors and mixed sex cord-stromal tumors are also recognized as distinct entities under the current WHO classification (Kapoor and Leslie, StatPearls, updated June 2024).

  - **Leydig Cell Tumors –** the most common sex cord-stromal tumor of the testis, accounting for approximately 1-3% of all testicular tumors in adults (Nolazco and Leslie, StatPearls, updated September 2025). They arise from the Leydig cells responsible for testosterone production and display a bimodal age distribution, with one peak in prepubertal boys and a second larger peak in adults aged 30-60 years. Approximately 90% are benign and organ-confined. Malignant transformation occurs in approximately 2.5% of adult cases and is characterized by large tumor size, vascular invasion, and infiltrative margins; when metastatic disease develops, prognosis is poor as Leydig cell tumors respond poorly to both chemotherapy and radiotherapy (Nolazco and Leslie, StatPearls, updated September 2025).

  - **Sertoli Cell Tumors –** rare sex cord-stromal tumors arising from Sertoli cells, accounting for approximately 0.4-1.5% of all testicular tumors (Kapoor and Leslie, Stat Pearls, updated June 2024). They can occur at any age but are most commonly diagnosed in adults with a mean age of approximately 45 years, with a subset occurring in infants and young children. Like Leydig cell tumors, Sertoli cell tumors can be hormonally active - producing estrogens and inhibin - causing gynecomastia in adults and isosexual precocious puberty in prepubertal boys. The vast majority are benign; however, malignant transformation occurs in approximately 10-15% of cases and is associated with tumors greater than 5 cm, vascular invasion, nuclear pleomorphism, and a high mitotic rate (Kapoor and Leslie, StatPearls, updated June 2024). A well-recognized association exists between Sertoli cell tumors-particularly the large cell calcifying subtype - and genetic syndromes including Peutz-Jeghers syndrome, Carney complex, and androgen insensitivity syndrome (Kapoor and Leslie, StatPearls, updated June 2024).

Procedures:

- **Radical Inguinal Orchiectomy –** through a small groin incision, the surgeon removes the entire affected testis and spermatic cord up to the internal ring, avoiding the scrotum to prevent tumor seeding and aberrant lymphatic spread. A testicular prosthesis can be placed at the same time if desired.

When it's used:

- Any solid intratesticular mass suspicious for malignancy (germ-cell tumor), regardless of stage
- Urgent cases with acute hemorrhage/rupture from a tumor
- To obtain definitive histology and serum-marker correlation

- **Testis-Sparing Surgery (Partial Orchiectomy) –** excision of the tumor with a margin while preserving viable testicular tissue; performed via inguinal approach with cord clamped briefly for a bloodless field. Intra-operative ultrasound and frozen-section analysis guide resection.

When it's used:

- Small (<2 cm), polar, likely benign masses) or indeterminate lesions
- Bilateral tumors or tumor in a solitary testis when organ preservation is crucial
- Prepubertal boys

Both partial and radical orchiectomy are most commonly performed as outpatient or same-day surgical procedures, meaning the majority of patients are discharged home within a few hours of surgery. Those undergoing testis-sparing surgery, scrotal revision,or testicular prosthesis insertion usually stay one night or are discharged the same day. In the first 1-2 weeks following either surgery, physical activity is limited to gentle walking only. Short, slow walks around the home are encouraged as early as the day of or day after surgery, as they promote circulation, reduce the risk of blood clots, and support overall healing. Any activity that raises intra-abdominal pressure - including lifting, straining, or vigorous movement - is strictly avoided during this period. Walks should be kept brief and on flat surfaces, with duration increased by a few minutes each day as comfort allows.

Rest is prioritized, and patients are advised to spend the majority of their time off their feet with the surgical site supported.

From weeks 2-4, walking duration and pace can be progressively increased as the incision heals and pain continues to subside. Patients are typically comfortable taking longer walks outdoors during this phase, and light stretching of the lower extremities may be gently introduced. However, any movement that directly engages the core or places tension on the groin and abdominal region remains off-limits. For those recovering from a radical orchiectomy, particular care is taken around the inguinal incision site, and exercises that stretch or load that area are deferred until cleared by the surgical team. Running, cycling, resistance training, and recreational sport are not appropriate during this phase for either procedure.

Between weeks 4-8, and assuming no complications or ongoing treatment, most patients receive clearance to begin a more structured return to exercise. Low-impact cardiovascular activity such as brisk walking or light use of an elliptical machine is typically introduced first, with intensity kept at a comfortable conversational pace. Light resistance training using bodyweight or minimal loads may begin toward the end of this phase, focusing on upper body movements that do not recruit the core or place downward pressure on the pelvic region. Seated dumbbell curls, light upper body machine work, and resistance band movements performed from a stable standing position are reasonable starting points. Core exercises including crunches, planks, and any rotational movements re main off-limits throughout this phase.

From months 2-4, exercise programming can expand meaningfully for patients who are not undergoing chemotherapy or additional surgical intervention. Cardiovascular training may progress to include light jogging, swimming, or stationary cycling with a comfortable seat, provided there is no discomfort at the surgical site. Resistance training volume and load can be gradually increased, and compound lower body movements such as bodyweight squats and light leg press work may be reintroduced cautiously. Core strengthening can begin in a controlled and progressive manner, starting with diaphragmatic breathing exercises, dead bugs, and pelvic tilts before advancing to more demanding movements. Patients undergoing chemotherapy during this window will experience significant fatigue, immune suppression, and reduced exercise tolerance, and their

programming must be modified accordingly, prioritizing gentle walking and light mobility work over structured training. By months 4-6, patients who have completed or avoided adjuvant treatment and are progressing without complications can work to ward returning to a near-normal exercise routine. Running, sport-specific training, heavier resistance work, and full core programming are typically appropriate by this stage, provided the individual has rebuilt a base of strength and endurance progressively and has received explicit clearance from their medical team. Effort should continue to be increased gradually, and any return to contact sport or high-impact activity warrants a specific conversation with the treating physician.

Potential Side-effects of Testis-Sparing Surgery (Partial Orchiectomy):

- Mild pain or swelling in the groin or scrotum
- Risk of local recurrence; need for regular ultrasound follow-up
- Temporary changes in hormone levels
- Scarring or firmness in the testis
- Infection (rare)
- Possible bleeding or hematoma within the scrotum

- **Retroperitoneal Lymph-node Dissection (RPLND) –** one of the most technically demanding and curative procedures used in the management of testicular cancer, primarily for nonseminomatous germ cell tumors (NSGCT). It involves the removal of lymphatic tissue located along the great vessels of the retroperitoneum - specifically the paracaval (right of the inferior vena cava), interaortocaval (between the aorta and vena cava), and para-aortic (left of the aorta) nodal chains. These are the primary sites of metastasis because testicular lymphatic drainage follows the gonadal vessels upward to the retroperitoneum rather than into the inguinal nodes.

The procedure begins with the patient under general anesthesia. An incision is typically made along the midline of the abdomen (open RPLND), though some centers now perform the surgery laparoscopically or robotically for select early-stage cases. The surgeon carefully mobilizes the intestines to expose the major vessels and meticulously removes lymphatic tissue en bloc according to a predetermined template. Modern nerve-sparing techniques are used to preserve the sympathetic fibers responsible for antegrade ejaculation, significantly reducing the risk of postoperative sexual dysfunction. If performed post-chemotherapy, the dissection is often more complex due to fibrosis and desmoplastic reactions around the vessels.

RPLND serves two purposes: diagnostic (staging) and therapeutic (curative). In early-stage NSGCT, it definitively determines whether microscopic metastases are present - approximately 70% of clinical stage I NSGCT patients undergoing RPLND are found to have no nodal metastases and can be spared chemotherapy entirely, while the remaining 30% with confirmed nodal disease can proceed directly to targeted adjuvant treatment (McHugh, Taza, and Feldman, CA: A Cancer Journal for Clinicians, 2024). After chemotherapy, RPLND removes residual teratoma or viable tumor resistant to systemic treatment, with approximately 90% of resected post-chemotherapy specimens containing either necrosis or teratoma (Nicolai, Nazzani, Tesone, et al., Tumori Journal, 2023). Minimally invasive approaches have shown shorter recovery times and reduced postoperative pain, though open surgery remains the gold standard in advanced or fibrotic cases due to superior visualization and control of vascular structures (EAU, Guidelines on Testicular Cancer, 2024).

When it's used:

- Clinical stage I-II nonseminomatous as primary therapy in selected
- For staging/therapy when surveillance/chemo are less favored
- Post-chemotherapy residual mass
- Select seminoma with residual masses when PET/biopsy inconclusive and resectable

The hospital stay following a retroperitoneal lymph node dissection is considerably longer and more involved than that associated with orchiectomy. A full bilateral radical RPLND, which involves the removal of an extensive network of lymph nodes from the retroperitoneal space behind the abdominal cavity, typically requires a hospital stay of 4-7 days. A modified template or nerve-sparing radical RPLND may allow for a somewhat shorter stay of 3-5 days, while a partial or limited template RPLND, which targets a smaller and more defined nodal region, may result in a stay of 2-4 days depending on the surgical approach and the patient's recovery progress. Laparoscopic or robotic-assisted approaches, when appropriate, are generally associated with shorter inpatient stays than open surgery.

During the first two weeks at home fatigue is profound, and patients are advised to rest frequently and avoid any activity beyond very gentle, short-duration walking. Brief walks of 5-10 minutes on flat surfaces are encouraged several times throughout the day to promote circulation and reduce the risk of deep vein thrombosis, but these should be kept well within the patient's comfort level and terminated at the first sign of significant discomfort or fatigue. The abdominal incision, which in open RPLND typically runs from the sternum to below the navel, requires careful protection, and any movement that creates tension across the midline must be avoided. Patients are generally restricted from lifting anything heavier than a few pounds, climbing stairs excessively, or performing any bending or twisting movements during this phase.

Between weeks 2-4, walking tolerance generally improves and patients are able to gradually extend the duration and frequency of their walks. By the end of week four, many patients are comfortable walking for 20-30 minutes at a time on flat ground, though pace remains slow and deliberate. Light daily activities such as personal hygiene, preparing simple meals, and moving around the home are typically manageable by this stage, but patients remain restricted from driving, lifting, and any form of structured exercise beyond walking. Bowel function, which is often sluggish in the early weeks following retroperitoneal surgery due to the handling of the intestines and surrounding structures, typically continues to normalize during this period. Fatigue remains a prominent feature of recovery for most patients through the end of this phase.

From weeks 4-8, and with surgical clearance, a more deliberate and structured return to physical activity can begin. Walking may progress to brisker paces and moderate inclines, and for patients who underwent a minimally invasive approach, light stationary cycling may be introduced toward the end of this phase. Upper body resistance training using very light loads and controlled movements may be cautiously reintroduced, provided it does not engage the abdominal wall or create intra-abdominal pressure. Core exercise remains strictly off-limits at this stage, as the abdominal structures continue to heal and the risk of hernia or internal strain remains elevated.

By months 2-4, cardiovascular training may include brisk walking, light jogging for those who are progressing well, and low-resistance stationary cycling. Lower body resistance training using bodyweight movements and light loads can be gradually reintroduced, with careful attention to avoiding excessive intra-abdominal pressure during exercises. Core rehabilitation begins during this phase in a very structured and progressive manner, starting with diaphragmatic breathing, gentle pelvic floor activation, and movements such as dead bugs and heel slides before progressing to more demanding exercises.

From months 4-6 patients who are recovering without complications and have completed any adjuvant treatment can work toward a substantial return to normal physical function. Running, swimming, recreational sport, and progressive resistance training across all major muscle groups are generally appropriate by this stage, provided the individual has rebuilt a meaningful base of strength and cardiovascular endurance through the preceding months and has received explicit clearance from their surgical team. Core training can progress to include planks, rotational exercises, and loaded abdominal work as tolerated.

Potential Side-effects of Retroperitoneal Lymph-node Dissection (RPLND):

- Abdominal pain and bloating from surgical manipulation
- Ileus (temporary bowel inactivity)
- Chyle leak or lymphocele (fluid accumulation)
- Bleeding or infection
- Retrograde ejaculation if sympathetic nerves are injured (rare with nerve-sparing techniques)
- Fatigue and temporary reduced endurance
- Long scar and mild restriction in trunk extension early on

Types of Treatment Used:

- Chemotherapy
- Adjuvant radiotherapy
- Para-aortic field radiotherapy
- Hormonal therapy
- Targeted therapy
- Immunotherapy

Cycling Restrictions and Return Guidelines After Testicular Cancer Surgery

Procedure	Reason to Avoid Cycling Early	Recommended Time to Resume Cycling	Precautions When Resuming
Radical Inguinal Orchiectomy	Pressure on groin incision and risk of hematoma formation	6-8 weeks	Begin with upright or recumbent stationary bike; use padded seat and supportive shorts; stop if pain or swelling occurs
Testis-Sparing Surgery (Partial Orchiectomy)	Local tenderness and risk of disrupting delicate tissue repair	6-8 weeks	Start with short sessions; ensure no incision tenderness; avoid aggressive posture or long rides
Retroperitoneal Lymph Node Dissection (RPLND)	Increased intra-abdominal pressure, strain on abdominal incision, and risk of lymph leak or hernia	10-12 weeks	Focus first on walking and gentle cardio; return only after full core healing; maintain neutral spine posture
Post-Chemotherapy Residual Mass Resection/Metastasectomy	Fatigue, abdominal weakness, and delayed tissue healing post-therapy	10-12 weeks or longer	Confirm full wound healing and stamina before resuming; begin with very low resistance and short duration
Scrotal or Inguinal Scar Revision/ Hemiscrotectomy	Local pressure and friction at the surgical site	6-8 weeks	Use wide, soft seat and supportive garment; stop immediately with pain or irritation
Thoracic Metastasectomy - post-chemotherapy residual disease	Limited breathing capacity and chest discomfort during exertion	6-8 weeks	Prioritize deep breathing and upright posture; use low resistance; stop with shortness of breath or fatigue
Testicular Prosthesis Insertion	Direct saddle pressure may displace prosthesis or cause pain	2-4 weeks	Resume when no discomfort remains; light stationary cycling first
Fertility Procedures (Micro-TESE)	Minor tenderness and risk of incision irritation	2-4 weeks	Resume when no discomfort remains; light stationary cycling first

References for Chart:

1. Alberta Health Services, MyHealth Alberta: Orchiectomy, 2025

2. Cancer Research UK, Testicular Cancer: After Surgery, 2025

3. MSKCC, About Your Orchiectomy, updated March 2026

CANCER OF THE SMALL INTESTINE

In the United States, an estimated 13,920 new cases of small intestine cancer and 2,060 deaths were projected for 2025, reflecting a steady rise in incidence observed across all sexes and ethnicities over the past two decades (NCI, Small Intestine Cancer Treatment PDQ, updated 2025). Small intestine cancer occurs slightly more often in men than women, most commonly affects people between the ages of 55 and 69, and is rising in incidence - particularly neuroendocrine tumors, which now represent the most frequently diagnosed subtype at approximately 54% of all US cases (NCI, SEER Cancer Stat Facts: Small Intestine Cancer, 2024). Risk factors include alcohol consumption, smoking, and diets high in red and processed meat, as well as several hereditary and inflammatory conditions discussed below.

The main types of cancer found in the small intestine are adenocarcinoma, neuroendocrine tumors (formerly called carcinoid tumors), gastrointestinal stromal tumors (GISTs), and lymphoma. Symptoms may include pain or cramps in the middle abdomen, unexplained weight loss, a palpable abdominal lump, and blood in the stool. Adenocarcinoma is the most common histologic type and most often develops in the duodenum, the portion of the small intestine closest to the stomach. Tumors arising at the ampulla of Vater - where the duodenum meets the pancreatic and bile ducts - are known as ampullary cancers and are clinically managed similarly to pancreatic cancer due to their anatomical proximity. Adenocarcinomas may grow and obstruct the intestine; the overall five-year survival rate for all stages of small intestine cancer combined is approximately 71%, though outcomes for advanced adenocarcinoma are significantly poorer (NCI, SEER Cancer Stat Facts: Small Intestine Cancer, 2024).

Neuroendocrine tumors of the small intestine represent the most common GI site for this tumor type, with approximately 40% of all gastrointestinal neuroendocrine tumors originating in the small bowel (ACS, Small Intestine Cancer, 2024). Approximately 20% will spread, most commonly to the liver. When metastatic neuroendocrine tumors release large quantities of serotonin and other bioactive substances into the systemic circulation - typically after liver metastasis bypasses hepatic detoxification - patients may develop carcinoid syndrome, characterized by facial flushing, diarrhea, abrupt drops in blood pressure, abdominal cramping, and bronchospasm (NCI, Small Intestine Cancer Treatment PDQ, updated 2025). Even with metastatic disease, these tumors tend to grow slowly and patients may survive for many years.

Several conditions significantly elevate the risk of small intestine cancer. People with celiac disease have an increased risk of enteropathy-associated T-cell lymphoma and small intestine adenocarcinoma, as chronic immune-mediated damage to the intestinal lining creates a permissive environment for malignant transformation. Crohn's disease, which most commonly affects the lower small intestine, is associated with a substantially elevated risk of small bowel adenocarcinoma, most often arising in the ileum. Survivors of colon cancer also carry an increased risk of small intestine cancer, likely due to shared genetic and environmental risk factors (ACS, Small Intestine Cancer Risk Factors, 2024).

Hereditary conditions associated with elevated small intestine cancer risk include familial adenomatous polyposis (FAP), caused by mutations in the APC gene, in which polyps develop throughout the colon, stomach, and small intestine - with most small intestine cancers in FAP arising in the duodenum. Lynch syndrome, caused by mismatch repair gene mutations, impairs the body's ability to correct DNA damage and increases the risk of cancers of the small intestine, colon, endometrium, and ovaries (ACS, Small Intestine Cancer Risk Factors, 2024).

Peutz-Jeghers Syndrome (PJS), caused by germline mutations in the STK11 gene, significantly increases the lifetime risk of small intestine adenocarcinoma through the development of hamartomatous polyps throughout the gastrointestinal tract, which can cause bleeding, obstruction, and malignant transformation (Siddiqui, Puckett, and Dunn, StatPearls, updated February 2025; NCCN, Genetic/Familial High-Risk Assessment: Colorectal, Endometrial, and Gastric, Version 1.2025).

MUTYH-Associated Polyposis (MAP), caused by biallelic mutations in the MUTYH gene, is associated with an elevated risk of small intestine cancer - particularly duodenal and jejunal adenocarcinoma - in addition to its well-recognized colorectal cancer risk (ACS, Small Intestine Cancer Risk Factors, 2024; NCCN, Genetic/Familial High-Risk Assessment: Colorectal, Endometrial, and Gastric, Version 1.2025).

Cystic fibrosis, caused by biallelic pathogenic variants in the CFTR gene, is associated with a recognized increased risk of gastrointestinal cancers, particularly colorectal cancer, likely related to chronic intestinal inflammation, CFTR-mediated disruption of epithelial homeostasis, and impaired intestinal defense mechanisms (Shugg, Gallaway, Powell, et al., Pediatric Pulmonology, 2025).

A diet high in dietary fiber may help reduce the risk of small intestine cancer. Surgical management is primarily guided by tumor location and histological type, as cancers of the duodenum, jejunum, and ileum differ significantly in their behavior, presentation, and surgical approach (ACS, Small Intestine Cancer, 2024).

Procedures:

- **Segmental Small-bowel Resection (Jejunum or Ileum) –** this surgery removes the section of the small intestine that contains the tumor, along with a small amount of healthy intestine on either side to make sure no cancer cells are left behind. The surgeon also removes nearby fatty tissue that contains lymph nodes. After the diseased section is removed, the two healthy ends of the intestine are sewn back together so digestion can continue normally.

  This is the most common operation used when cancer is found in the middle or lower parts of the small intestine and has not spread widely. It is often done with the goal of curing the cancer. The surgery may also be needed if a tumor is causing problems such as bleeding, blockage of the intestine, or a tear in the bowel wall. In many cases, this procedure can be done using minimally invasive techniques, which may allow for faster recovery.

When it's used:

- When the cancer is confined to one area and can be completely removed

Hospital stay after a segmental small-bowel resection of the jejunum or ileum typically ranges from 3-5 days, depending on whether the surgery is performed open or minimally invasively and how quickly bowel function returns. During this time, the primary goals are pain control, early mobilization, and gradual reintroduction of intestinal activity. Patients are encouraged to begin sitting up and walking short distances within the first 24 hours to reduce the risk of blood clots, support lung function, and stimulate bowel movement. Oral intake is advanced slowly as bowel sounds return and gas or stool is passed, and most patients are discharged once pain is controlled with oral medication and they can tolerate light activity.

During the first two weeks after discharge, activity should focus on rest and gentle movement. Short, frequent walks on flat surfaces are recommended, while lifting more than ten pounds, bending, twisting, or any activity that increases abdominal pressure should be avoided. Core exercises, straining, and high-impact movements are contraindicated at this stage because the intestinal reconnection and abdominal wall are still fragile. Fatigue is common, and activity should be paced conservatively, with rest periods built into the day.

From weeks 2-6, walking duration can gradually increase to 20-30 minutes per day as tolerated. Light mobility work for the hips, shoulders, and spine may be introduced, provided movements remain pain-free and do not stress the abdominal region. Resistance training is generally limited to very light upper-body work using bands or small dumbbells, and breathing should remain relaxed to avoid bearing down. Cycling, running, abdominal strengthening, and contact activities should still be avoided during this phase.

Between 6-12 weeks postoperatively, most patients can begin a more structured return to exercise if healing has progressed normally and there are no complications such as hernia, bowel symptoms, or incisional pain. Low-impact cardiovascular exercise such as brisk walking, stationary cycling with an upright posture, or swimming can be introduced gradually. Strength training may progress cautiously using light to moderate resistance, focusing on controlled movements and proper breathing.

Core exercise can be reintroduced slowly, emphasizing gentle activation and stability rather than intensity. Throughout this period, any increase in abdominal pain, swelling, changes in bowel habits, or incision discomfort should prompt a reduction in activity and communication with the medical team before further progression.



Potential Side-effects of Segmental Small-Bowel Resection (Jejunum or Ileum):

- Abdominal pain or soreness during the early recovery period
- Temporary bloating, gas, or slowed bowel function
- Nausea or vomiting as the digestive tract adjusts
- Infection at the incision site or within the abdomen
- Bleeding during or after surgery
- Leakage at the site where the bowel is reconnected, which may cause fever, increasing pain, or abdominal swelling
- Temporary changes in bowel habits, including diarrhea or more frequent stools
- Fatigue and reduced stamina during healing
- Scar tissue (adhesions) that may increase the risk of future bowel obstruction
- Short-bowel symptoms if a large length of intestine is removed, including poor absorption and loose stools
- Electrolyte imbalances related to fluid shifts or bowel changes
- Nutrient absorption issues, especially after ileal resection
- Risk of hernia at the incision site
- Lymphatic fluid leakage if extensive mesenteric tissue is removed
- Risk of cancer recurrence if margins or lymph-node removal are inadequate

- **Segmental Duodenal Resection (Pancreas-preserving surgery) –** this surgery removes only the portion of the duodenum that contains the tumor, while keeping the pancreas, bile duct, and most surrounding organs intact. The duodenum is the first part of the small intestine just beyond the stomach, and it sits very close to the pancreas and bile duct, so surgery in this area must be done carefully.

  During the operation, the surgeon frees the duodenum so it can be safely accessed and checks how close the tumor is to critical structures. The section of the duodenum with the tumor is removed along with a small margin of healthy tissue to make sure all cancer cells are taken out. Nearby lymph nodes may also be removed to check whether the cancer has spread. After the diseased section is removed, the remaining intestine is reconnected so food can continue to pass through normally.

  When it's used:

  - When the tumor is located in a part of the duodenum that is far enough away from the pancreas and bile duct that those structures do not need to be removed

  - Most often considered for early-stage duodenal cancers, certain neuroendocrine tumors, gastrointestinal stromal tumors, or benign but problematic growths

  Hospital stay after a segmental duodenal resection typically lasts 4-7 days, depending on the surgical approach and how quickly bowel function and pain control stabilize. Because the duodenum plays a key role in digestion and sits close to the stomach and pancreas, early recovery focuses on careful monitoring for nausea, delayed stomach emptying, or leakage at the reconnection site. Walking usually begins within the first 24 hours to support circulation, lung function, and bowel activity, but overall energy levels are often low. Oral intake is advanced slowly, and patients are discharged once pain is controlled with oral medication, bowel function is returning, and they can move independently.

  During the first two weeks after discharge, exercise should be limited to gentle walking several times per day on flat surfaces. The abdominal tissues and intestinal connection are vulnerable during this phase, so lifting more than ten pounds, bending, twisting, straining, or any activity that increases abdominal pressure should be avoided. Core exercises, abdominal bracing, and high-impact movements are contraindicated. Fatigue and early fullness are common, and activity should be paced conservatively with frequent rest periods.

  From weeks 2-6, walking duration can gradually increase as stamina improves, often reaching twenty to thirty minutes per day if tolerated. Light mobility work for the shoulders, hips, and spine may be added as long as movements remain pain-free and do not stress the abdomen. Very light upper-body resistance using bands or small dumbbells may be introduced with careful attention to breathing, avoiding breath holding or forceful exertion. Cycling, running, abdominal strengthening, and contact activities should continue to be avoided during this period due to the risk of stressing the surgical site.

  Between 6-12 weeks after surgery, most individuals can begin a gradual return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activities such as brisk walking, upright stationary cycling, or swimming may be added slowly. Strength training can progress cautiously with light to moderate resistance, emphasizing controlled movements and proper breathing. Core work should be reintroduced gently, focusing on stability and coordination rather than intensity. Any increase in abdominal pain, bloating, nausea, incision discomfort, or changes in bowel function should prompt immediate reduction in activity and reassessment with the medical team before progressing further.

Potential Side-effects of Segmental Duodenal Resection (Pancreas-preserving surgery):

- Abdominal pain or soreness during the early recovery period
- Temporary bloating, gas, or slowed bowel function
- Nausea or vomiting as the digestive tract adjusts
- Delayed stomach emptying, leading to early fullness or discomfort after meals
- Leakage at the intestinal reconnection site (anastomotic leak), which may cause fever, abdominal pain, or infection
- Infection at the incision site or inside the abdomen
- Bleeding during or after surgery
- Scar tissue (adhesions) that may increase the risk of future bowel obstruction
- Temporary changes in bowel habits, including diarrhea or more frequent stools
- Fatigue and reduced stamina during the healing process
- Nutrient absorption changes if a larger portion of the duodenum is removed
- Rare injury to nearby structures such as bile ducts or blood vessels

- **Whipple Procedure (Pancreatoduodenectomy) –** surgical removal of the head and neck of the pancreas, sometimes the body of the pancreas, the gallbladder, part of the stomach, the lower half of the bile duct, part of the small intestine, and some surrounding tissue. This is the most common procedure to remove a cancer in the exocrine pancreas. The remaining bile duct is attached to the small intestine so that the bile from the liver can continue to enter the small intestine. Finally, the stomach is reattached to the small intestine so food can pass through the digestive tract. After this operation, the patient can generally produce adequate amounts of insulin and digestive enzymes.

Most often, this operation is done through a large incision down the middle of the stomach. Occasionally it can be performed as a laparoscopic procedure, which is sometimes known as keyhole surgery. This is a complex operation that requires a highly skilled surgeon. It carries a relatively high risk of complications that can be life threatening.

When it's used:

- Tumors located in the pancreatic head or uncinate process that are confined to the gland and have no major arterial invasion
- Cancers of the distal bile duct that pass through the head of the pancreas and require en bloc removal for clear margins
- Ampullary (ampulla of Vater) tumors where the bile and pancreatic ducts join before entering the small intestine
- Duodenal cancers involving the first or second portion of the duodenum near the pancreas
- Select borderline-resectable tumors with limited vascular involvement that become operable after neoadjuvant therapy (chemotherapy or chemoradiation)
- Non-malignant but high-risk or symptomatic lesions in the pancreatic head

Hospital stays are typically 7-10 days for open surgery, or 5-7 when performed using minimally invasive robotic or laparoscopic techniques. Early mobilization is initiated within the first 24 hours, with short assisted walks as soon as the patient is stable. During the first 4-6 weeks at home, all activity must remain gentle and progressive. Short walks several times per

day form the cornerstone of early recovery and should be gradually extended in both duration and distance as energy allows. Lifting anything heavier than 10 pounds, bending, twisting, and any activity that engages or strains the core must be strictly avoided for a minimum of 6 weeks to protect the multiple surgical anastomoses and reduce risk of hernia, wound dehiscence, and intern al strain.

High-energy activities such as jogging, cycling, tennis, and contact sports should not be attempted during this period. Fatigue is common and often significant during this phase, lasting 6-8 weeks or longer, and activity periods should always be balanced with adequate rest.

Between weeks 5-8, light stretching, gentle flexibility exercises, and low-impact activity such as swimming or stationary cycling can be cautiously introduced as pain subsides and the surgical drain, if still in place, has been removed.

Between months 2-3, walking distance and pace can be progressively increased, with a return to normal daily activities typically achievable by 4-6 weeks post-discharge for most patients. Strenuous exercise, heavy resistance training, and core strengthening should not be resumed until at least 3 months post-operatively to avoid hernia formation or strain at the operative site.

Potential Side-effects of a Whipple Procedure (Pancreatoduodenectomy):

- Pancreatic fistula
- Delayed gastric emptying Bile leak
- Post-pancreatectomy hemorrhage
- Intra-abdominal abscess
- Wound infection
- Malnutrition/weight loss
- New or worsened diabetes
- Anastomotic ulcer
- Deep Vein Thrombosis (DVT)
- Pulmonary Embolism (PE)

Types of Treatment Used:

- Chemotherapy
- External Beam Radiation Therapy
- Targeted Therapy
- Immunotherapy
- Hormone-based and Biologic Therapy

CANCER OF THE LIP AND ORAL CAVITY

Lip and oral cavity cancer refers to cancer that starts in the cells lining the lips and the inside of the mouth (ACS, What Is Oral Cavity and Oropharyngeal Cancer?, 2024). There were 389,846 new cases of lip and oral cavity cancer worldwide in 2022, along with approximately 188,230 deaths (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Incidence rates are highest in countries in South-Central Asia, and oral cavity cancer is the most frequent lip, oral cavity, and pharyngeal cancer subsite among women in 141 countries and among men in 93 countries worldwide (Rumgay et al., CA: A Cancer Journal for Clinicians, 2026).

The oral cavity consists of the following areas:

- Front 2/3 of the tongue
- Roof of the mouth
- Floor of the mouth under the tongue
- Inside of the cheeks and lips
- Gums
- Area behind the wisdom teeth

Symptoms include white or red sores in the mouth, lip, gums, or tongue that do not heal, a lump in the mouth, pain or bleeding in the mouth, loose teeth, trouble chewing or swallowing, jaw inflammation, and a chronic sore throat. People who use smokeless tobacco products and people who smoke pipes or cigarettes are at the highest risk for cancers of the lip and oral cavity (ACS, Oral Cavity and Oropharyngeal Cancer Risk Factors, 2024). Exposure to UV radiation from the sun or tanning beds increases the risk of lip cancer specifically. Frequent or heavy alcohol consumption is also a significant risk factor - the risk of these cancers in people who both drink and smoke heavily is approximately 35 times higher than in people who do not smoke or drink (ACS, Oral Cavity and Oropharyngeal Cancer Risk Factors, 2024). In Southeast Asia, South Asia, and certain other regions, many people chew betel quid or gutka - a mixture of betel quid and tobacco - which is also associated with an increased risk of cancer of the mouth (ACS, Oral Cavity and Oropharyngeal Cancer Risk Factors, 2024).

HPV infection is an important and growing risk factor, though it is most strongly associated with oropharyngeal cancers - including cancers of the tonsil and base of the tongue - rather than oral cavity cancer specifically. The number of oropharyngeal cancers linked to HPV has risen greatly over the past few decades, and these cancers are becoming more common in younger people who have a history of multiple sex partners, including oral sex, and no history of alcohol abuse or tobacco use. HPV is believed to be transmitted through sexual contact, particularly oral sex.

The risk for cancers of the lip and oral cavity increases with age. The average age at diagnosis for oral cancer is 64, and more than two-thirds of individuals with this disease are over age 55, although it may occur in younger people as well (ACS, Oral Cavity and Oropharyngeal Cancer Risk Factors, 2024).

Procedures:

Lip and oral cavity cancers are most often treated with surgery when the disease is removable, and the "right" operation depends on where the tumor sits (lip, tongue, floor of mouth, gum, cheek, hard palate), how deep it goes, whether it involves the jawbone, and whether lymph nodes in the neck are at risk.

- **Local Excision / Wide Local Excision (small tumor removal) –** removal of the cancer with a rim of healthy tissue around it to reduce the chance cancer cells are left behind. For very small lip or oral lesions, this may be done through the mouth or directly on the lip. The surgeon aims for "clear margins," meaning the edges of the removed tissue are free of cancer under the microscope.

When it's used:

- Early, small, well-defined cancers of the lip or oral lining
- Superficial tumors that have not grown deeply

Hospital stay after local excision or wide local excision for small lip or oral cavity tumors is typically short, with many patients treated as outpatients or requiring only an overnight stay. Because this surgery involves removal of a limited amount of tissue and usually does not require reconstruction, recovery is often faster than with more extensive oral cancer procedures. Early care focuses on pain control, wound monitoring, and ensuring that swallowing and speech remain safe. Gentle movement, including short walks, is encouraged on the day of surgery or the following day to support circulation and reduce fatigue.

During the first 1-2 weeks after surgery, activity should remain light. Walking is appropriate and encouraged, but strenuous exercise, heavy lifting, or any activity that significantly increases heart rate or blood pressure should be avoided to reduce the risk of bleeding at the surgical site. Exercises that cause jaw clenching, facial strain, or forceful breathing are contraindicated. If the excision was on the lip, activities that stretch the mouth excessively or place tension on the incision should be limited. Fatigue and localized soreness are common, and rest should be prioritized.

From weeks 2-6, most patients can gradually increase walking duration and resume light daily activities as comfort allows. Low-impact cardiovascular exercise such as easy stationary cycling or gentle treadmill walking may be introduced if there is no swelling, bleeding, or wound discomfort. Resistance training should remain light and avoid breath holding or straining. Movements that place pressure on the face, jaw, or mouth, as well as contact sports, should still be avoided during this phase.

Between 6-12 weeks postoperatively, patients can usually return to a more normal exercise routine if healing is complete and there are no complications. Cardiovascular intensity can increase gradually, and strength training can progress cautiously with attention to proper breathing and posture. Activities that involve direct impact to the face or risk of trauma to the surgical area should be avoided until cleared by the surgical team. Any new pain, bleeding, swelling, or changes in speech or swallowing should prompt a reduction in activity and communication with the care team before further progression.

Potential Side-effects of Local Excision / Wide Local Excision (Small Tumor Removal) :

- Mild to moderate pain or soreness at the surgical site
- Swelling of the lip, cheek, tongue, or surrounding tissues
- Bruising around the incision area
- Temporary numbness or tingling near the surgical site
- Minor bleeding or oozing from the wound, especially in the first few days
- Infection at the incision site
- Tightness or pulling sensation as the wound heals
- Temporary changes in speech clarity or articulation, depending on tumor location
- Difficulty chewing or mild swallowing discomfort during early recovery
- Sensitivity to temperature or spicy foods
- Scarring, which may affect appearance depending on location
- Fatigue during the initial healing phase
- Jaw stiffness or limited mouth opening if surgery was near jaw muscles

- **Glossectomy –** refers to surgery to remove part or all of the tongue, most commonly to treat tongue and oral cavity cancers. The type of glossectomy depends on how much of the tongue is involved, where the tumor is located, and how deeply it has grown.

- **Partial Glossectomy –** removes a small portion of the tongue containing the tumor along with a margin of healthy tissue. Most of the tongue remains intact. This is the most common type used for early-stage tongue cancers. Surgeons aim to preserve tongue movement so speech and swallowing are affected as little as possible. Reconstruction is often not needed, or a small local tissue repair is used.

- **Hemiglossectomy –** removes approximately half of the tongue, usually on one side. This is done when the tumor is larger or deeper but still limited to one side of the tongue. Because a significant portion of tongue muscle is removed, reconstruction with tissue from another part of the body is often needed to restore bulk and mobility. Speech and swallowing are affected initially but often improve with therapy.

- **Extended Hemiglossectomy –** removes one side of the tongue plus nearby tissues such as the floor of the mouth or part of the tonsil region if the cancer has spread locally. This is used for more advanced tumors that extend beyond the tongue itself but are still surgically removable. Reconstruction is almost always required, and recovery involves intensive speech and swallowing rehabilitation.

- **Subtotal Glossectomy –** removes most of the tongue but leaves a small portion behind, usually at the base or one side. This is used for very advanced tongue cancers where preserving even a small amount of tongue tissue may help with swallowing or airway protection. Reconstruction is complex, and long-term speech and swallowing changes are common.

- **Total Glossectomy –** removes the entire tongue. This is reserved for very advanced or recurrent cancers when no tongue tissue can be safely preserved. Because the tongue plays a critical role in speech and swallowing, patients typically require major reconstruction and often a permanent feeding tube. Speech is significantly altered, but communication is still possible through therapy and assistive methods

- **Base-of-tongue Glossectomy (posterior tongue surgery) –** removes tumors located in the back part of the tongue, often accessed through the mouth using specialized tools or robotic surgery. The goal is to remove the tumor while avoiding large external incisions. Swallowing changes may occur, but recovery is often faster than with open approaches.

Each type of glossectomy balances cancer control with preservation of speech, swallowing, and quality of life. The more tongue tissue that must be removed, the greater the need for reconstruction, rehabilitation, and long-term adaptation.

When it's used:

- Partial - for small, localized Stage I-II tumors confined to the oral tongue
- Hemi - larger tumors involving one side of the tongue that have not crossed the midline
- Subtotal - large Stage III-IV tumors involving more than half the tongue
- Total - advanced tumors involving the full extent of the tongue including the base
- Total with laryngectomy - most advanced cases where the tumor has extended into the larynx

Hospital stay after a glossectomy varies based on how much of the tongue is removed and whether reconstruction is required. For partial or hemiglossectomies without major reconstruction, hospitalization is often 3-5 days, while more extensive procedures such as extended, subtotal, or total glossectomies - especially those involving free-flap reconstruction - typically require 7-10 days or longer. Early in the hospital stay, care focuses on airway safety, pain control, wound monitoring, and swallowing assessment. Some patients may have a temporary feeding tube or tracheostomy, which are managed closely until swelling decreases and swallowing or breathing is deemed safe. Gentle sitting, standing, and short walks usually begin within the first 1-2 days to reduce the risk of blood clots and support overall recovery.

During the first two weeks after discharge, activity should remain very light. Walking short distances several times per day is encouraged, but fatigue is common and rest periods are essential. Lifting more than 10 pounds, straining, bending forward repeatedly, or holding the breath during movement should be avoided to prevent pressure in the neck and surgical site. High-impact activities, resistance training, and any exercise that causes neck tension or jaw clenching are contraindicated. Attention is often directed toward posture, gentle neck range of motion within comfort limits, and relaxed breathing, particularly if a neck dissection or reconstruction was per-formed.

From weeks 2-6, walking duration can gradually increase as stamina improves, often progressing to twenty to thirty minutes per day if tolerated. Light mobility exercises for the shoulders, upper back, and neck may be introduced carefully to prevent stiffness, especially in patients who have had neck surgery. Resistance training, if introduced at all, should be limited to very light upper- and lower-body movements using bands or body weight, with strict avoidance of heavy loads, overhead straining, or breath holding. Jaw, tongue, and swallowing rehabilitation typically continues during this phase and often dictates overall energy levels.

Between 6-12 weeks after surgery, most individuals can begin a gradual return to more structured exercise if healing is uncomplicated and there are no airway, wound, or swallowing concerns. Low-impact cardiovascular activities such as brisk walking or stationary cycling with an upright posture can be added cautiously. Strength training may progress slowly using light to moderate resistance, emphasizing controlled movement, proper breathing, and avoidance of neck strain. Core exercise should be gentle and non-straining. Throughout this period, any increase in neck swelling, pain, difficulty breathing or swallowing, voice changes, or wound issues should prompt immediate reduction in activity and reassessment by the medical team before further progression.

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Potential Side-effects of all Glossectomies:

- Changes in speech clarity, volume, or articulation
- Difficulty swallowing (dysphagia), especially with solid foods
- Increased risk of choking or aspiration, particularly early in recovery
- Loss or reduction of taste sensation
- Numbness or altered sensation of the tongue or mouth
- Excess saliva or difficulty controlling saliva
- Dry mouth, especially if radiation therapy is also required
- Tongue swelling during early healing
- Pain or soreness in the mouth, jaw, or throat
- Limited tongue mobility affecting eating and speaking
- Fatigue related to surgery and recovery
- Weight loss due to eating difficulties
- Temporary or permanent feeding tube dependence in more extensive resections
- Changes in bite alignment or chewing mechanics
- Scarring or tightness in the mouth or floor of mouth complications
- Bleeding during or after surgery
- Changes in voice quality (muffled or slurred speech)
- Jaw stiffness or reduced mouth opening (trismus)
- Need for prolonged speech and swallowing therapy

Mandibulectomy – refers to surgery that removes part or all of the lower jaw when oral cavity cancer involves or is firmly attached to the mandible. The extent of surgery depends on how deeply the tumor has invaded the bone and surrounding tissues.

- **Marginal Mandibulectomy –** removes only the outer portion of the jawbone while preserving the continuity of the jaw; this is used when cancer is close to the bone or lightly erodes its surface but has not invaded deeply. Because the jaw remains intact, chewing mechanics are often preserved, and reconstruction may be minimal or unnecessary.

- **Segmental Mandibulectomy –** removes a full section of the jawbone, creating a gap that disrupts jaw continuity. This is required when cancer has invaded deeply into the bone or spread along it. Segmental resections almost always require reconstruction using bone and soft tissue from another part of the body to restore jaw shape, bite alignment, and facial structure.

- **Total Mandibulectomy –** in rare cases of very advanced disease, a total mandibulectomy may be performed, removing most or all of the lower jaw; this is reserved for extensive or recurrent cancers and requires complex reconstruction and long-term rehabilitation.

When it's used:

- Marginal **–** is used when the tumor is adjacent to but has not invaded the mandible bone itself

- Segmental **–** is used when the tumor has directly invaded the mandible

- Total **–** is used when the tumor involves the entire mandible. Reserved for the most advanced cases requiring complete jaw removal.

Hospital stay depends on the extent of surgery and whether reconstruction is required. After a marginal mandibulectomy without major reconstruction, hospitalization is often 5-7 days. Segmental or total mandibulectomy with free-flap reconstruction typically requires 7-10 days or longer, with close monitoring of the reconstructed tissue, airway, and swallowing vv safety. Early in the hospital stay, care focused on airway protection, pain control, wound and flap monitoring, and initiation of gentle movement. Sitting up and short walks usually begin within the firs 1-2 days to support circulation and reduce complications. Feeding tubes and temporary tracheostomies are common in more extensive cases.

During the first two weeks after discharge, activity should be limited to gentle walking and light daily movement. Lifting more than ten pounds, bending, straining, or any activity that increases pressure in the neck or face should be avoided. Exercises that involve jaw clenching, forceful breathing, or upper-body straining are contraindicated.

Attention should be given to posture and gentle shoulder and neck movement within comfort limits, particularly if neck surgery was performed. Fatigue is common, and rest periods are essential.

From weeks 2-6, walking duration can increase gradually as stamina improves. Light mobility work for the shoulders, upper back, and neck may be added carefully to prevent stiffness. Resistance training, if introduced, should be very light and avoid breath holding, overhead straining, or heavy gripping that could increase facial or neck tension.

High-impact activities, contact sports, and cycling that places pressure through the jaw or neck should be avoided. Jaw mobility and speech or swallowing therapy often continue during this phase and may limit overall exercise intensity.

Between 6-12 weeks after surgery, most individuals can begin a cautious return to more structured exercise if healing is uncomplicated and reconstruction is stable. Low-impact cardiovascular activity such as brisk walking or up right stationary cycling may be added gradually. Strength training can progress slowly with light to moderate resistance, emphasizing controlled movements, proper breathing, and avoidance of neck or jaw strain. Core exercise should be gentle and non-straining. Any increase in facial swelling, pain, numbness, bite changes, wound issues, or difficulty breathing or swallowing should prompt immediate reduction in activity and reassessment by the medical team before further progression.

Potential Side-effects of all Mandibulectomies:

- Significant facial swelling and pain early in recovery
- Numbness or altered sensation of the lower lip, chin, or jaw due to nerve involvement
- Difficulty chewing and speaking, and changes in bite alignment
- Jaw stiffness and limited mouth opening are common, particularly when muscles of chewing are affected
- Tooth loss may occur, and dental rehabilitation is often needed
- Infection, bleeding, or wound-healing complications can occur, especially when reconstruction is performed
- Patients may experience shoulder or neck stiffness if a neck dissection is done at the same time
- Long-term effects can include facial asymmetry, chronic tightness, fatigue, changes in appearance
- Emotional or psychological distress related to altered facial structure and function

Maxillectomy – refers to surgery that removes part or all of the upper jaw (maxilla) to treat cancers of the hard palate, upper gum, nasal cavity floor, or adjacent structures. The extent of surgery depends on how far the tumor has spread.

- **Partial Maxillectomy –** removes a limited portion of the upper jaw or hard palate while preserving surrounding structures; this is used when the tumor is small and confined

- **Subtotal Maxillectomy –** removes a larger section of the maxilla, often including part of the hard palate or upper gum, and may create an opening between the mouth and nasal cavity that requires reconstruction or a prosthetic device called an obturator

- **Total Maxillectomy –** removes most or all of the upper jaw on one side and is reserved for more advanced tumors; this often requires complex reconstruction using tissue from another part of the body to restore facial shape and separate the oral and nasal cavities

- **Extended Maxillectomy –** is performed when cancer involves nearby areas such as the orbit, nasal cavity, or cheek, combining maxillary removal with adjacent soft tissue or bone resection

When it's used:

- Partial – is used when the tumor is small, well-defined, and confined to a limited area of the upper jaw or hard palate

- Subtotal – is used when the tumor is larger or involves more of the maxilla, hard palate, or upper gum, but has not yet spread extensively to adjacent regions

- Total – is reserved for advanced tumors that affect most or all of one side of the upper jaw, where complete removal is necessary for adequate cancer control

- Extended – is used when the cancer has spread beyond the maxilla itself into neighboring structures- such as the eye socket (orbit), nasal cavity, or cheek - requiring removal of both the maxilla and portions of those adjacent tissues or bones

Hospital stay varies based on the extent of surgery and whether reconstruction is performed. Partial maxillectomies without major reconstruction typically require 4-6 days in the hospital, while subtotal or total maxillectomies with free-flap reconstruction often require 7-10 days or longer. Early hospital care focuses on airway safety, pain control, wound or flap monitoring, and assessment of swallowing and speech. Some patients use a temporary feeding tube, and those with obturators receive early fitting and instruction. Gentle sitting, standing, and short walks usually begin within the first one to two days to reduce complications and support recovery.

During the first two weeks after discharge, activity should be limited to gentle walking and light daily movement. Lifting more than 10 pounds, bending, straining, or any activity that increases pressure in the face or sinuses should be avoided to reduce bleeding and swelling. High-impact exercise, resistance training, and movements that involve breath holding or forceful exertion are contraindicated. Exercises that risk facial impact or vibration should be avoided. Fatigue and facial swelling are common, so rest periods are important.

From weeks 2-6, walking duration can gradually increase as stamina improves. Light mobility exercises for the shoulders, upper back, and neck may be introduced carefully, especially if a neck dissection was performed. Resistance training, if started, should be very light and avoid breath holding, overhead straining, or movements that increase facial pressure. Cycling, running, contact sports, and activities that cause sinus pressure should continue to be avoided. Speech and swallowing therapy or obturator adjustments often continue during this phase and may influence overall exercise tolerance.

Between 6-12 weeks after surgery, most individuals can begin a cautious return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling can be introduced gradually. Strength training may progress slowly using light to moderate resistance with careful attention to breathing and posture. Activities that risk facial trauma, heavy lifting, or high-impact movement should still be avoided until cleared by the surgical team. Any increase in facial swelling, pain, nasal leakage, bleeding, vision changes, or difficulty breathing or swallowing should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects of all Maxillectomies:

- Facial swelling and pain during early recovery
- Changes in facial appearance or symmetry
- Numbness or altered sensation of the cheek, upper lip, or nose
- Difficulty chewing and swallowing
- Speech changes due to altered oral or nasal airflow
- Nasal regurgitation of food or liquids
- Dry mouth
- Sinus congestion or chronic sinus infections
- Bleeding or infection
- Wound-healing complications
- Jaw stiffness
- Tooth loss or dental alignment changes
- Fatigue
- Emotional or psychological distress related to appearance or function
- Need for an obturator or complex reconstruction

Laryngectomy – refers to surgery to remove part or all of the larynx (voice box) to treat cancers of the larynx or nearby structures when organ-preserving treatments are not appropriate. The extent of surgery depends on tumor size, location, and spread.

- **Partial Laryngectomy –** removes only the cancer-affected portion of the larynx while preserving some voice and normal breathing through the mouth and nose; examples include supraglottic laryngectomy, which removes structures above the vocal cords, and vertical or hemilaryngectomy, which removes one side of the larynx. These procedures are used for selected early or intermediate cancers when safe margins can be achieved and laryngeal function can be preserved.

- **Total Laryngectomy –** removes the entire larynx and permanently separates the airway from the mouth and nose, creating a permanent opening in the neck called a stoma for breathing. This is used for advanced cancers, recurrent disease after radiation or chemotherapy, or tumors that extensively impair vocal cord movement.

- **Extended Laryngectomy –** refers to removal of the larynx plus nearby structures such as part of the pharynx, tongue base, or thyroid gland when cancer has spread locally.

When it's used:

- Partial **–** is used when the tumor is small and confined to one area of the larynx, and enough healthy tissue can be preserved to maintain some degree of normal breathing, swallowing, and voice. The patient must have adequate lung function to handle the risk of aspiration during recovery.

- Total **–** is used when the tumor is too large or centrally located to allow partial removal with clear margins, when the cancer has recurred after radiation or chemoradiation, or when the patient does not have sufficient lung reserve to safely undergo a partial procedure

- Extended **–** is used when the cancer has spread beyond the larynx into neighboring structures such as the pharynx, esophagus, thyroid gland, or trachea, requiring removal of those structures alongside the larynx to achieve clear margins. This often requires complex reconstruction of the swallowing passage.

Hospital stay varies by procedure. Partial laryngectomies typically require 5-7 days in the hospital, while total or extended laryngectomies often require 7-10 days or longer, especially if reconstruction is performed. Early care focuses on airway protection, wound healing, and swallowing safety.

Many patients require a temporary feeding tube, and those with total laryngectomy receive education on stoma care and alternative speech methods. Gentle movement, sitting up, and short walks usually begin within the first 1-2 days to reduce complications such as blood clots and pneumonia.

During the first two weeks after discharge, activity should be limited to gentle walking and light daily movement. Lifting more than 10 pounds, bending, straining, or holding the breath during exertion should be avoided to protect neck incisions and reconstructed tissues. Activities that increase pressure around the neck or stoma, including heavy resistance exercise, forceful coughing, or swimming, are contraindicated. Attention to upright posture and relaxed breathing through the stoma is important, particularly after total laryngectomy.

From weeks 2-6, walking duration can gradually increase as stamina improves. Light shoulder, upper-back, and neck mobility exercises may be introduced carefully to prevent stiffness, especially if a neck dissection was performed. Resistance training should remain very light and avoid overhead straining, breath holding, or gripping that increases neck tension. Cycling, running, contact sports, and water-based activities should still be avoided due to fall risk, airway exposure, and stoma safety.

Between 6-12 weeks after surgery, most individuals can begin a cautious return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activity such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance, emphasizing controlled movements and steady breathing.

Swimming remains contraindicated after total laryngectomy unless specialized protection and medical clearance are obtained. Any increase in neck swelling, breathing difficulty, stoma irritation, bleeding, or swallowing problems should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects of all Laryngectomies:

- Loss or alteration of voice
- Difficulty speaking or need for alternative speech methods
- Swallowing difficulties
- Neck and shoulder stiffness
- Numbness or altered sensation around the neck
- Fatigue
- Changes in breathing patterns
- Increased mucus production
- Coughing or throat clearing
- Infection or wound-healing complications
- Bleeding
- Dry mouth
- Altered smell or taste
- Emotional or psychological distress related to communication and body image changes
- Risk of aspiration with partial procedures
- Long-term speech and swallowing therapy; risk of cancer recurrence depending on tumor stage and margins.

Types of Treatment Used:

- Chemotherapy/Chemoradiation
- Radiation Therapy
- Targeted Therapy
- Immunotherapy
- Induction (Neoadjuvant) Chemotherapy

Neck Dissection – refers to surgery to remove lymph nodes and surrounding tissue in the neck to treat or prevent the spread of head and neck cancers, including cancers of the oral cavity, throat, larynx, and salivary glands. The type of neck dissection performed depends on how extensive the lymph node involvement is and which structures can be safely preserved.

- **Selective Neck Dissection –** is used when lymph nodes appear clinically negative (not enlarged or suspicious) but the primary tumor carries a significant enough risk of microscopic spread to warrant preventive removal. Also used for early-stage disease where only the nodal groups most likely to be involved based on the tumor's location need to be ad dressed.

- **Modified Radical Neck Dissection –** removes lymph nodes from a wider area but preserves one or more key structures, most often the spinal accessory nerve to reduce shoulder dysfunction.

- **Radical Neck Dissection –** is the most extensive form and removes nearly all lymphatic tissue on one side of the neck along with the spinal accessory nerve, internal jugular vein, and sternocleidomastoid muscle. Bilateral neck dissection may be performed when cancer affects or threatens lymph nodes on both sides of the neck.

When it's used:

- Selective – is used when lymph nodes appear clinically negative (not enlarged or suspicious) but the primary tumor carries a significant enough risk of microscopic spread to warrant preventive removal. Also used for early-stage disease where only the nodal groups most likely to be involved based on the tumor's location need to be addressed.

- Modified Radical – is used when there is confirmed or suspected lymph node involvement but the cancer has not directly invaded the major structures of the neck. Preserving the spinal accessory nerve, internal jugular vein, or sternocleidomastoid muscle is still feasible without compromising cancer clearance.

- Radical – is used when the cancer has directly in vaded or is inseparable from one or more of the major neck structures, making their removal necessary to achieve clear margins. It is reserved for advanced nodal disease where preservation of those structures is not oncologically safe.

Removal of one jugular vein usually causes minimal or no problems, as there are many other veins in the neck through which blood can flow. If a bilateral neck dissection is being performed, the surgeon will try to save at least one jugular vein - simultaneous ligation of both internal jugular veins can result in facial edema, cerebral edema, blindness, and hypoxia (Winters and Hohman, StatPearls, updated March 2026).

The spinal accessory nerve is a cranial nerve that provides motor control of the sternocleidomastoid and trapezius muscles. Removal or damage of this nerve during neck dissection results in denervation of the trapezius muscle, destabilizing the scapula and causing a characteristic shoulder syndrome including shoulder droop, limited shoulder range of motion, muscle wasting in the shoulder muscles, winged scapula, and weakness in shoulder flexion, abduction, and external rotation (Winters and Hohman, StatPearls, updated March 2026).

Removal of the sternocleidomastoid muscle causes the neck to appear sunken and results in reduced coverage of the carotid artery. This reduced carotid protection can become significant in the event of a postoperative infection or wound breakdown, as carotid exposure increases the risk of catastrophic hemorrhage. If both sternocleidomastoid muscles are removed, the patient's ability to flex the head forward will be reduced, as the SCM is the primary flexor of the cervical spine (Winters and Hohman, StatPearls, updated March 2026).

Hospital stay after neck dissection typically ranges from 3-5 days for selective procedures and 5-7 days or longer for modified radical or radical dissections, especially if combined -with tumor resection or reconstruction. Early hospital care focuses on pain control, drain management, and monitoring shoulder and neck movement. Gentle walkling and sitting up-right usually begin within the first 24 hours to support circulation and lung function.

During the first two weeks, activity should be limited to light walking and gentle daily movement. Lifting more than 10 pounds, overhead reaching, forceful pulling, and activities that strain the neck and shoulders should be avoided to protect healing tissues and nerves. Sudden head movements, contact sports, and resistance training are contraindicated during this phase. In patients where the sternocleidomastoid (SCM) muscle has been removed, altered cervical biomechanics and postural asymmetry are present from the outset, and gentle posture awareness,

relaxed breathing, and early physiotherapy referral are essential during this initial period to begin compensatory retraining of the remaining cervical musculature. Where the spinal accessory nerve (SAN) has been stretched, damaged, or sacrificed, physiotherapy should ideally begin before or immediately after surgery - shoulder drop, scapular winging, and weakness in shoulder elevation are expected consequences of trapezius denervation, and early guided movement is critical to prevent the development of frozen shoulder which is a common and functionally devastating complication.

From weeks 2-6, walking duration can gradually increase as stamina improves. Guided range-of-motion exercises for the neck and shoulders are introduced during this phase to prevent progressive stiffness and frozen shoulder. In patients with SAN injury, rehabilitation must specifically target trapezius retraining, scapular stabilization, and compensatory strengthening of the serratus anterior and rhomboids, with neuromuscular electrical stimulation (NMES) considered as an adjunct where available. In patients where the SCM has been removed, cervical mobility exercises and progressive strengthening of the contralateral SCM and deep cervical flexors should be introduced to address postural imbalance and compensate for the permanent structural deficit. Resistance exercises may begin cautiously using very light resistance bands or body weight, with emphasis on scapular stability, symmetry, and controlled movement. Overhead lifting, heavy weights, and high-impact activities should still be avoided, as shoulder weakness and fatigue are particularly pronounced following SAN injury or SCM resection during this period.

Between 6-12 weeks after surgery, most patients can begin a gradual return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activities such as brisk walking or stationary cycling can be added. Strength training may progress slowly using light to moderate resistance, emphasizing proper posture, scapular stability, and avoidance of neck strain. Overhead lifting should be introduced cautiously and only if shoulder control and endurance have adequately recovered (may be significantly delayed in patients with SAN sacrifice or SCM resection), where functional recovery can take 12-24 months and some degree of permanent deficit should be anticipated.

Any increase in neck swelling, shoulder pain, numbness, weakness, or drainage from the surgical site should prompt immediate reduction in activity and evaluation by the medical team.Recovery timelines broadly follow the same progression across all three procedures - gentle mobilization within 24 hours, light activity for the first 2 weeks, graduated range-of-motion and light resistance exercise from weeks 2-6, and a return to more structured program.

Between weeks 6-12, however the duration and complexity of rehabilitation extends considerably further in modified radical and radical neck dissection, with functional recovery taking 12-24 months in cases involving spinal accessory nerve sacrifice or SCM resection, and some degree of permanent deficit anticipated following radical neck dissection.

Potential Side-effects of all Neck Dissections:

- Neck and shoulder pain
- Stiffness and weakness
- Numbness or altered sensation along the neck, ear, or jaw
- Shoulder droop or limited arm elevation due to spinal accessory nerve involvement
- Swelling or fluid accumulation
- Infection or wound-healing problems
- Scarring
- Fatigue
- Limited range of motion
- Headaches
- Difficulty with posture
- Cosmetic changes in the neck
- Emotional distress
- Risk of lymphedema in the face or neck

A tracheotomy and a tracheostomy are closely related airway procedures used to create a direct opening into the windpipe (trachea) through the front of the neck, allowing a person to breathe without using the nose or mouth. The distinction is subtle but important.

- **Tracheotomy –** refers to the surgical act of creating the opening in the trachea
- **Tracheostomy –** refers to the ongoing condition in which that opening is maintained and a tube remains in place to support breathing

When it's used:

- Tracheostomy **–** is used as a permanent airway when the larynx has been completely removed, as there is no longer a natural connection between the upper airway and the lungs.

- Tracheotomy **–** is used as a temporary measure to secure the airway during or after major head and neck surgery when swelling or anatomical changes would otherwise obstruct normal breathing.

In many cancer patients the tracheostomy is temporary, but in cases such as total laryngectomy or permanent airway obstruction, it becomes lifelong.

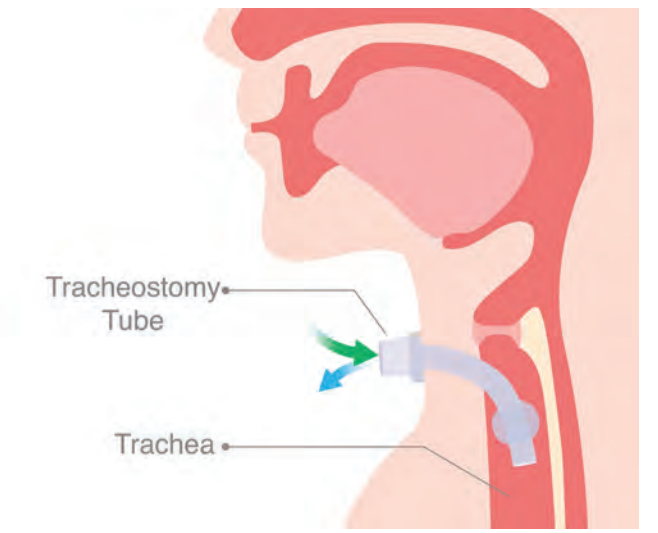
Hospital stay after tracheotomy or tracheostomy typically ranges from 3-7 days, though it may be longer when performed alongside major cancer surgery.

During the first two weeks after discharge, activity should be limited to gentle walking and basic daily movement. The tracheostomy site is still healing, and sudden movements, bending forward repeatedly, lifting more than ten pounds, or straining can increase pressure around the opening and raise the risk of bleeding or tube displacement.

Any exercise that causes heavy breathing, coughing, or neck strain should be avoided. Water exposure is a major concern during this phase; swimming, submerging the head, or showering without proper protection is contraindicated because water entering the tracheostomy can cause serious breathing emergencies. Dusty, smoky, or cold environments should also be avoided, as they can irritate the airway.

From weeks 2-6, walking distance and frequency can increase gradually as endurance improves, provided breathing remains comfortable and secretions are manageable. Gentle mobility exercises for the shoulders, upper back, and neck may be introduced carefully to prevent stiffness, particularly if the tracheostomy was placed during extensive head and neck surgery. Resistance exercise, if introduced, should be very light and avoid breath holding, forceful exertion, or pressure from clothing or equipment near the tracheostomy tube. Activities with a high risk of falls, impact, or tube dislodgement remain inappropriate during this period.

Between 6-12 weeks after the procedure, many individuals can begin a cautious return to more structured exercise if the airway is stable and healing is complete. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance with careful attention to breathing and posture. Swimming and water-based exercise remain contraindicated unless the tracheostomy has been removed or the patient has specialized protective equipment and explicit medical clearance. Throughout this phase, any increase in breathing difficulty, excessive mucus, bleeding, pain, or changes in tube position should prompt immediate reduction in activity and medical evaluation.



Potential Side-effects of Tracheotomy/Tracheostomy:

- Neck pain or soreness
- Bleeding
- Infection at the stoma site
- Swelling or skin breakdown around the opening
- Excess mucus production
- Difficulty clearing secretions
- Coughing
- Shortness of breath
- Changes in voice or inability to speak normally
- Difficulty swallowing
- Aspiration of food or liquids
- Narrowing of the trachea over time
- Accidental tube blockage or displacement
- Altered sense of smell or taste
- Fatigue related to altered breathing mechanics
- Emotional or psychological distress related to communication challenges, body image, and reliance on a visible airway device

Types of Treatment Used:

- External beam radiation therapy
- Intensity-modulated radiation therapy (IMRT)
- Image-guided radiation therapy (IGRT)
- Chemotherapy/Chemoradiation
- Immunotherapy
- Targeted therapy

CANCER OF THE THYROID

In the United States alone, approximately 45,240 new cases of thyroid cancer are expected in 2026, with about 2,320 deaths, and the cancer affects almost three times as many women as men (ACS, Key Statistics for Thyroid Cancer, 2026). Globally, there were approximately 821,173 new cases and 47,485 deaths in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Thyroid cancer is the most common endocrine tumor and one of the most curable forms of cancer. It currently ranks as the 9th most common cancer diagnosis overall and the 5th most common among women, with rising incidence rates historically attributed to increased use of diagnostic imaging and more sensitive detection tools (ACS, Key Statistics for Thyroid Cancer, 2026).

Radiation exposure to the head or neck during childhood is a well-established risk factor, including radiation therapy used to treat cancers such as Hodgkin lymphoma or as part of stem cell transplant preparation. After exposure, the minimum latency period before the appearance of thyroid cancer is approximately 5-10 years, and the risk is greatest when exposure occurs during childhood (Siegel et al., CA: A Cancer Journal for Clinicians, 2026). The most common symptom is a lump in the neck detected during a physical exam. Other symptoms may include a tight or full feeling in the neck, difficulty breathing or swallowing, hoarseness, swollen lymph nodes, and persistent pain in the throat or neck. Additional risk factors include goiter or thyroid nodules, a family history of thyroid cancer, certain genetic conditions such as familial medullary thyroid cancer (FMTC), multiple endocrine neoplasia type 2A (MEN2A), and multiple endocrine neoplasia type 2B (MEN2B), and being of Asian descent (ACS, Thyroid Cancer Risk Factors, 2024).

The prognosis for thyroid cancer is typically excellent, with a five-year relative survival rate of 98.4% overall, 99.9% for localized disease, 98.3% for regional disease, and approximately 57% for distant metastatic disease (NCI, SEER Cancer Stat Facts: Thyroid Cancer, 2024). There are four main classifications of thyroid cancer: papillary, follicular, medullary, and anaplastic. Papillary thyroid cancer accounts for approximately 80-84% of all thyroid cancers; it is slow-growing and highly treatable, even when it has spread to the cervical lymph nodes (ACS, Types of Thyroid Cancer, 2024). Follicular carcinoma is more aggressive than papillary but remains treatable in most cases and is more commonly seen in older adults. Medullary carcinoma arises from the parafollicular C cells, frequently invades the cervical lymph nodes, and often requires total thyroidectomy with extensive lymph node dissection; approximately one in four cases is hereditary (ACS, Types of Thyroid Cancer, 2024). Anaplastic thyroid cancer is the most aggressive form, with an overall five-year survival rate of only approximately 8%; it typically affects people over the age of 60 and is characterized by explosive cell growth and rapid spread (NCI, SEER Cancer Stat Facts: Thyroid Cancer, 2024).

Procedures:

- **Thyroidectomy –** is surgery to remove part or all of the thyroid gland, which sits at the front of the neck and plays a major role in regulating metabolism, energy, heart rate, and temperature. The type of thyroidectomy performed depends on tumor size, cancer type, spread to lymph nodes, risk level, and patient-specific factors.

1. Thyroid Lobectomy (Hemithyroidectomy) – removes one half (one lobe) of the thyroid gland and often the thin connecting tissue between the two lobes (the isthmus). This approach preserves the remaining lobe, which may continue to produce enough thyroid hormone for normal body function, although some patients still require medication. It is commonly used for small, low-risk thyroid cancers confined to one side of the gland, indeterminate nodules that may be cancer, or diagnostic situations where removing the whole thyroid is not initially necessary. Because less tissue is removed, the risks of permanent low calcium levels and long-term voice problems are lower than with more extensive surgery, but some patients may later need a second operation if higher-risk features are found.

When it's used:

- Small, low-risk papillary or follicular thyroid cancers confined to one lobe
- Tumors without clear spread to lymph nodes
- Diagnostic and treatment approach for certain indeterminate nodules that turn out to be cancer

2. Subtotal Thyroidectomy – removes most of the thyroid gland but leaves a small amount of thyroid tissue behind on one or both sides. Historically, this was used more often for benign thyroid disease, but it is now rarely performed for thyroid cancer because leaving thyroid tissue behind can complicate cancer monitoring and increase recurrence risk. As a result, subtotal thyroidectomy is uncommon in modern cancer care and has largely been replaced by total thyroidectomy when extensive removal is needed.

When it's used:

- Early or low-risk thyroid cancer and preservaton of parathyroid function

3. Total Thyroidectomy – removes the entire thyroid gland. Because no thyroid tissue remains, lifelong thyroid hormone replacement is required. This is the most common operation for thyroid cancer worldwide and is used for larger tumors, cancers involving both lobes, aggressive cancer types, most medullary thyroid cancers, recurrent disease, or when radioactive iodine treatment is planned. The surgery requires careful protection of the vocal cord nerves and parathyroid glands. While the risk of temporary voice changes or low calcium levels is higher than with lobectomy, total thyroidectomy allows for more effective cancer treatment, clearer long-term monitoring, and reduced risk of residual disease.

When it's used:

- Larger tumors
- Tumors in both lobes
- Cancers with higher-risk features
- Many cases where postoperative radioactive iodine treatment is planned
- Most medullary thyroid cancers
- Recurrent disease after previous surgery

4. Completion Thyroidectomy – is a second surgery performed after an initial lobectomy to remove the remaining thyroid tissue. This is done when final pathology from the first surgery reveals higher-risk cancer features, cancer in multiple areas, or the need for radioactive iodine therapy. The goal is to convert a partial removal into a complete thyroidectomy to improve cancer control and monitoring. Because scar tissue is present from the first operation, completion surgery can be technically more challenging but is commonly and safely performed when indicated.

When it's used:

- When a patient has already undergone a lobectomy and final pathology reveals higher-risk features
- Cancer in multiple areas
- Need for radioactive iodine treatment

5. Extended Thyroidectomy (Locally Invasive Thyroidectomy) – goes beyond removing the thyroid gland alone and includes removal of nearby structures that have been invaded by cancer, such as part of the windpipe, voice box area, esophagus, or surrounding soft tissues. This approach is used in locally advanced thyroid cancers where complete tumor removal is still possible and beneficial. These surgeries are complex and performed in specialized centers, often alongside airway reconstruction or additional procedures to preserve breathing and swallowing.

When it's used:

- Thyroid cancer has grown into nearby structures such as the windpipe, voice box region, or surrounding soft tissues but can still be surgically removed to achieve local control

6. Minimally Invasive and Remote-access Thyroidectomy – in selected centers and carefully chosen patients, thyroidectomy can be performed using minimally invasive or remote-access techniques designed to reduce visible neck scarring. These approaches may use smaller neck incisions or access routes through the mouth (transoral), armpit, or behind the ear. They are typically limited to small, low-risk tumors without extensive lymph node involvement and require specialized expertise. While cosmetic outcomes can be excellent, these techniques are not suitable for many thyroid cancers and are not widely used for advanced disease.

When it's used:

- For patients with small, low-risk tumors and no significant lymph node involvement

Hospital stay after thyroidectomy is usually short, and the recovery timeline is broadly similar across lobectomy, total thyroidectomy, completion thyroidectomy, and many minimally invasive approaches, with differences mainly driven by whether lymph nodes were removed and how extensive the neck dissection was. Most people go home the same day or after one overnight stay following a lobectomy or uncomplicated total thyroidectomy, while total thyroidectomy with central or lateral neck dissection more commonly requires one to two nights, and extended/invasive resections may require several days. In the hospital, walking is encouraged the day of surgery to reduce clot risk, and the team monitors for neck swelling, voice changes, swallowing discomfort, and low calcium symptoms (more relevant after total/completion thyroidectomy).

In the first 1-2 weeks at home, exercise should be limited to easy walking several times per day and gentle posture work, with strict avoidance of heavy lifting, straining, or breath-holding because these increase neck and upper chest pressure and can worsen swelling or bleeding; a practical lifting limit is to keep loads light (often under 10-15 pounds) and avoid carrying heavy bags, pushing/pulling heavy doors, or intense household tasks. High-impact exercise, contact sports, swimming if there is any open incision concern, and vigorous overhead lifting should be avoided during this early period, and any activity that triggers pulling at the incision, dizziness, tingling around the mouth/hands (possible low calcium), or significant hoarseness should be scaled back.

From weeks 2-6, most people can gradually increase walking to 20-30 minutes as tolerated and add low



intensity cardio such as easy stationary cycling, along with gentle neck and shoulder range-of-motion work to prevent stiffness (especially important if any neck dissection was performed). Light strength training can restart if the incision is healing well, using very low resistance and smooth breathing - no Valsalva, no maximal effort, and no heavy overhead work - focusing on lower body and supported upper-body movements that do not load the neck (machines or seated exercises are often easier early on).

If a lateral neck dissection was performed, shoulder fatigue and reduced arm elevation can persist for weeks, so overhead pressing and heavy pulling should be delayed while scapular control and shoulder range improve.

From weeks 6-12, most individuals can return to a more normal training plan if cleared by the surgical team: low-impact cardio can progress in duration and intensity, resistance training can increase gradually, and overhead lifting can be reintroduced cautiously as long as there is no neck tightness, nerve-related shoulder weakness, or swelling.

Potential Side-effects of all Thyroidectomies:

- Neck pain, tightness, or soreness
- Swelling or bruising at the incision site
- Temporary difficulty swallowing or a sensation of throat fullness
- Hoarseness or voice changes due to irritation or injury of the vocal cord nerves
- Temporary or permanent vocal cord weakness or paralysis
- Low calcium levels (hypocalcemia), causing tingling in the lips, fingers, or toes, muscle cramps, or spasms
- Fatigue, especially during early recovery or while thyroid hormone levels are being adjusted
- Need for lifelong thyroid hormone replacement after total or completion thyroidectomy
- Headache or neck stiffness
- Infection at the surgical site
- Bleeding or hematoma in the neck
- Numbness or altered sensation around the incision or lower jaw
- Cough or throat irritation
- Emotional changes or mood fluctuations related to hormone shifts
- Weight changes during hormone adjustment period
- Long-term risk of osteoporosis

- **Central Neck Dissection (Level VI Lymph Node Removal) –** this removes lymph nodes in the center of the neck near the thyroid, windpipe, and voice nerves. It can be done on one side or both. It may be therapeutic (when nodes are involved) or prophylactic in select high-risk cases.

When it's used:

- Known or strongly suspected spread to central neck nodes
- Medullary thyroid cancer often requires systematic node evaluation
- Certain higher-risk papillary cancers

- **Lateral Neck Dissection (Levels II–V Lymph Node Removal) –** this removes lymph nodes along the side of the neck when thyroid cancer has spread there. It's more extensive than central neck dissection and usually performed only when nodal spread is confirmed.

When it's used:

- Biopsy-proven or clearly suspected lateral neck node metastases
- Recurrent nodal disease

Hospital stay after neck dissection depends on the extent of surgery and whether it is combined with tumor removal or reconstruction. Selective neck dissections typically require a hospital stay of 3-5 days, while modified radical or radical neck dissections often require five to seven days or longer, particularly when multiple drains are used or when swallowing, nerve, or shoulder function needs close monitoring. Early hospital care focuses on pain control, drain management, monitoring for bleeding or infection, and prevention of complications such as shoulder dysfunction and lymphedema. Patients are usually encouraged to sit upright and begin short, assisted walks within the first 24 hours to support circulation and lymphatic flow.

During the first two weeks after discharge, activity should remain light and controlled. Gentle walking is encouraged several times per day, but lifting more than 10 pounds, overhead reaching, forceful pulling or pushing, sudden head movements, and activities that strain the neck or shoulders should be avoided. Because lymph nodes and lymphatic vessels have been removed, there is a risk of head, neck, and facial lymphedema, which may present as swelling, tightness, or heaviness. Upper extremity lymphatic drainage exercises should be introduced early to support lymph flow. Direct pressure, aggressive massage, or tight clothing around the neck should be avoided.

From weeks 2-6, walking duration can gradually increase to 15-30 minutes as endurance improves. Guided lymphatic drainage techniques and postural exercises become increasingly important during this phase to reduce swelling and prevent tissue fibrosis. Gentle, pain-free shoulder and neck mobility exercises are emphasized to reduce stiffness and protect shoulder function, particularly if the spinal accessory nerve was affected. Light resistance exercises using bands or very light weights may be added cautiously for the lower body and supported upper-body movements, but overhead lifting, heavy resistance, and high-impact activities remain contraindicated due to ongoing nerve vulnerability and lymphedema risk.

Between 6-12 weeks after surgery, most individuals can progress toward more structured exercise if healing is stable and swelling is well controlled. Low-impact cardiovascular activities such as brisk walking or stationary cycling are generally appropriate and help promote lymph circulation. Strength training can advance gradually using light to moderate resistance, with careful attention to posture,scapular stability, and balanced muscle activation. Overhead lifting -should only be introduced once shoulder strength and control have improved and should remain low load with slow progression.

Potential Side-effects of Neck Dissections:

- Neck pain and stiffness
- Numbness and tingling
- Swelling
- Shoulder weakness or limited arm movement
- Voice changes
- Swallowing difficulties
- Possible permanent nerve damage

- **Tracheal or Laryngeal "shave" Resection and Airway Reconstruction –** these are advanced surgical techniques used when thyroid cancer extends beyond the thyroid gland and invades nearby airway structures, such as the trachea (windpipe) or the larynx (voice box). In some cases, the cancer involves only the outer surface of these structures. When this happens, surgeons may perform a "shave" resection, carefully peeling the tumor off the outer wall of the trachea or larynx without fully entering the airway. This approach aims to remove all visible cancer while preserving the integrity of the airway, voice, and swallowing function as much as possible.

  When cancer penetrates deeper into the airway wall, a more extensive procedure may be required. This can involve removing a segment of the trachea or part of the larynx that contains the tumor, followed by reconstruction to restore a stable airway. Tracheal reconstruction may include reconnecting the remaining ends of the windpipe, while laryngeal reconstruction may involve reshaping or reinforcing the voice box to preserve breathing and swallowing. These procedures are often performed alongside total thyroidectomy and lymph node removal and require meticulous surgical planning due to the critical nerves and blood vessels in the area.

  Airway reconstruction surgeries are typically reserved for patients whose disease is still potentially controllable with surgery and who do not have widespread metastatic spread.

  When it's used:

  - When the tumor has grown beyond the thyroid gland and is directly involving the windpipe or voice box area but remains potentially controllable with surgery

  - When imaging or intraoperative findings show superficial or limited invasion of the trachea or larynx that can be completely removed while preserving or reconstructing a safe airway

  - When the primary goal is to prevent or relieve airway obstruction, reduce local tumor burden, and improve breathing and swallowing

Hospital stay following tracheal or laryngeal shave resection or airway reconstruction is typically longer than for standard thyroid surgery and often ranges from 5-10 days, depending on the extent of airway involvement and reconstruction. Patients may require temporary airway support, close monitoring for swelling or breathing difficulty, and careful assessment of voice and swallowing function. Early mobilization begins in the hospital with short, assisted walks to support circulation and lung function, while the surgical team monitors the airway and healing closely.

During the first two weeks after discharge, activity should be limited to gentle walking and light daily movement. Any activity that increases pressure in the chest or neck, such as lifting more than 10 pounds, straining, bending forward repeatedly, or holding the breath during effort, should be strictly avoided to protect the airway repair. Exercises that involve neck strain, forceful coughing, or rapid head movements are contraindicated. Voice rest or limited voice use may be recommended depending on the extent of laryngeal involvement, and fatigue is common during this early phase.

From weeks 2-6, walking can gradually increase in duration and frequency as stamina improves, provided there is no shortness of breath, neck swelling, or airway discomfort. Gentle shoulder and upper-back mobility may be introduced carefully to prevent stiffness, but neck range-of-motion should remain conservative and pain-free. Resistance training, if introduced, should be very light and avoid upper-body straining, overhead lifting, or breath holding. Any sensation of airway tightness, dizziness, voice changes, or swallowing difficulty should prompt immediate reduction in activity.

Between 6-12 weeks after surgery, many individuals can begin a cautious return to more structured exercise if healing is stable and airway function has normalized. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance, with strict attention to breathing technique and avoidance of neck compression or Valsalva maneuvers. High-impact activities, contact sports, and heavy lifting remain contraindicated until cleared by the surgical team.

Potential Side-effects of Tracheal or Laryngeal "Shave" Resection and Airway Reconstruction:

- Hoarseness or voice changes
- Difficulty swallowing
- Aspiration
- Cough or throat clearing
- Airway swelling or narrowing
- Airway weakness -
- Need for temporary tracheostomy
- Vocal cord weakness or paralysis
- Air leak or fistula
- Infection

A tracheotomy and a tracheostomy are closely related airway procedures used to create a direct opening into the windpipe (trachea) through the front of the neck, allowing a person to breathe without using the nose or mouth. The distinction is subtle but important.

- **Tracheotomy –** refers to the surgical act of creating the opening in the trachea
- **Tracheostomy –** refers to the ongoing condition in which that opening is maintained and a tube remains in place to support breathing

When it's used:

- Tracheostomy **–** is used as a permanent airway when the larynx has been completely removed, as there is no longer a natural connection between the upper airway and the lungs.
- Tracheotomy **–** is used as a temporary measure to secure the airway during or after major head and neck surgery when swelling or anatomical changes would otherwise obstruct normal breathing.

In many cancer patients the tracheostomy is temporary, but in cases such as total laryngectomy or permanent airway obstruction, it becomes lifelong.

Hospital stay after tracheotomy or tracheostomy typically ranges from 3-7 days, though it may be longer when performed alongside major cancer surgery.

During the first two weeks after discharge, activity should be limited to gentle walking and basic daily movement. The tracheostomy site is still healing, and sudden movements, bending forward repeatedly, lifting more than ten pounds, or straining can increase pressure around the opening and raise the risk of bleeding or tube displacement.

Any exercise that causes heavy breathing, coughing, or neck strain should be avoided. Water exposure is a major concern during this phase; swimming, submerging the head, or showering without proper protection is contraindicated because water entering the tracheostomy can cause serious breathing emergencies. Dusty, smoky, or cold environments should also be avoided, as they can irritate the airway.

From weeks 2-6, walking distance and frequency can increase gradually as endurance improves, provided breathing remains comfortable and secretions are manageable. Gentle mobility exercises for the shoulders, upper back, and neck may be introduced carefully to prevent stiffness, particularly if the tracheostomy was placed during extensive head and neck surgery. Resistance exercise, if introduced, should be very light and avoid breath holding, forceful exertion, or pressure from clothing or equipment near the tracheostomy tube. Activities with a high risk of falls, impact, or tube dislodgement remain inappropriate during this period.

Between 6-12 weeks after the procedure, many individuals can begin a cautious return to more structured exercise if the airway is stable and healing is complete. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance with careful attention to breathing and posture. Swimming and water-based exercise remain contraindicated unless the tracheostomy has been removed or the patient has specialized protective equipment and explicit medical clearance. Throughout this phase, any increase in breathing difficulty, excessive mucus, bleeding, pain, or changes in tube position should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects of Tracheotomy/Tracheostomy:

- Neck pain or soreness
- Bleeding
- Infection at the stoma site
- Swelling or skin breakdown around the opening
- Excess mucus production
- Difficulty clearing secretions
- Coughing
- Shortness of breath
- Changes in voice or inability to speak normally
- Difficulty swallowing
- Aspiration of food or liquids
- Narrowing of the trachea over time
- Accidental tube blockage or displacement
- Altered sense of smell or taste
- Fatigue related to altered breathing mechanics
- Emotional or psychological distress related to communication challenges, body image, and reliance on a visible airway device

Hormone Treatment After a Total Thyroidectomy – the body can no longer produce thyroid hormones, making lifelong thyroid hormone replacement therapy essential. These hormones regulate metabolism, cardiovascular function, thermoregulation, neuromuscular activity, bone health, and cognitive function. Without replacement, patients will develop hypothyroidism, which can significantly impair quality of life and, in severe cases, become life-threatening (ATA, Hypothyroidism, 2024).

- **Levothyroxine (T4) –** is the most commonly prescribed and evidence-based treatment following thyroidectomy. T4 is a prohormone that the body converts into the active hormone T3 at the tissue level based on metabolic demand, allowing for relatively stable blood levels and once-daily dosing. In patients treated for thyroid cancer, levothyroxine dosing may be intentionally higher to suppress thyroid-stimulating hormone (TSH), reducing the risk of cancer recurrence. Dose adjustments are individualized based on age, weight, cardiovascular health, bone density, pregnancy status, and cancer history (Ryu, Choi, Park, et al., Endocrinology and Metabolism, 2024; Kim et al., Endocrinology and Metabolism, 2024).

- **Liothyronine (T3) –** provides the active thyroid hormone directly and acts more rapidly than T4. It is sometimes used short-term - for example, when preparing for radioactive iodine therapy - or as adjunct therapy in patients who continue to experience symptoms despite adequate T4 levels. Because T3 has a shorter half-life and can cause rapid hormone fluctuations, it requires careful dosing and is not typically used alone for long-term replacement except in specific clinical scenarios (ATA, Combination T4 and T3 Therapy, 2024).

- **Combination Therapy (T4 + T3) –** some patients benefit from combination therapy using both levothyroxine (T4) and liothyronine (T3). This approach attempts to more closely mimic normal thyroid physiology, particularly in individuals who have impaired peripheral conversion of T4 to T3. While not first-line therapy, combination treatment may be considered for patients with persistent fatigue, cognitive symptoms, or mood disturbances despite normalized lab values. This approach requires close monitoring due to potential cardiovascular and bone health risks (Cappelli et al., Thyroid, 2024).

- **Desiccated Thyroid Extract (Natural Thyroid Hormone) –** is derived from porcine thyroid glands and contains both T4 and T3 in a fixed ratio. While some patients report symptomatic improvement, DTE is less standardized, may result in supraphysiologic T3 levels, and is generally not recommended for thyroid cancer survivors due to difficulty achieving precise TSH suppression. Its use remains controversial and is typically reserved for carefully selected patients under specialist supervision (ATA, Hypothyroidism, 2024).

Special Considerations: Cancer, Aging, Bone & Heart Health

Hormone dosing after thyroidectomy must account for long-term risks, including atrial fibrillation, osteoporosis, muscle loss, and metabolic changes - especially in postmenopausal women and older adults. In thyroid cancer survivors, TSH suppression strategies evolve over time as recurrence risk decreases. Regular monitoring of TSH, Free T4, Free T3, bone density, and cardiovascular markers is essential to avoid overtreatment or undertreatment (Rossi et al., Frontiers in Endocrinology, 2025); Vidal-Trecan et al., Frontiers in Endocrinology, 2025).

Hypothyroidism after Thyroidectomy

Following a total thyroidectomy, hypothyroidism is inevitable because the body no longer produces thyroid hormones essential for metabolic regulation. Untreated or inadequately treated hypothyroidism can lead to profound fatigue, weight gain, cold intolerance, bradycardia, constipation, depression, cognitive slowing, dyslipidemia, and reduced exercise tolerance. Over time, chronic hypothyroidism increases the risk of cardiovascular disease, sarcopenia, insulin resistance, and impaired bone remodeling. In cancer survivors, uncontrolled hypothyroidism may also interfere with recovery, functional capacity, and quality of life. Early initiation of appropriate thyroid hormone replacement and ongoing dose titration - guided by TSH, free T4, symptoms, and clinical context - is critical to prevent systemic deconditioning and long-term complications (Rossi et al., Frontiers in Endocrinology, 2025).

Hyperthyroidism after Thyroidectomy

Although the thyroid gland has been removed, hyperthyroidism can occur after thyroidectomy due to excessive thyroid hormone replacement, most commonly from overtreatment with levothyroxine or combination therapy. Iatrogenic hyperthyroidism accelerates metabolic rate and places significant stress on the cardiovascular, skeletal, and neuromuscular systems. Common symptoms include palpitations, tachycardia, anxiety, heat intolerance, unintended weight loss, insomnia, tremor, muscle weakness, and reduced exercise recovery. Over time, chronic thyroid hormone excess increases the risk of atrial fibrillation, myocardial strain, osteoporosis, and fracture, particularly in postmenopausal women and older adults (Vidal-Trecan et al., Frontiers in Endocrinology, 2025; Rossi et al., Frontiers in Endocrinology, 2025)). In thyroid cancer survivors, TSH suppression may be intentionally used to reduce recurrence risk, but must be carefully balanced against long-term cardiovascular and bone health risks through individualized dosing and regular monitoring (Ryu et al., Endocrinology and Metabolism, 2024).



CANCER OF THE LARNYX

There were 189,191 new cases and approximately 103,359 deaths from laryngeal cancer worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Fortunately, no additional treatment beyond the initial biopsy may be required for carcinoma in situ of the larynx. A laser may be used to eradicate affected areas of the organ's lining. Early-stage tumors can be treated with radiation alone or in conjunction with surgical procedures to remove part of the larynx, with local control rates of 80-95% for locally isolated disease (NCCN, Head and Neck Cancers, Version 1.2025). Laryngeal cancer is distinct in that a person may have no secondary lesion or malignant lymph nodes yet still be classified as stage IV if the tumor has encroached upon the throat or soft tissue of the neck. Supraglottic cancer is the most likely subsite to involve the lymph nodes, and 25–50% of these patients will have node-positive disease at presentation (ACS, Laryngeal and Hypopharyngeal Cancer Risk Factors, 2024).

People with laryngeal cancer face a substantial risk of developing a secondary cancer of the head, neck, or esophagus, particularly if they continue to smoke and drink. Tobacco use is the most important risk factor for laryngeal and hypopharyngeal cancers, accounting for more than 70% of all laryngeal cancer cases, and the risk is significantly higher in smokers than in nonsmokers (Koroulakis and Agarwal, StatPearls, 2024). Smoke from cigarettes, pipes, and cigars all increase the risk. Moderate or heavy alcohol use further increases risk, and people who both smoke and drink are many times more likely to develop these cancers than those who do neither. Additional risk factors include human papillomavirus (HPV) infection, poor diet, obesity, and occupational exposures to carcinogenic substances such as asbestos, nickel fumes, sulfuric acid mist, and wood dust (Koroulakis and Agarwal, StatPearls, 2024).

Cancers of the larynx and hypopharynx are 4-5 times more common in men than in women, and because they develop over many years they are not common in young people, though an increasing incidence has been observed among female and younger populations in recent surveillance data (ACS, Laryngeal and Hypopharyngeal Cancer Risk Factors, 2024). More than half of patients with these cancers are 65 or older at the time of diagnosis, and laryngeal cancer is more common among African Americans and white individuals than among Asian Americans and Latinos (ACS, Laryngeal and Hypopharyngeal Cancer Risk Factors, 2024).

Symptoms depend on the size and location of the tumor. Since most tumors begin in the vocal cords, they almost always cause hoarseness or other changes in the voice. Tumors in the area above the vocal cords may cause a lump in the throat, difficult or painful swallowing, a persistent cough, a sore throat, or an earache. Tumors arising below the vocal cords, which are rare, can cause shortness of breath or harsh noisy breathing. Large tumors may cause swollen neck glands, pain, weight loss, bad breath, and frequent choking on food. Hoarseness lasting more than three weeks should be evaluated by a physician.

Procedures:

- **Cordectomy –** a surgical procedure involving removal of part or all of a true vocal cord, most commonly performed using transoral laser microsurgery with a CO_2 laser. The extent of tissue removed varies according to tumor depth and spread, ranging from superficial excision of the epithelium to complete removal of the vocal fold and, in extended cases, adjacent structures. The aim of cordectomy is to achieve complete oncologic resection while preserving as much laryngeal structure and function as possible, particularly voice and swallowing, and it represents a key larynx-preserving surgical option in modern practice.

When it's used:

- Early-stage glottic laryngeal cancer
- Disease is confined to the vocal cord and there is no cartilage invasion or extralaryngeal spread
- Recurrent (localized) early glottic cancer following radiotherapy
- High-grade dysplasia when definitive excision is required

After a cordectomy, the hospital stay is usually short, reflecting the minimally invasive nature of the procedure. Most patients are admitted for same-day surgery or remain in hospital for 1-2 nights.
The primary focuses during this period are airway observation, pain control, and monitoring for bleeding or laryngeal oedema. A tracheostomy is rarely required. Swallowing is typically preserved, and many patients are able to resume oral intake within the first 24 hours, although mild throat discomfort and odynophagia are common. Voice rest is often advised initially, and patients are reviewed by speech and language therapy to receive guidance on voice protection and recovery.

During the first month after discharge, recovery centers on mucosal healing and gradual return of vocal function. Hoarseness is expected and may be pronounced in the early weeks, particularly after deeper cordectomies. Patients are advised to limit voice use, avoid shouting or prolonged speaking, and maintain good hydration to support healing. Fatigue is usually mild, and most individuals can resume light daily activities within days. Follow-up endoscopy is commonly performed during this period to assess healing and exclude early recurrence.

Anxiety related to voice change and cancer surveillance is common, and reassurance and education are important aspects of care.

Between 1-3 months postoperatively, voice quality typically continues to improve, although it may not return to baseline and depends on the extent of resection. Speech and language therapy plays a central role during this phase, focusing on optimizing voice efficiency and reducing compensatory strain. Swallowing is usually normal, and dietary restrictions are uncommon. Most patients have returned to work and normal routines by this stage, although professional voice users may require longer rehabilitation and adjustment.

Exercise is encouraged after cordectomy, with early mobilization such as walking recommended from the first postoperative day. Gentle general aerobic activity can be resumed quickly as tolerated. Patients should avoid activities that involve forceful breath holding, heavy lifting, or significant straining for the first one to two weeks, as these can increase laryngeal pressure and risk bleeding. High-impact exercise and strenuous upper-body workouts are usually deferred for 2-3 weeks. Voice-related exercise is guided by speech and language therapy, and patients are advised not to attempt vocal strengthening or projection exercises independently in the early recovery period.

Contraindications during recovery include smoking and exposure to irritants such as smoke or dust, which impair mucosal healing and increase recurrence risk. Alcohol excess should be avoided, particularly in the early weeks. Whispering is discouraged, as it can strain the healing vocal fold. Patients are advised to seek urgent medical review if they experience increasing breathlessness, significant bleeding, or sudden deterioration in voice or swallowing.

Potential Side-effects of Cordectomy :

- Bleeding
- Laryngeal swelling
- Throat clearing
- Coughing
- Increased mucus production
- Mild to severe hoarseness (may be permanent in extended cordectomies)
- Vocal fatigue and reduced vocal endurance
- Temporary throat pain and discomfort swallowing
- Mild dysphagia
- Aspiration (uncommon)

- **Total Laryngectomy –** involves complete surgical removal of the larynx, resulting in permanent separation of the airway from the upper aerodigestive tract. Breathing occurs through a permanent tracheostoma, and natural voice production is lost, requiring alaryngeal speech rehabilitation such as tracheoesophageal puncture or an electrolarynx. Total laryngectomy is most commonly performed as salvage surgery following failed organ-preservation treatment, rather than as a primary modality. It remains the most oncologically definitive option, particularly in advanced disease, but carries significant functional, psychological, and quality-of-life consequences.

When it's used:

Advanced laryngeal tumors with:

- Thyroid or cricoid cartilage destruction
- Extralaryngeal soft tissue extension
- Persistent or recurrent disease after radiotherapy or chemoradiotherapy
- Non-functional larynx with severe aspiration or airway compromise
- Extensive transglottic tumors not suitable for conservation surgery

- **Transoral Laser Microsurgery (TLM) –** is the most common surgical treatment for early-stage laryngeal cancer and represents the dominant larynx-preserving surgical technique worldwide. It involves transoral excision of the tumor using a CO_2 laser under microscopic visualization, allowing highly precise resection while preserving uninvolved laryngeal structures. TLM offers excellent oncologic control comparable to radiotherapy, often with superior voice outcomes, short hospital stays, and minimal morbidity. Importantly, it can be repeated for local recurrence, preserving future treatment options.

  When it's used:
  - Carcinoma in situ
  - Earlier stage glottic cancers
  - Selected early supraglottic tumors with good endoscopic exposure
  - Mobile vocal cords without deep muscle or cartilage invasion
  - Patients in whom radiotherapy is to be avoided or preserved for salvage

- **Transoral Supraglottic Laryngectomy (Laser or Robotic) –** is a moderately common procedure for selected supraglottic cancers. It removes supraglottic structures such as the epiglottis, false vocal cords, and aryepiglottic folds while preserving the true vocal cords and laryngeal framework. Compared with traditional open supraglottic laryngectomy, transoral approaches offer reduced surgical morbidity, shorter recovery times, and avoidance of large neck incisions. Voice is usually preserved, but swallowing rehabilitation is often required due to a risk of aspiration.

  When it's used:
  - Early to intermediate supraglottic cancers
  - No fixation of the true vocal cords
  - No invasion of the base of tongue or pre-epiglottic space beyond limits
  - Adequate pulmonary reserve to tolerate temporary aspiration
  - Favorable transoral access

After a laryngectomy, patients typically remain in hospital for approximately 1-2 weeks, depending on the extent of surgery and their postoperative progress. The immediate priorities during this period are airway management, pain control, wound care, and nutritional support. Patients who have undergone total laryngectomy breathe permanently through a tracheostoma, and early education focuses on stoma care, humidification, and suctioning. Those who have had partial or transoral laryngectomy may have a temporary tracheostomy or none at all. Oral intake is usually delayed initially, with nutrition provided via a nasogastric tube or gastrostomy to allow safe healing of the pharynx and reduce the risk of complications such as fistula formation. Speech and language therapists and physiotherapists are involved early to support communication, breathing, posture, and safe mobilization.

The first month after discharge is centered on wound healing, adapting to changes in breathing and communication, and gradually restoring basic function. Fatigue is common and patients are encouraged to pace activities and prioritize rest. Swallowing is reintroduced cautiously once healing is confirmed, particularly after total laryngectomy, while patients who have undergone partial or transoral procedures may resume oral intake sooner but often experience temporary swallowing difficulties or aspiration. Communication rehabilitation begins early, with total laryngectomy patients learning alternative methods of speech such as an electrolarynx, followed later by tracheoesophageal speech if appropriate. Emotional adjustment during this phase can be significant, and psychological support is often required.

Between the second and third postoperative months, most patients experience steady functional improvement. Strength and endurance increase, swallowing becomes more efficient, and diet progresses towards normal textures as tolerated. Voice or speech rehabilitation continues, and patients gain confidence in daily activities and self-care. Neck and shoulder stiffness, particularly in those who have undergone neck dissection, may become more noticeable, making ongoing physiotherapy important. If adjuvant radiotherapy is required, recovery may be slower, with increased fatigue, skin changes, mucosal irritation, and fibrosis affecting swallowing and neck mobility.

Exercise is encouraged throughout recovery but must be gradual and carefully progressed. Early mobilization such as regular walking is recommended from the first postoperative days to prevent deconditioning. Gentle neck and shoulder range-of-motion exercises are important, especially after neck dissection, to reduce stiffness and shoulder dysfunction. Breathing exercises and humidification techniques are essential for patients with a tracheostoma, while swallowing exercises prescribed by speech and language therapists support safe and efficient eating. More strenuous activity and heavy lifting should be avoided for at least 6-8 weeks, and patients are advised to avoid swimming until all wounds are fully healed. Those with a permanent stoma must never submerge it in water without specialized protective equipment. Contact sports and activities that place the neck or airway at risk are discouraged, particularly in the early months of recovery.

After total laryngectomy, patients experience permanent loss of normal voice and smell, increased mucus production, coughing, and potential stoma-related complications such as infection or narrowing. There is also a risk of early post-operative complications such as pharyngocutaneous fistula.

Partial and transoral laryngectomies are more commonly associated with temporary aspiration, altered voice quality, and, in some cases, airway swelling requiring short-term airway support.

Potential Side-effects for all Laryngectomies:

- Pain
- Fatigue
- Temporary or chronic swallowing difficulties
- Temporary or chronic speech difficulties
- Neck stiffness
- Reduced shoulder mobility
- Changes to voice range from hoarseness after partial procedures to complete loss of natural voice after total laryngectomy
- Psychological effects such as anxiety, depression, and altered body image are common
- Neck lymphedema
- Fibrosis
- Reduced exercise tolerance, particularly in those who receive radiotherapy

- **Laryngopharyngectomy –** a surgical procedure involving removal of the entire larynx together with part or all of the pharynx, most commonly the hypopharynx. It is an extension of total laryngectomy performed when tumor spread goes beyond the larynx into adjacent pharyngeal structures. The operation results in permanent separation of the airway from the upper aerodigestive tract with formation of a permanent tracheostoma, and it requires pharyngeal reconstruction using regional or free tissue flaps to restore swallowing. Because of its extent and functional impact, it is one of the most radical procedures used in head and neck cancer surgery.

When it's used:

- Advanced laryngeal cancer with extension into the hypopharynx
- Involvement of the piriform sinus, posterior pharyngeal wall, or postcricoid region
- Advanced tumors with extensive submucosal spread beyond the larynx
- Situations where clear pharyngeal margins cannot be achieved with total laryngectomy alone
- Recurrent or persistent disease after radiotherapy or chemoradiotherapy involving both the larynx and pharynx

After a laryngopharyngectomy, the hospital stay is typically longer than for other laryngeal surgeries, usually around 2-3 days, reflecting the extent of re section and the need for complex reconstruction. In the immediate postoperative period, care focuses on airway management through a permanent tracheostoma, monitoring of the reconstructed pharynx, pain control, and prevention of complications such as infection, bleeding, or fistula formation. Nutritional support is provided via a nasogastric tube or gastrostomy, as oral intake is avoided until the pharyngeal repair has healed adequately. Wound care, flap monitoring if a free or regional flap has been used, and careful observation for signs of pharyngocutaneous fistula are critical. Speech and language therapists, physiotherapists, and dietitians are involved early to support communication, mobilization, and nutritional planning. During the first month after discharge, recovery is centered on healing, adaptation to the permanent stoma, and gradual restoration of basic function. Fatigue is common and often significant.

Swallowing is not introduced until healing is confirmed, usually with a contrast swallow study, after which oral intake is reintroduced gradually under specialist supervision. Communication relies on non-verbal methods initially, with early introduction of laryngeal speech options such as an electrolarynx. Emotional and psychological adjustment during this period is substantial, as patients adapt to loss of natural voice, altered swallowing, and body image changes.

Between 1-3 months postoperatively, functional recovery continues steadily but remains demanding. Swallowing improves gradually, although many patients experience prolonged dysphagia and require ongoing speech and language therapy. Diet progression can be slow, and some patients remain partially dependent on enteral feeding during this period. Voice rehabilitation continues, with selected patients beginning assessment for tracheoesophageal puncture if appropriate. Neck and shoulder stiffness, particularly if bilateral neck dissection has been performed, is common and requires ongoing physiotherapy. If adjuvant radiotherapy is planned or underway, recovery may be slower, with increased fatigue, mucosal irritation, fibrosis, and worsening swallowing difficulties.

Exercise is encouraged but must be cautious and progressive. Early mobilization such as gentle walking is recommended from the early postoperative period to reduce deconditioning and respiratory complications. Gentle neck, shoulder, and upper limb range-of-motion exercises are important to prevent stiffness and shoulder dysfunction, particularly after neck dissection. Breathing exercises and humidification techniques are essential for stoma care. As recovery progresses, low-impact aerobic activity can be gradually increased as tolerated, guided by overall stamina and nutritional status Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intratho racic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstruction.

Swimming is contraindicated until wounds are fully healed and, even thereafter, patients with a permanent stoma require specialized protective equipment to prevent water entry into the airway. Contact sports and activities that risk trauma to the neck or stoma should be avoided. Exposure to smoke, dust, and respiratory irritants should be minimized, and smoking is strongly contraindicated due to its negative effects on healing and cancer outcomes.

Potentials Side-effects of Laryngopharyngectomy:

- Pain
- Fatigue
- Wound infection
- Bleeding
- Pharyngocutaneous fistula
- Partial or complete flap failure
- Swallowing difficulties
- Permanent voice loss
- Communication depends on laryngeal speech methods such as an electrolarynx or tracheoesophageal speech
- Permanent dependence on a tracheostoma
- Vulnerability to inhalation of dust, smoke, and cold air
- Loss of normal nasal airflow leads to reduced or absent sense of smell, which can also affect taste and appetite
- Neck and shoulder problems are common, especially when neck dissection is performed
- Chronic pain due to nerve injury or fibrosis
- Lymphedema of the neck and face
- Psychological effects such as anxiety, depression, altered body image, and social withdrawal
- Pharyngeal or esophageal stenosis may develop over time, sometimes requiring dilation procedures

A tracheotomy and a tracheostomy are closely related airway procedures used to create a direct opening into the windpipe (trachea) through the front of the neck, allowing a person to breathe without using the nose or mouth. The distinction is subtle but important.

- **Tracheotomy –** refers to the surgical act of creating the opening in the trachea
- **Tracheostomy –** refers to the ongoing condition in which that opening is maintained and a tube remains in place to support breathing

When it's used:

- Tracheostomy **–** is used as a permanent airway when the larynx has been completely removed, as there is no longer a natural connection between the upper airway and the lungs.

- Tracheotomy **–** is used as a temporary measure to secure the airway during or after major head and neck surgery when swelling or anatomical changes would otherwise obstruct normal breathing.

In many cancer patients the tracheostomy is temporary, but in cases such as total laryngectomy or permanent airway obstruction, it becomes lifelong.

Hospital stay after tracheotomy or tracheostomy typically ranges from 3-7 days, though it may be longer when performed alongside major cancer surgery.

During the first two weeks after discharge, activity should be limited to gentle walking and basic daily movement. The tracheostomy site is still healing, and sudden movements, bending forward repeatedly, lifting more than ten pounds, or straining can increase pressure around the opening and raise the risk of bleeding or tube displacement.

Any exercise that causes heavy breathing, coughing, or neck strain should be avoided. Water exposure is a major concern during this phase; swimming, submerging the head, or showering without proper protection is contraindicated because water entering the tracheostomy can cause serious breathing emergencies. Dusty, smoky, or cold environments should also be avoided, as they can irritate the airway.

From weeks 2-6, walking distance and frequency can increase gradually as endurance improves, provided breathing remains comfortable and secretions are manageable. Gentle mobility exercises for the shoulders, upper back, and neck may be introduced carefully to prevent stiffness, particularly if the tracheostomy was placed during extensive head and neck surgery. Resistance exercise, if introduced, should be very light and avoid breath holding, forceful exertion, or pressure from clothing or equipment near the tracheostomy tube. Activities with a high risk of falls, impact, or tube dislodgement remain inappropriate during this period.

Between 6-12 weeks after the procedure, many individuals can begin a cautious return to more structured exercise if the airway is stable and healing is complete. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance with careful attention to breathing and posture. Swimming and water-based exercise remain contraindicated unless the tracheostomy has been removed or the patient has specialized protective equipment and explicit medical clearance. Throughout this phase, any increase in breathing difficulty, excessive mucus, bleeding, pain, or changes in tube position should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects of Tracheotomy/Tracheostomy:

- Neck pain or soreness
- Bleeding
- Infection at the stoma site
- Swelling or skin breakdown around the opening
- Excess mucus production
- Difficulty clearing secretions
- Coughing
- Shortness of breath
- Changes in voice or inability to speak normally
- Difficulty swallowing
- Aspiration of food or liquids
- Narrowing of the trachea over time
- Accidental tube blockage or displacement
- Altered sense of smell or taste
- Fatigue related to altered breathing mechanics
- Emotional or psychological distress related to communication challenges, body image, and reliance on a visible airway device

• **Total Thyroidectomy –** a total thyroidectomy removes the entire thyroid gland. Because no thyroid tissue remains, lifelong thyroid hormone replacement is required. This is the most common operation for thyroid cancer worldwide and is used for larger tumors, cancers involving both lobes, aggressive cancer types, most medullary thyroid cancers, recurrent disease, or when radioactive iodine treatment is planned. The surgery requires careful protection of the vocal cord nerves and parathyroid glands. While the risk of temporary voice changes or low calcium levels is higher than with lobectomy, total thyroidectomy allows for more effective cancer treatment, clearer long-term monitoring, and reduced risk of residual disease.

When it's used:

- Larger tumors
- Tumors in both lobes
- Cancers with higher-risk features
- Many cases where postoperative radioactive iodine treatment is planned
- Most medullary thyroid cancers
- Recurrent disease after previous surgery

Hospital stay after thyroidectomy is usually short, and the recovery timeline is broadly similar across lobectomy, total thyroidectomy, completion thyroidectomy, and many minimally invasive approaches, with differences mainly driven by whether lymph nodes were removed and how extensive the neck dissection was. Most people go home the same day or after one overnight stay following a lobectomy or uncomplicated total thyroidectomy, while total thyroidectomy with central or lateral neck dissection more commonly requires one to two nights, and extended/invasive resections may require several days. In the hospital, walking is encouraged the day of surgery to reduce clot risk, and the team monitors for neck swelling, voice changes, swallowing discomfort, and low calcium symptoms (more relevant after total/completion thyroidectomy).

In the first 1-2 weeks at home, exercise should be limited to easy walking several times per day and gentle posture work, with strict avoidance of heavy lifting, straining, or breath-holding because these increase neck and upper chest pressure and can worsen swelling or bleeding;a practical lifting limit is to keep loads light (often under 10-15 pounds) and avoid carrying heavy bags, pushing/pulling heavy doors, or intense household tasks. High-impact exercise, con tact sports, swimming if there is any open incision concern, and vigorous overhead lifting should be avoided during this early period, and any activity that triggers pulling at the incision, dizziness, tingling around the mouth/hands (possible low calcium), or significant hoarseness should be scaled back.

From weeks 2-6, most people can gradually increase walking to 20-30 minutes as tolerated and add low-intensity cardio such as easy stationary cycling, along with gentle neck and shoulder range-of-motion work to prevent stiffness (especially important if any neck dissection was performed). Light strength training can restart if the incision is healing well, using very low resistance and smooth breathing - no Valsalva, no maximal effort, and no heavy overhead work - focusing on lower body and supported upper-body movements that do not load the neck (machines or seated exercises are often easier early on). If a lateral neck dissection was performed, shoulder fatigue and reduced arm elevation can persist for weeks, so overhead pressing and heavy pulling should be delayed while scapular control and shoulder range improve. From weeks 6-12, most individuals can return to a more normal training plan if cleared by the surgical team: low-impact cardio can progress in duration and intensity, resistance training can increase gradually, and overhead lifting can be reintroduced cautiously as long as there is no neck tightness, nerve-related shoulder weakness, or swelling.

Potential Side-effects of all Thyroidectomies:

- Neck pain, tightness, or soreness
- Swelling or bruising at the incision site
- Temporary difficulty swallowing or a sensation of throat fullness
- Hoarseness or voice changes due to irritation or injury of the vocal cord nerves
- Temporary or permanent vocal cord weakness or paralysis
- Low calcium levels (hypocalcemia), causing tingling in the lips, fingers, or toes, muscle cramps, or spasms
- Fatigue, especially during early recovery or while thyroid hormone levels are being adjusted
- Need for lifelong thyroid hormone replacement after total or completion thyroidectomy
- Headache or neck stiffness
- Infection at the surgical site
- Bleeding or hematoma in the neck
- Numbness or altered sensation around the incision or lower jaw
- Cough or throat irritation
- Emotional changes or mood fluctuations related to hormone shifts
- Weight changes during hormone adjustment period
- Long-term risk of osteoporosis

- **Lateral Neck Dissection (levels II-V lymph node removal) –** this removes lymph nodes along the side of the neck when thyroid cancer has spread there. It's more extensive than central neck dissection and usually performed only when nodal spread is confirmed.

When it's used:

- Biopsy-proven or clearly suspected lateral neck node metastases
- Recurrent nodal disease

- **Modified Radical Neck Dissection –** removes lymph nodes from a wider area but preserves one or more key structures, most often the spinal accessory nerve to reduce shoulder dysfunction.

- **Radical Neck Dissection –** is the most extensive form and removes nearly all lymphatic tissue on one side of the neck along with the spinal accessory nerve, internal jugular vein, and sternocleidomastoid muscle. Bilateral neck dissection may be performed when cancer affects or threatens lymph nodes on both sides of the neck.

When it's used:

- Lateral – clinically node-negative (N0) supraglottic or hypopharyngeal cancer where occult metastasis risk exceeds 20%, confirmed limited nodal disease at specific nodal levels, early to moderately advanced cancer where targeted nodal clearance is sufficient
- Modified Radical – is used when there is confirmed or suspected lymph node involvement but the cancer has not directly invaded the major structures of the neck. Preserving the spinal accessory nerve, internal jugular vein, or sternocleidomastoid muscle is still feasible without compromising cancer clearance.
- Radical – is used when the cancer has directly invaded or is inseparable from one or more of the major neck structures, making their removal necessary to clear margins. It is reserved for advanced nodal disease where preservation of those structures is not oncologically safe.

Hospital stay after neck dissection typically ranges from 3-5 days for selective procedures and 5-7 days or longer for modified radical or radical dissections, especially if combined -with tumor resection or reconstruction. Early hospital care focuses on pain control, drain management, and monitoring shoulder and neck movement. Gentle walkling and sitting up-right usually begin within the first 24 hours to support circulation and lung function.

During the first two weeks, activity should be limited to light walking and gentle daily movement. Lifting more than 10 pounds, overhead reaching, forceful pulling, and activities that strain the neck and shoulders should be avoided to protect healing tissues and nerves. Sudden head movements, contact sports, and resistance training are contraindicated during this phase. In patients where the sternocleidomastoid (SCM) muscle has been removed, altered cervical biomechanics and postural asymmetry are present from the outset, and gentle posture awareness, relaxed breathing, and early physiotherapy referral are essential during this initial period to begin compensatory retraining of the remaining cervical musculature. Where the spinal accessory nerve (SAN) has been stretched, damaged, or sacrificed, physiotherapy should ideally begin before or immediately after surgery - shoulder drop, scapular winging, and weakness in shoulder elevation are expected consequences of trapezius denervation, and early guided movement is critical to prevent the development of frozen shoulder which is a common and functionally devastating complication.

From weeks 2-6, walking duration can gradually increase as stamina improves. Guided range-of-motion exercises for the neck and shoulders are introduced during this phase to prevent progressive stiffness and frozen shoulder. In patients with SAN injury, rehabilitation must specifically target trapezius retraining, scapular stabilization, and compensatory strengthening of the serratus anterior and rhomboids, with neuromuscular electrical stimulation (NMES) considered as an adjunct where available. In patients where the SCM has been removed, cervical mobility exercises and progressive strengthening of the contralateral SCM and deep cervical flexors should be introduced to address postural imbalance and compensate for the permanent structural deficit. Resistance exercises may begin cautiously using very light resistance bands or body weight, with emphasis on scapular stability, symmetry, and controlled movement. Overhead lifting, heavy weights, and high-impact activities should still be avoided, as shoulder weakness and fatigue are particularly pronounced following SAN injury or SCM resection during this period.

Between 6-12 weeks after surgery, most patients can begin a gradual return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activities such as brisk walking or stationary cycling can be added. Strength training may progress slowly using light to moderate resistance, emphasizing

proper posture, scapular stability, and avoidance of neck strain. Overhead lifting should be introduced cautiously and only if shoulder control and endurance have adequately recovered (may be significantly delayed in patients with SAN sacrifice or SCM resection), where functional recovery can take 12-24 months and some degree of permanent deficit should be anticipated. Any increase in neck swelling, shoulder pain, numbness, weakness, or drainage from the surgical site should prompt immediate re duction in activity and evaluation by the medical team.

Recovery timelines broadly follow the same progression across all three procedures - gentle mobilization within 24 hours, light activity for the first 2 weeks, graduated range-of-motion and light resistance exercise from weeks 2-6, and a return to more structured activity between weeks 6-12, however the duration and complexity of rehabilitation extends considerably further in modified radical and radical neck dissection, with functional recovery taking 12-24 months in cases involving spinal accessory nerve sacrifice or SCM resection, and some degree of permanent deficit anticipated following radical neck dissection.

Potential Side-effects of all Neck Dissections:

- Neck pain and stiffness
- Numbness and tingling in cheek, neck, and ear
- Swelling
- Shoulder weakness or limited arm and head movements
- Voice changes
- Swallowing difficulties
- Possible permanent nerve damage
- Blood clots

Types of treatment used:

- Definitive radiotherapy (RT)
- Concurrent chemoradiotherapy (CRT)
- Radiotherapy
- Targeted therapy
- Immunotherapy
- Induction (neoadjuvant) chemotherapy or immunotherapy

CANCER OF THE PHARNYX

Cancer of the throat, or pharynx, is divided into three types based on anatomical location: nasopharyngeal, oropharyngeal, and hypopharyngeal. Combined, these pharyngeal cancer subtypes accounted for an estimated 313,091 new cases and 166,689 deaths worldwide in 2022 (Kim, Yoo, Jo, et al., Journal of Korean Medical Science, 2025). Men are more than twice as likely as women to develop pharyngeal cancers, with age-standardized incidence rates approximately three times higher in males than females (Bray et al., CA: A Cancer Journal for Clinicians, 2024).

Oropharyngeal carcinoma accounted for 106,400 new cases and 52,305 deaths worldwide in 2022, and is closely associated with high-risk human papillomavirus (HPV) infection - particularly HPV types 16 and 18 - as well as tobacco use, alcohol consumption, and betel quid chewing (Bray et al., CA: A Cancer Journal for Clinicians, 2024). The incidence of HPV-positive oropharyngeal cancer has increased dramatically over the past two decades, with studies demonstrating a threefold increase between 2000-2017, particularly among white males under the age of 65 in the United States and other high-income countries (Chen, Current Oncology Reports, 2025). Incidence rates for HPV-associated oropharyngeal cancers have been increasing by approximately 0.7% per year between 2012-2021 in the United States (NCI, SEER Cancer Stat Facts: Oropharyngeal Cancer, 2024). The oropharynx includes the base of the tongue, the soft palate and uvula, and the tonsils. A combination of radiation and surgery is used as primary treatment for early-stage oropharyngeal cancer, with organ-preservation approaches increasingly preferred.

Nasopharyngeal carcinoma accounted for 120,434 new cases and 73,482 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). It is the only head and neck malignancy not primarily associated with tobacco and alcohol use. Instead, approximately 70% of all nasopharyngeal cancers are caused by persistent infection with the Epstein-Barr virus (EBV), and additional risk factors include consumption of salt-preserved foods and occupational exposure to dust (NCI, Nasopharyngeal Cancer Treatment PDQ, updated 2025). Because the nasopharynx is located behind the nasal cavity and is inaccessible through conventional surgery, radiation therapy is the standard treatment. Surgery may be used selectively to address lymph nodes that have not responded to radiation.

Hypopharyngeal carcinoma accounted for 86,257 new cases and 40,902 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). It is the most aggressive of the three pharyngeal subtypes and the most likely to spread at the time of diagnosis due to its silent clinical course. Risk factors include tobacco use, heavy alcohol consumption, smokeless tobacco, and gastroesophageal reflux. The hypopharynx includes the pyriform sinus, the pharyngoesophageal junction, and the posterior wall of the lower throat. This cancer is typically discovered at an advanced stage because early symptoms are minimal or absent.

Tumors of the pharynx carry a higher risk of metastasis than those of the larynx or oral cavity, and approximately 60% of all oral and pharyngeal cancers are moderately advanced or metastatic at the time of diagnosis, with an overall five-year relative survival rate of approximately 69% (NCI, SEER Cancer Stat Facts: Oral Cavity and Pharynx Cancer, 2024).

Most people with oropharyngeal and oral cavity cancers use tobacco and are significantly more likely than nonsmokers to develop these cancers. Drinking alcohol increases risk substantially, with approximately 7 out of 10 oral cancer patients being heavy drinkers. The risk is highest in people who both smoke and drink heavily, with some studies suggesting the combined risk may be as much as 100 times that of people who do neither (NCI, Head and Neck Cancers, updated 2025). A diet low in fruits and vegetables is also associated with increased risk, and people with weakened immune systems - including those with HIV/AIDS or those taking immunosuppressive medications - face an elevated risk of these cancers (ACS, Oral Cavity and Oropharyngeal Cancer Risk Factors, 2024).

Procedures:

- **Transoral Robotic Surgery (TORS) and Transoral Laser Microsurgery –** the use of transoral robotic surgery or transoral laser microsurgery, is one of the most commonly used surgical approach for early-stage oropharyngeal. These minimally invasive techniques allow precise tumor removal through the mouth without external incisions, preserving swallowing and speech while reducing morbidity. They are now standard practice in many centers, particularly for well-lateralized tumors of the tonsil, base of tongue, and lateral pharyngeal wall, and are frequently combined with selective neck dissection.

  When it's used:
  - Early-stage oropharyngeal cancers
  - Small, well-localized tumors of the tonsil or base of tongue
  - Favorable anatomy with good transoral exposure
  - Priority is preservation of speech and swallowing function
  - HPV-associated disease where surgical de-escalation may be considered

- **Open Oropharyngectomy –** this procedure is reserved for selected advanced or recurrent oropharyngeal cancers when transoral approaches are not feasible. This procedure requires external access to the pharynx and may involve mandibulotomy or pharyngotomy. Because it is associated with higher morbidity, longer hospitalization, and greater impact on swallowing and speech, its use has declined significantly with the success of minimally invasive techniques.

  When it's used:
  - Tumors not accessible by transoral approaches
  - Large or anatomically unfavorable oropharyngeal tumors
  - Recurrent disease after radiation or chemoradiation
  - Situations requiring en bloc resection to achieve oncologic control

After an open oropharyngectomy, the hospital stay is typically longer than with transoral approaches and usually lasts around 10-14 days, though it may be longer if reconstruction, neck dissection, or complications occur. In the immediate postoperative period, care focuses on airway protection, pain control, wound management, and nutritional support.

Many patients require a temporary tracheostomy to protect the airway from postoperative swelling, and close monitoring is needed for bleeding, infection, and flap or wound viability if reconstruction has been performed. Oral intake is usually withheld initially, with nutrition provided via a nasogastric tube or gastrostomy to allow the surgical site to heal safely.

Early involvement of speech-language pathology, physical therapy, and dietetics is routine to support communication strategies, mobility, and nutritional planning.

During the first four weeks after discharge, recovery is focused on wound healing, gradual return of basic function, and management of fatigue, which is often significant. Swallowing is reintroduced cautiously once healing is confirmed, often after imaging or endoscopic assessment, and patients commonly experience dysphagia, nasal regurgitation, or aspiration during this phase. Diet progression is slow and guided closely by speech-language therapy, and some patients remain partially dependent on tube feeding. Speech may be altered due to changes in oropharyngeal anatomy, and articulation difficulties are common. Pain and stiffness in the jaw, neck, and shoulders are frequent, particularly if mandibulotomy or neck dissection has been performed.

Between 1-3 months after surgery, functional recovery continues but remains gradual. Swallowing efficiency usually improves with therapy, although dietary restrictions may persist and require ongoing rehabilitation. Speech clarity often improves but may not return fully to baseline, especially after larger resections. Neck and shoulder stiffness may become more pronounced during this period, highlighting the importance of continued physical therapy. If adjuvant radiation therapy is planned or underway, recovery may be slower, with increased fatigue, mucosal irritation, fibrosis, and worsening swallowing and speech difficulties.

Exercise is encouraged throughout recovery but must be carefully structured. Early mobilization such as short, frequent walks is recommended as soon as medically safe to reduce deconditioning and respiratory complications. In the first several weeks, exercise should focus on gentle activity, posture, and range-of-motion exercises for the neck, shoulders, and jaw, including jaw-opening exercises to reduce trismus. As healing progresses, low-impact aerobic activity such as longer walks or stationary cycling can be gradually increased, guided by pain levels, fatigue, and nutritional status. All exercises should be introduced gradually and ideally under the guidance of physical therapy.

Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and increase the risk of bleeding. Contact sports and activities with a risk of trauma to the neck or face should be avoided. Swimming is contraindicated until all surgical wounds have fully healed, and care should be taken with activities that strain the jaw or neck in the early recovery period. Smoking and exposure to smoke or other irritants are strongly contraindicated, as they impair healing and worsen long-term outcomes.

Potential Side-effects of Open Oropharyngectomy:

- Pain in the throat, jaw, neck, or face
- Prolonged fatigue and reduced stamina
- Swallowing difficulties, which may be temporary or long term
- Aspiration or coughing when eating or drinking
- Nasal regurgitation of food or liquids
- Prolonged or permanent dependence on tube feeding in severe cases
- Speech changes, including reduced clarity or altered resonance
- Difficulty with articulation, especially after large resections
- Persistent dry mouth, particularly if radiation therapy is given
- Bleeding or hematoma formation
- Pharyngocutaneous or orocutaneous fistula formation
- Jaw stiffness or trismus, especially if mandibulotomy is performed
- Neck and shoulder stiffness or weakness following neck dissection
- Chronic neck or shoulder pain
- Changes in taste or appetite
- Weight loss and nutritional deficiencies
- Scarring or cosmetic changes to the face or neck
- Lymphedema of the neck or face
- Psychological effects including anxiety, depression, al tered body image, and social withdrawal
- Side effects related to adjuvant radiation or chemoradiation, such as fibrosis, worsening swallowing difficulty, mucositis, and chronic pain

- **Partial Pharyngectomy with Laryngeal Preservation –** this procedure is used selectively for hypopharyngeal cancer, particularly small, lateralized tumors of the piriform sinus. The goal is to remove the involved segment of the pharynx while preserving the larynx and maintaining speech. This approach requires careful patient selection due to the risk of aspiration and the need for prolonged swallowing rehabilitation.

When it's used:

- Early-stage hypopharyngeal cancer
- Lateralized piriform sinus tumors
- Mobile vocal cords with preserved laryngeal function
- Adequate pulmonary reserve to tolerate aspiration risk

After a partial pharyngectomy with laryngeal preservation, the hospital stay is typically shorter than after total laryngopharyngectomy but longer than after transoral procedures, usually lasting about 7-12 days. Early post-operative care focuses on airway safety, pain control, wound monitoring, and nutritional support. Some patients may require a temporary tracheostomy due to postoperative swelling or aspiration risk, although this is often removed before discharge. Oral intake is usually withheld initially, with nutrition provided through a nasogastric tube or gastrostomy to protect the surgical site while healing \ begins. Close monitoring for bleeding, infection, and pharyngeal leaks is essential. Speech-language pathology and physical therapy are involved early to assess swallowing risk, begin compensatory strategies, and support safe mobilization.

During the first four weeks after discharge, recovery centers on healing of the pharyngeal defect and gradual reintroduction of swallowing. Fatigue is common, and patients are encouraged to pace activities. Swallowing is restarted cautiously once healing is confirmed, often with instrumental assessment, as aspiration risk is higher with laryngeal preservation. Many patients experience coughing with swallowing, throat discomfort, or a sensation of food sticking, and diet progression is guided closely by speech-language therapy. Some degree of temporary tube feeding support is common during this phase. Voice is usually preserved but may be weak or hoarse initially. Neck and shoulder stiffness may occur, particularly if neck dissection has been performed.

Between 1-3 months after surgery, swallowing function typically improves with therapy, although some patients continue to experience aspiration or require dietary modifications. Most patients gradually transition to full oral intake, but recovery can be prolonged if adjuvant radiation therapy is required.

Speech generally improves as swelling subsides, although articulation or resonance changes may persist depending on the extent of resection. Physical endurance improves gradually, but ongoing rehabilitation is often needed for neck mobility and shoulder strength.

Exercise during recovery should be progressive and carefully supervised. Early mobilization with short, frequent walks is encouraged as soon as medically safe to reduce deconditioning and pulmonary complications. Gentle range-of-motion exercises for the neck and shoulders are important, especially after neck dissection, to prevent stiffness and shoulder dysfunction. Jaw-opening exercises may be recommended to reduce trismus if surgical access involved the mandible. As recovery progresses, low-impact aerobic activity such as longer walks or stationary cycling can be increased gradually, guided by fatigue, pain, and nutritional status.

Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least six to eight weeks, as these may increase aspiration risk or compromise wound healing. Contact sports and activities with a risk of neck trauma should be avoided.

Swimming is contraindicated until all wounds are fully healed and swallowing safety is well established. Patients are advised to avoid smoking and exposure to smoke or other airway irritants, as these impair healing and worsen swallowing outcomes.

Potential Side-effects after Partial Pharyngectomy with Laryngeal Preservation:

- Swallowing difficulties, which are common and may be temporary or long term
- Aspiration or coughing during eating and drinking due to preserved laryngeal airway
- Delayed return to full oral intake, with temporary dependence on tube feeding
- Throat pain and discomfort, especially during swallowing
- Sensation of food sticking in the throat
- Prolonged fatigue during recovery
- Voice changes such as hoarseness, weakness, or reduced projection
- Altered speech resonance or clarity
- Risk of pharyngeal leak or fistula formation
- Wound infection or delayed wound healing
- Bleeding or hematoma formation
- Neck and shoulder stiffness or weakness, particularly if neck dissection is performed
- Chronic neck or shoulder pain
- Reduced range of motion
- Jaw stiffness or trismus, depending on surgical access
- Changes in taste or appetite
- Weight loss and nutritional deficiencies
- Lymphedema of the neck or face
- Scarring or cosmetic changes
- Lymphedema of the neck or face
- Scarring or cosmetic changes
- Side effects related to adjuvant radiation therapy, including fibrosis, worsening swallowing difficulty, dry mouth, and fatigue
- Psychological effects such as anxiety, fear of choking, altered body image, and reduced quality of life

• **Laryngopharyngectomy –** a surgical procedure involving removal of the entire larynx together with part or all of the pharynx, most commonly the hypopharynx. It is an extension of total laryngectomy performed when tumor spread goes beyond the larynx into adjacent pharyngeal structures. The operation results in permanent separation of the airway from the upper aerodigestive tract with formation of a permanent tracheostoma, and it requires pharyngeal reconstruction using regional or free tissue flaps to restore swallowing. Because of its extent and functional impact, it is one of the most radical procedures used in head and neck cancer surgery.

When it's used:

- Advanced hypopharyngeal cancer
- Tumor spread involving the larynx and hypopharynx
- Recurrent or persistent disease after chemoradiotherapy
- Situations where clear margins cannot be achieved with lesser surgery

After a laryngopharyngectomy, the hospital stay is typically longer than for other laryngeal surgeries, usually around 2-3 days, reflecting the extent of re section and the need for complex reconstruction. In the immediate postoperative period, care focuses on airway management through a permanent tracheostoma, monitoring of the reconstructed pharynx, pain control, and prevention of complications such as infection, bleeding, or fistula formation. Nutritional support is provided via a nasogastric tube or gastrostomy, as oral intake is avoided until the pharyngeal repair has healed adequately. Wound care, flap monitoring if a free or regional flap has been used, and careful observation for signs of pharyngocutaneous fistula are critical. Speech and language therapists, physiotherapists, and dietitians are involved early to support communication, mobilization, and nutritional planning. During the first month after discharge, recovery is centered on healing, adaptation to the permanent stoma, and gradual restoration of basic function. Fatigue is common and often significant. Swallowing is not introduced until healing is confirmed, usually with a contrast swallow study, after which oral intake is reintroduced gradually under specialist supervision. Communication relies on non-verbal methods initially, with early introduction of laryngeal speech options such as an electrolarynx. Emotional and psychological adjustment during this period is substantial, as patients adapt to loss of natural voice, altered swallowing, and body image changes.

Between 1-3 months postoperatively, functional recovery continues steadily but remains demanding. Swallowing improves gradually, although many patients experience prolonged dysphagia and require ongoing speech and language therapy. Diet progression can be slow, and some patients remain partially dependent on enteral feeding during this period. Voice rehabilitation continues, with selected patients beginning assessment for tracheoesophageal puncture if appropriate. Neck and shoulder stiffness, particularly if bilateral neck dissection has been performed, is common and requires ongoing physiotherapy. If adjuvant radiotherapy is planned or underway, recovery may be slower, with increased fatigue, mucosal irritation, fibrosis, and worsening swallowing difficulties.

Exercise is encouraged but must be cautious and progressive. Early mobilization such as gentle walking is recommended from the early postoperative period to reduce deconditioning and respiratory complications. Gentle neck, shoulder, and upper limb range-of-motion exercises are important to prevent stiffness and shoulder dysfunction, particularly after neck dissection. Breathing exercises and humidification techniques are essential for stoma care. As recovery progresses, low-impact aerobic activity can be gradually increased as tolerated, guided by overall stamina and nutritional status Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstruction.

Swimming is contraindicated until wounds are fully healed and, even thereafter, patients with a permanent stoma require specialized protective equipment to prevent water entry into the airway. Contact sports and activities that risk trauma to the neck or stoma should be avoided. Exposure to smoke, dust, and respiratory irritants should be minimized, and smoking is strongly contraindicated due to its negative effects on healing and cancer outcomes.

Exercise is encouraged but must be cautious and progressive. Early mobilization such as gentle walking is recommended from the early postoperative period to reduce deconditioning and respiratory complications. Gentle neck, shoulder, and upper limb range-of-motion exercises are important to prevent stiffness and shoulder dysfunction, particularly after neck dissection. Breathing exercises and humidification techniques are essential for stoma care. As recovery progresses, low-impact aerobic activity can be gradually increased as tolerated, guided by overall stamina and nutritional status Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstruction.

Potentials Side-effects of Laryngopharyngectomy:

- Pain
- Fatigue
- Wound infection
- Bleeding
- Pharyngocutaneous fistula
- Partial or complete flap failure
- Swallowing difficulties
- Permanent voice loss
- Communication depends on laryngeal speech methods such as an electrolarynx or tracheoesophageal speech
- Permanent dependence on a tracheostoma
- Vulnerability to inhalation of dust, smoke, and cold air
- Loss of normal nasal airflow leads to reduced or absent sense of smell, which can also affect taste and appetite
- Neck and shoulder problems are common, especially when neck dissection is performed
- Chronic pain due to nerve injury or fibrosis
- Lymphedema of the neck and face
- Psychological effects such as anxiety, depression, altered body image, and social withdrawal
- Pharyngeal or esophageal stenosis may develop over time, sometimes requiring dilation procedures

- **Total Thyroidectomy –** removes the entire thyroid gland. Because no thyroid tissue remains, lifelong thyroid hormone replacement is required. This is the most common operation for thyroid cancer worldwide and is used for larger tumors, cancers involving both lobes, aggressive cancer types, most medullary thyroid cancers,recurrent disease, or when radioactive iodine treatment is planned. The surgery requires careful protection of the vocal cord nerves and parathyroid glands. While the risk of temporary voice changes or low calcium levels is higher than with lobectomy, total thyroidectomy allows for more effective cancer treatment, clearer long-term monitoring, and reduced risk of residual disease.

When it's used:

- Larger tumors
- Tumors in both lobes
- Cancers with higher-risk features
- Many cases where postoperative radioactive iodine treatment is planned
- Most medullary thyroid cancers
- Recurrent disease after previous surgery

Hospital stay after thyroidectomy is usually short, and the recovery timeline is broadly similar across lobectomy, total thyroidectomy, completion thyroidectomy, and many minimally invasive approaches, with differences mainly driven by whether lymph nodes were removed and how extensive the neck dissection was. Most people go home the same day or after one overnight stay following a lobectomy or uncomplicated total thyroidectomy, while total thyroidectomy with central or lateral neck dissection more commonly requires one to two nights, and extended/invasive resections may require several days. In the hospital, walking is encouraged the day of surgery to reduce clot risk, and the team monitors for neck swelling, voice changes, swallowing discomfort, and low calcium symptoms (more relevant after total/completion thyroidectomy).

In the first 1-2 weeks at home, exercise should be limited to easy walking several times per day and gentle posture work, with strict avoidance of heavy lifting, straining, or breath-holding because these increase neck and upper chest pressure and can worsen swelling or bleeding; a practical lifting limit is to keep loads light (often under 10-15 pounds) and avoid carrying heavy bags, pushing/pulling heavy doors, or intense household tasks. High-impact exercise, contact sports, swimming if there is any open incision concern, and vigorous overhead lifting should be avoided during this early period, and any activity that triggers pulling at the incision, dizziness, tingling around the mouth/hands (possible low calcium), or significant hoarseness should be scaled back.

From weeks 2-6, most people can gradually increase walking to 20-30 minutes as tolerated and add low-intensity cardio such as easy stationary cycling, along with gentle neck and shoulder range-of-motion work to prevent stiffness (especially important if any neck dissection was performed). Light strength training can restart if the incision is healing well, using very low resistance and smooth breathing - no Valsalva, no maximal effort, and no heavy overhead work - focusing on lower body and supported upper-body movements that do not load the neck (machines or seated exercises are often easier early on).

If a lateral neck dissection was performed, shoulder fatigue and reduced arm elevation can persist for weeks, so overhead pressing and heavy pulling should be delayed while scapular control and shoulder range improve.

From weeks 6-12, most individuals can return to a more normal training plan if cleared by the surgical team: low-impact cardio can progress in duration and intensity, resistance training can increase gradually, and overhead lifting can be reintroduced cautiously as long as there is no neck tightness, nerve-related shoulder weakness, or swelling.

Potential Side-effects of all Thyroidectomies:

- Neck pain, tightness, or soreness
- Swelling or bruising at the incision site
- Temporary difficulty swallowing or a sensation of throat fullness
- Hoarseness or voice changes due to irritation or injury of the vocal cord nerves
- Temporary or permanent vocal cord weakness or paralysis
- Low calcium levels (hypocalcemia), causing tingling in the lips, fingers, or toes, muscle cramps, or spasms
- Fatigue, especially during early recovery or while thyroid hormone levels are being adjusted
- Need for lifelong thyroid hormone replacement after total or completion thyroidectomy
- Headache or neck stiffness
- Infection at the surgical site
- Bleeding or hematoma in the neck
- Numbness or altered sensation around the incision or lower jaw
- Cough or throat irritation
- Emotional changes or mood fluctuations related to hormone shifts
- Weight changes during hormone adjustment period
- Long-term risk of osteoporosis

- **Radical Neck Dissection –** the most extensive procedure, removing lymph node levels I-V, the internal jugular vein (IJV), sternocleidomastoid muscle (SCM), and spinal accessory nerve (CN XI). It is generally reserved for advanced, extensive cancer involving these structures.

When it's used:

- When the cancer has directly invaded or is inseparable from one or more of the major neck structures making their removal necessary to achieve clear margins. It is reserved for advanced nodal disease where preservation of those structures is not oncologically safe.

Hospital stay after neck dissection typically ranges from 3-5 days for selective procedures and 5-7 days or longer for modified radical or radical dissections, especially if combined -with tumor resection or reconstruction. Early hospital care focuses on pain control, drain management, and monitoring shoulder and neck movement. Gentle walkling and sitting up-right usually begin within the first 24 hours to support circulation and lung function.

During the first two weeks, activity should be limited to light walking and gentle daily movement. Lifting more than 10 pounds, overhead reaching, forceful pulling, and activities that strain the neck and shoulders should be avoided to protect healing tissues and nerves. Sudden head movements, contact sports, and resistance training are contraindicated during this phase. In patients where the sternocleidomastoid (SCM) muscle has been removed, altered cervical biomechanics and postural asymmetry are present from the outset, and gentle posture awareness, relaxed breathing, and early physiotherapy referral are essential during this initial period to begin compensatory retraining of the remaining cervical musculature. Where the spinal accessory nerve (SAN) has been stretched, damaged, or sacrificed, physiotherapy should ideally begin before or immediately after surgery - shoulder drop, scapular winging, and weakness in shoulder elevation are expected consequences of trapezius denervation, and early guided movement is critical to prevent the development of frozen shoulder which is a common and functionally devastating complication.

From weeks 2-6, walking duration can gradually increase as stamina improves. Guided range-of-motion exercises for the neck and shoulders are introduced during this phase to prevent progressive stiffness and frozen shoulder. In patients with SAN injury, rehabilitation must specifically target trapezius retraining, scapular stabilization, and compensatory strengthening of the serratus anterior and rhomboids, with neuromuscular electrical stimulation (NMES) considered as an adjunct where available. In patients where the SCM has been removed, cervical mobility exercises and progressive strengthening of the contralateral SCM and deep cervical flexors should be introduced to address postural imbalance and compensate for the permanent structural deficit. Resistance exercises may begin cautiously using very light resistance bands or body weight, with emphasis on scapular stability, symmetry, and controlled movement. Overhead lifting, heavy weights, and high-impact activities should still be avoided, as shoulder weakness and fatigue are particularly pronounced following SAN injury or SCM resection during this period.

Between 6-12 weeks after surgery, most patients can begin a gradual return to more structured exercise if healing is uncomplicated. Low-impact cardiovascular activities such as brisk walking or stationary cycling can be added. Strength training may progress slowly using light to moderate resistance, emphasizing proper posture, scapular stability, and avoidance of neck strain. Overhead lifting should be introduced cautiously and only if shoulder control and endurance have adequately recovered (may be significantly delayed in patients with SAN sacrifice or SCM resection), where functional recovery can take 12-24 months and some degree of permanent deficit should be anticipated. Any increase in neck swelling, shoulder pain, numbness, weakness, or drainage from the surgical site should prompt immediate re duction in activity and evaluation by the medical team.

Recovery timelines broadly follow the same progression across all three procedures - gentle mobilization within 24 hours, light activity for the first 2 weeks, graduated range-of-motion and light resistance exercise from weeks 2-6, and a return to more structured activity between weeks 6-12, however the duration and complexity of rehabilitation extends considerably further in modified radical and radical neck dissection, with functional recovery taking 12-24 months in cases involving spinal accessory nerve sacrifice or SCM resection, and some degree of permanent defi cit anticipated following radical neck dissection.

Potential Side-effects of all Neck Dissections

- Neck pain and stiffness
- Numbness and tingling in cheek, neck, and ear
- Swelling
- Shoulder weakness or limited arm and head movements
- Voice changes
- Swallowing difficulties
- Possible permanent nerve damage
- Blood clots

A tracheotomy and a tracheostomy are closely related airway procedures used to create a direct opening into the windpipe (trachea) through the front of the neck, allowing a person to breathe without using the nose or mouth. The distinction is subtle but important.

- **Tracheotomy –** refers to the surgical act of creating the opening in the trachea
- **Tracheostomy –** refers to the ongoing condition in which that opening is maintained and a tube remains in place to support breathing

When it's used:

- Tracheostomy **–** is used as a permanent airway when the larynx has been completely removed, as there is no longer a natural connection between the upper airway and the lungs.
- Tracheotomy **–** is used as a temporary measure to secure the airway during or after major head and neck surgery when swelling or anatomical changes would otherwise obstruct normal breathing.

In many cancer patients the tracheostomy is temporary, but in cases such as total laryngectomy or permanent airway obstruction, it becomes lifelong. Hospital stay after tracheotomy or tracheostomy typically ranges from 3-7 days, though it may be longer when performed alongside major cancer surgery.

During the first two weeks after discharge, activity should be limited to gentle walking and basic daily movement. The tracheostomy site is still healing, and sudden movements, bending forward repeatedly, lifting more than ten pounds, or straining can increase pressure around the opening and raise the risk of bleeding or tube displacement.

Any exercise that causes heavy breathing, coughing, or neck strain should be avoided. Water exposure is a major concern during this phase; swimming, submerging the head, or showering without proper protection is contraindicated because water entering the tracheostomy can cause serious breathing emergencies. Dusty, smoky, or cold environments should also be avoided, as they can irritate the airway.

From weeks 2-6, walking distance and frequency can increase gradually as endurance improves, provided breathing remains comfortable and secretions are manageable. Gentle mobility exercises for the shoulders, upper back, and neck may be introduced carefully to prevent stiffness, particularly if the tracheostomy was placed during extensive head and neck surgery. Resistance exercise, if introduced, should be very light and avoid breath holding, forceful exertion, or pressure from clothing or equipment near the tracheostomy tube. Activities with a high risk of falls, impact, or tube dislodgement remain inappropriate during this period.

Between 6-12 weeks after the procedure, many individuals can begin a cautious return to more structured exercise if the airway is stable and healing is complete. Low-impact cardiovascular activities such as brisk walking or upright stationary cycling may be added gradually. Strength training can progress slowly using light to moderate resistance with careful attention to breathing and posture. Swimming and water-based exercise remain contraindicated unless the tracheostomy has been removed or the patient has specialized protective equipment and explicit medical clearance. Throughout this phase, any increase in breathing difficulty, excessive mucus, bleeding, pain, or changes in tube position should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects of Tracheotomy/Tracheostomy:

- Neck pain or soreness
- Bleeding
- Infection at the stoma site
- Swelling or skin breakdown around the opening
- Excess mucus production
- Difficulty clearing secretions
- Coughing
- Shortness of breath
- Changes in voice or inability to speak normally
- Difficulty swallowing
- Aspiration of food or liquids
- Narrowing of the trachea over time
- Accidental tube blockage or displacement
- Altered sense of smell or taste
- Fatigue related to altered breathing mechanics
- Emotional or psychological distress related to communication challenges, body image, and reliance on a visible airway device

- **Throat Reconstructive Surgery –** also known as pharyngeal or pharyngoesophageal reconstruction and is performed after removal of part or all of the pharynx for head and neck cancer. Its main purpose is to restore continuity of the throat so that patients can swallow safely and maintain nutrition, while also supporting speech rehabilitation when possible. Reconstruction is planned at the same time as tumor removal and is considered an essential component of modern surgical cancer care rather than a secondary procedure. This is performed using free tissue transfer, where tissue with its own blood supply is taken from another part of the body and microsurgically connected to vessels in the neck. The radial forearm free flap is frequently used for smaller or moderate defects because it is thin and flexible, closely resembling natural pharyngeal tissue. The anterolateral thigh flap is preferred for larger defects when more bulk is needed. These techniques allow surgeons to recreate a functional swallowing tube and reduce complications such as leakage or narrowing. Patients are initially fed through a tube while healing occurs, and swallowing is gradually reintroduced once imaging confirms the reconstruction is intact.

When it's used:

- A significant portion of the pharynx has been removed for cancer control
- Primary closure of the throat is not possible without tension
- Total laryngopharyngectomy or partial pharyngectomy creates a large defect
- Restoration of swallowing is required to allow oral nutrition
- Adequate patient fitness allows for prolonged surgery and microsurgical reconstruction is significant during this period, as patients cope with changes in speech, swallowing, appearance, and independence.

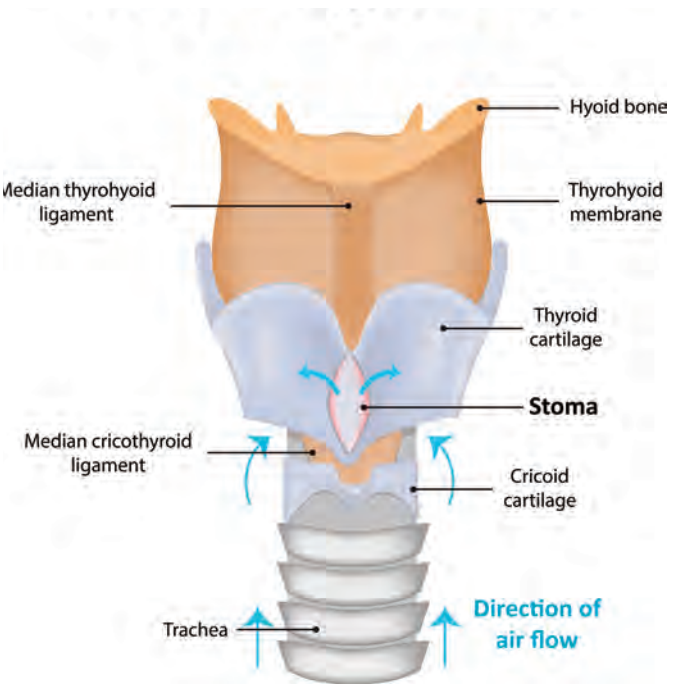
After throat reconstructive surgery, hospital stay is typically prolonged and averages 2-3 weeks, depending on the extent of resection, type of reconstruction, and postoperative course. Early care focuses on airway management, close monitoring of the reconstructed pharynx or flap, pain control, and prevention of complications such as infection, bleeding, or fistula formation. Most patients breathe through a tracheostoma, either temporary or permanent, and require humidification, suctioning, and stoma care education. Oral intake is avoided initially, with nutrition provided via a nasogastric tube or gastrostomy to protect the reconstruction while healing occurs. If free flap reconstruction has been performed, frequent flap checks are essential in the first days to ensure adequate blood supply. Speech-language pathology, physical therapy, and nutrition teams are involved early to support communication strategies, safe mobility, and nutritional planning.

During the first month after discharge, recovery is centered on wound healing, adaptation to altered anatomy, and gradual restoration of basic function. Fatigue is common and often marked. Swallowing is not resumed until imaging confirms that the reconstructed throat has healed and there is no leak, after which oral intake is reintroduced slowly under specialist supervision. Swallowing may initially be effortful and inefficient, and many patients continue partial tube feeding during this phase. Communication relies on non-verbal methods or alaryngeal speech devices if the larynx has been removed. Emotional and psychological adjustment.

Between 1-3 months after surgery, functional recovery continues but remains gradual. Swallowing typically improves with therapy, although some patients experience prolonged dysphagia or dietary limitations. Speech rehabilitation progresses, and selected patients may begin evaluation for tracheoesophageal speech if appropriate. Neck and shoulder stiffness, particularly after neck dissection, often becomes more apparent and requires continued physical therapy. If adjuvant radiation therapy is given, recovery may be slower, with increased fatigue, mucosal irritation, fibrosis, and worsening swallowing difficulty.

Exercise is an important part of recovery but must be carefully structured. Gentle mobilization, such as short walks, is encouraged as early as possible to reduce deconditioning and respiratory complications. During the first several weeks, exercise should focus on low-intensity activities, posture, and gentle range-of-motion exercises for the neck, shoulders, and upper back, particularly in patients who have undergone neck dissection. Breathing exercises and stoma humidification techniques are important for airway comfort and secretion management. As strength and stamina improve, low-impact aerobic activity such as longer walks or stationary cycling can be gradually increased, guided by fatigue levels and nutritional status.

Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstructed tissues. Swimming is contraindicated until wounds are fully healed and, even thereafter, patients with a permanent stoma require specialized protective equipment to prevent water entry into the airway. Contact sports and activities that risk trauma to the neck or stoma should be avoided. Exposure to smoke, dust, and other respiratory irritants should be minimized, and smoking is strictly contraindicated due to its negative impact on healing and cancer outcomes.



Potential Side-effects of Throat Reconstructive Surgery:

- Dysphagia, which may be prolonged or permanent
- Delayed return to oral intake, with partial or long-term dependence on tube feeding
- Pharyngeal or esophageal stricture formation requiring dilation
- Sensation of food sticking or slow passage during swallowing
- Pharyngocutaneous fistula with leakage of saliva into the neck
- Wound infection or delayed wound healing
- Bleeding or hematoma formation
- Partial or complete flap failure following free flap reconstruction
- Permanent loss of natural voice if combined with laryngectomy
- Dependence on alaryngeal speech methods such as an electrolarynx or tracheoesophageal speech
- Reduced speech clarity, vocal endurance, or communication efficiency
- Permanent tracheostoma with increased mucus production
- Airway dryness, crusting, coughing, and irritation
- Increased sensitivity to cold air, smoke, and dust
- Stoma-related complications such as infection, narrowing, or skin irritation
- Neck and shoulder stiffness or weakness, particularly after neck dissection
- Chronic neck or shoulder pain
- Lymphedema of the neck and face
- Reduced range of motion
- Fibrosis and tissue stiffness, especially after radiation therapy
- Chronic pain or discomfort
- Xerostomia and taste changes if radiation is given
- Fatigue and reduced exercise tolerance
- Psychological effects including anxiety, depression, altered body image, and social withdrawal
- Reduced quality of life related to changes in swallowing, speech, and appearance

Glossectomy – refers to surgery to remove part or all of the tongue, most commonly to treat tongue and oral cavity cancers. The type of glossectomy depends on how much of the tongue is involved, where the tumor is located, and how deeply it has grown.

- **Partial Glossectomy –** removes a small portion of the tongue containing the tumor along with a margin of healthy tissue. Most of the tongue remains intact. This is the most common type used for early-stage tongue cancers. Surgeons aim to preserve tongue movement so speech and swallowing are affected as little as possible. Reconstruction is often not needed, or a small local tissue repair is used.

- **Hemiglossectomy –** removes approximately half of the tongue, usually on one side. This is done when the tumor is larger or deeper but still limited to one side of the tongue. Because a significant portion of tongue muscle is removed, reconstruction with tissue from another part of the body is often needed to restore bulk and mobility. Speech and swallowing are affected initially but often improve with therapy.

- **Extended Hemiglossectomy –** removes one side of the tongue plus nearby tissues such as the floor of the mouth or part of the tonsil region if the cancer has spread locally. This is used for more advanced tumors that extend beyond the tongue itself but are still surgically removable. Reconstruction is almost always required, and recovery involves intensive speech and swallowing rehabilitation.

- **Subtotal Glossectomy –** removes most of the tongue but leaves a small portion behind, usually at the base or one side. This is used for very advanced tongue cancers where preserving even a small amount of tongue tissue may help with swallowing or airway protection. Reconstruction is complex, and long-term speech and swallowing changes are common.

- **Total Glossectomy –** removes the entire tongue. This is eserved for very advanced or recurrent cancers when no tongue tissue can be safely preserved. Because the tongue plays a critical role in speech and swallowing, patients typically require major reconstruction and often a permanent feeding tube. Speech is significantly altered, but communication is still possible through therapy and assistive methods

- **Base-of-tongue Glossectomy (posterior tongue surgery) –** removes tumors located in the back part of the tongue, often accessed through the mouth using specialized tools or robotic surgery. The goal is to remove the tumor while avoiding large external incisions. Swallowing changes may occur, but recovery is often faster than with open approaches.

When it's used:

- Partial - for small, localized Stage I-II tumors confined to the oral tongue

- Hemi - larger tumors involving one side of the tongue that have not crossed the midline

- Subtotal - large Stage III-IV tumors involving more than half the tongue

- Total - advanced tumors involving the full extent of the tongue including the base

- Total with laryngectomy - most advanced cases where the tumor has extended into the larynx

After a glossectomy, the length of hospital stay depends on the extent of tongue resection and whether reconstruction or neck dissection has been performed. Patients undergoing a small partial glossectomy without reconstruction may remain in hospital for around five to seven days, whereas those undergoing hemiglossectomy, subtotal, or total glossectomy with free-flap reconstruction commonly require a hospital stay of 10-21 days. Early postoperative care focuses on airway protection, pain control, wound and flap monitoring, and nutritional support. A temporary tracheostomy is common after larger resections to protect the airway and manage secretions. Oral intake is usually withheld initially, with nutrition provided via a nasogastric tube or gastrostomy to protect the surgical site.

Speech and language therapy, physical therapy, and dietetics are involved early to plan communication strategies, begin tongue mobility exercises, and support safe mobilization.

During the first month after discharge, recovery centers on wound healing, management of fatigue, and gradual reintroduction of swallowing and speech. Swallowing is restarted cautiously once healing is confirmed, often with instrumental assessment, as impaired tongue control significantly increases aspiration risk. Many patients require modified diets and continued tube feeding during this phase. Speech is often markedly altered, particularly after larger resections, and communication may be slow and effortful. Tongue weakness, reduced range of motion, drooling, and difficulty manipulating food are

common. Emotional adjustment is substantial during this period, especially for patients coping with visible changes and loss of normal speech and eating.

Between 1-3 months after surgery, functional recovery continues gradually. Swallowing efficiency typically improves with therapy, although some patients continue to require dietary modifications or supplemental tube feeding, particularly after subtotal or total glossectomy. Speech intelligibility improves with rehabilitation but may not return to baseline, especially after extensive resections. Physical endurance increases slowly, but weight loss and fatigue may persist. If adjuvant radiation therapy is required, recovery may be slower, with increased fibrosis, dry mouth, and worsening swallowing difficulty.

Exercise during recovery should be progressive and closely supervised. Early mobilization with short, frequent walks is encouraged as soon as medically safe to reduce deconditioning and pulmonary complications. In the first several weeks, exercise should focus on low-intensity activity, posture, and gentle neck and shoulder range-of-motion exercises, particularly if neck dissection has been performed. Tongue range-of-motion, stretching, and strengthening exercises prescribed by speech and language therapy are critical and should be performed regularly to improve swallowing and speech outcomes. As healing progresses, low-impact aerobic exercise such as longer walks or stationary cycling can be gradually increased, guided by fatigue, pain, and nutritional status.

Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these may compromise wound healing or reconstruction. Contact sports and activities with a risk of facial or neck trauma should be avoided.

Swimming should be deferred until all surgical wounds have fully healed, and patients with a tracheostomy require specialized guidance before any water exposure. Smoking and exposure to smoke or other airway irritants are strictly contraindicated due to their negative effects on healing, swallowing function, and cancer outcomes

Potential Side-effects of all Glossectomies:

- Swallowing difficulties due to reduced tongue mobility and bolus control
- Aspiration or coughing during eating and drinking
- Delayed or incomplete return to oral intake
- Temporary or long-term dependence on tube feeding
- Speech changes, including reduced clarity and articulation
- Slurred or slowed speech
- Reduced speech intelligibility, especially after larger resections
- Reduced tongue strength and range of motion
- Difficulty manipulating food within the mouth
- Drooling or poor saliva control
- Altered taste sensation or loss of taste
- Changes in appetite and unintended weight loss
- Pain, swelling, or stiffness of the tongue and floor of mouth
- Scarring or fibrosis affecting tongue movement
- Neck and shoulder stiffness or weakness if neck dissection is performed
- Lymphedema of the tongue, neck, or face
- Psychological effects such as anxiety, frustration with communication, altered body image, and reduced quality of life
- Side effects related to adjuvant radiation therapy, including dry mouth, worsening swallowing difficulty, fibrosis, and fatigue

Mandibulectomy – involves removal of part of the mandible and is, uncommon in pharyngeal cancer used only when there is direct bony invasion. Its role is primarily in advanced oropharyngeal cancer, particularly tumors arising from the tonsil or base of tongue that invade the mandible.

Types of Mandibulectomies:

- **Marginal Mandibulectomy –** removal of the mandibular cortex while preserving mandibular continuity
- **Segmental Mandibulectomy –** removal of a full-thickness segment of mandible, disrupting continuity
- **Hemimandibulectomy –** removal of one half of the mandible; very rare

When it's used:

- Radiologic or intraoperative evidence of mandibular invasion
- Advanced oropharyngeal tumors
- Salvage surgery with bone involvement
- Clear margins cannot be achieved with soft-tissue resection alone

After a mandibulectomy, the length of hospital stay depends on the extent of bone removal and whether reconstruction has been performed. Patients undergoing a marginal mandibulectomy without complex reconstruction typically remain in hospital for about 7-10 days, while those undergoing segmental or hemimandibulectomy with free-flap reconstruction often require 14-21 days of inpatient care. Early postoperative management focuses on airway protection, pain control, wound and flap monitoring, and nutritional support. A temporary tracheostomy is common after larger resections to manage airway swelling and secretions. Oral intake is usually delayed initially, with nutrition provided via a nasogastric tube or gastrostomy to protect healing tissues. Close monitoring is required for bleeding, infection, wound breakdown, and flap viability when reconstruction is used. Speech-language pathology, physical therapy, dietetics, and dental or maxillofacial teams are involved early to support communication, mobility, and long-term functional planning.

During the first month after discharge, recovery is centered on wound healing, management of fatigue, and gradual return of basic function. Swallowing is cautiously reintroduced once healing is confirmed, often with modified diets, as chewing and bolus control are significantly impaired following mandibular resection. Jaw stiffness, pain, and reduced mouth opening are common, particularly after segmental mandibulectomy. Speech may be altered due to changes in jaw stability, dental occlusion, and tongue positioning. Facial swelling, numbness, and asymmetry are frequent early concerns. Many patients continue to rely partially on tube feeding during this period while oral intake is re-established.

Between 1-3 months after surgery, functional recovery continues gradually. Jaw mobility often improves with therapy, but trismus and malocclusion may persist and require ongoing rehabilitation or dental intervention. Chewing efficiency remains reduced, and patients often require soft or modified diets. Speech clarity typically improves but may not return fully to baseline, especially after extensive resections. Neck and shoulder stiffness, particularly if neck dissection was performed, may become more prominent and requires continued physical therapy. If adjuvant radiation therapy is required, recovery may slow further, with increased fibrosis, dry mouth, fatigue, and worsening swallowing and jaw mobility.

Exercise during recovery should be progressive and carefully structured. Early mobilization with short, frequent walks is encouraged as soon as medically safe to reduce deconditioning and pulmonary complications. In the first several weeks, exercise should focus on low-intensity activity, posture, and gentle neck and shoulder range-of-motion exercises. Jaw-opening and stretching exercises are essential after mandibulectomy to prevent or reduce trismus and should be performed regularly under guidance from speech-language pathology or physical therapy. As healing progresses, low-impact aerobic activities such as longer walks or stationary cycling can be gradually increased, guided by pain, fatigue, and nutritional status.

Exercise contraindications include heavy lifting, strenuous upper-body exercise, and activities that significantly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstruction. Contact sports and activities with risk of facial or jaw trauma should be avoided.

Swimming should be deferred-until all surgical wounds have fully healed and reconstruction is stable. Excessive chewing, gum use, or forceful jaw exercises should be avoided early in recovery. Smoking and exposure to smoke or other irritants are strictly contraindicated due to their negative effects on bone healing, soft tissue recovery, and cancer outcomes.

Potential Side-effects of all Mandibulectomies:

- Swallowing difficulties due to impaired chewing and bolus preparation
- Delayed or incomplete return to normal oral intake
- Long-term need for soft or modified diets
- Chewing difficulty and reduced bite strength
- Malocclusion or misalignment of the teeth
- Difficulty wearing dentures or dental prostheses
- Jaw stiffness or trismus with reduced mouth opening
- Pain or discomfort with jaw movement
- Speech changes, including reduced clarity or articulation difficulty
- Slurred or altered speech due to jaw instability or tongue displacement
- Facial asymmetry or contour deformity
- Visible scarring or cosmetic changes to the lower face
- Numbness or altered sensation of the lower lip, chin, or jaw due to nerve injury
- Chronic neuropathic pain in the jaw or face
- Wound complications such as infection, delayed healing, or wound breakdown
- Fistula formation or exposure of reconstruction plates
- Flap-related complications if free-flap reconstruction is performed
- Neck and shoulder stiffness or weakness if neck dissection is performed
- Lymphedema of the neck or face
- Weight loss and nutritional deficiencies
- Fatigue and reduced physical endurance
- Psychological effects including anxiety, altered body image, social withdrawal, and depression
- Side effects related to adjuvant radiation therapy, including fibrosis, dry mouth, worsening swallowing difficulty, and chronic pain

Maxillectomy – involves removal of part or all of the maxilla and is very rarely used in pharyngeal cancer. It is not a standard procedure and is only indicated when tumors extend superiorly into the hard palate or maxilla, typically from the oropharynx.

Types of Maxillectomies:

- **Partial maxillectomy –** removal of a portion of the maxilla, often sparing orbital structures
- **Subtotal maxillectomy –** removal of most of the maxilla with preservation of key structures
- **Total maxillectomy –** complete removal of the maxilla noted rarely in pharyngeal cancer

When it's used:

- Superior extension of oropharyngeal cancer into the hard palate or maxilla
- Advanced tumors crossing anatomic subsites
- Bony invasion confirmed on imaging or intraoperatively

After a maxillectomy, the hospital stay varies with the extent of bone and soft-tissue removal and whether reconstruction or an obturator is used. Patients undergoing a limited partial maxillectomy may remain in hospital for approximately 5-7 days, while those undergoing subtotal or total maxillectomy - particularly with free-flap reconstruction - often require 10-21 days of inpatient care. Early postoperative priorities include airway monitoring, pain control, wound and flap surveillance if reconstruction has been performed, and management of oral–nasal separation. Nutrition is usually provided via a nasogastric tube or gastrostomy initially to protect the surgical site. Patients fitted with an obturator prosthesis may begin early adjustment and education with prosthodontics during the admission. Speech-language pathology, physical therapy, and dietetics are involved early to support communication strategies, safe mobilization, and nutritional planning.

During the first month after discharge, recovery focuses on wound healing, adaptation to altered oral and nasal anatomy, and gradual reintroduction of oral intake. Fatigue is common. Swallowing is restarted cautiously once healing is confirmed; patients may experience nasal regurgitation, altered taste, or difficulty with bolus control, particularly before obturator fitting or while flap edema subsides. Speech may be hypernasal or less intelligible initially, improving with therapy and prosthetic adjustment. Oral hygiene requires careful attention to prevent infection. Facial swelling, cheek numbness, and discomfort with chewing are common early issues, especially after larger resections.

Between 1-3 months postoperatively, functional recovery continues steadily. Swallowing efficiency and diet texture usually improve as patients adapt to prostheses or reconstructed anatomy, though some dietary limitations may persist. Speech clarity typically improves with ongoing therapy and obturator refinement. Jaw stiffness or trismus can become more apparent and requires consistent exercises. Physical endurance gradually increases, but recovery may be slowed if adjuvant radiation therapy is required, with additional effects such as mucositis, xerostomia, fibrosis, and fatigue impacting eating and exercise tolerance.

Exercise should be progressive and individualized. Early mobilization with short, frequent walks is encouraged as soon as medically safe to reduce deconditioning and pulmonary complications. In the first several weeks, exercise should emphasize low-intensity activity, posture, and gentle neck and shoulder range-of-motion exercises, particularly if neck dissection was performed. Jaw-opening and stretching exercises are important to prevent or reduce trismus and should be performed regularly as instructed. As healing progresses, low-impact aerobic activities such as longer walks or stationary cycling can be gradually increased, guided by pain, fatigue, and nutritional status.

Contraindications include heavy lifting, strenuous upper-body exercise, and activities that markedly increase intrathoracic pressure for at least 6-8 weeks, as these can compromise wound healing and reconstruction. Contact sports and activities with a risk of facial trauma should be avoided. Swimming should be deferred until all wounds have fully healed and any obturator or reconstruction is stable. Patients should avoid blowing the nose forcefully in the early postoperative period to protect the surgical site. Smoking and exposure to smoke or other irritants are strictly contraindicated due to their adverse effects on healing and long-term outcomes.

Potential Side-effects of all Maxillectomies:

- Swallowing difficulties due to loss of separation between the oral and nasal cavities
- Nasal regurgitation of food or liquids, especially before obturator fitting or if reconstruction is incomplete
- Delayed return to normal oral intake
- Dietary restrictions or need for long-term texture modification
- Speech changes, including hypernasal speech
- Reduced speech clarity or intelligibility
- Dependence on an obturator prosthesis or reconstructive flap for speech function
- Chewing difficulties due to loss of upper jaw support
- Malocclusion or difficulty wearing dentures
- Reduced bite strength
- Facial swelling, numbness, or altered sensation in the cheek, upper lip, or palate
- Facial asymmetry or cosmetic deformity
- Altered taste or reduced sense of smell
- Dry mouth, particularly if radiation therapy is given
- Wound complications such as infection, delayed healing, or fistula formation
- Flap-related complications if reconstruction is performed
- Trismus or jaw stiffness
- Neck and shoulder stiffness if neck dissection is performed
- Chronic sinus issues, including nasal crusting or infection
- Air leakage between the mouth and nose
- Psychological effects such as anxiety, altered body image, social withdrawal, and reduced quality of life
- Side effects related to adjuvant radiation therapy, including fibrosis, mucositis, fatigue, and worsening swallowing or speech difficulties

The type and severity of side effects depend on the extent of maxillary resection, use of reconstruction or obturators, and whether additional treatments are required.



Types of Treatment Used:

- Definitive radiotherapy (RT)
- Concurrent chemoradiotherapy (CRT)
- Altered-fractionation radiotherapy
- Radiotherapy
- Targeted therapy
- Immunotherapy
- Induction (neoadjuvant) chemotherapy
- Induction or (neoadjuvant) immunotherapy

CANCER OF THE ESOPHAGUS

There were 511,054 new cases and 445,391 deaths from esophageal cancer worldwide in 2022, with approximately 75% of all cases and deaths occurring in Asia (Qi et al., Chinese Medical Journal, 2024). Esophageal cancer is the ninth most commonly diagnosed cancer and the sixth leading cause of cancer-related death globally, with a five-year survival rate of less than 20% overall (Sheikh et al., Cancers, 2023).

The two main histological subtypes are esophageal squamous cell carcinoma (ESCC) and esophageal adenocarcinoma (EAC), which are epidemiologically and pathologically distinct. ESCC accounts for approximately 80-90% of cases worldwide and predominates in Eastern Asia and Southern Africa, while EAC is rising in incidence in Western countries - particularly the United States, Western Europe, and Australia - driven by increasing rates of obesity and gastroesophageal reflux disease (GERD) (Sheikh et al., Cancers, 2023).

Men are more than twice as likely as women to develop esophageal cancer, with age-standardized incidence rates approximately 2.5 times higher in men than women (Bray et al., CA: A Cancer Journal for Clinicians, 2024). Less than 15% of cases occur in people younger than 55, and risk increases steadily with age (ACS, Esophageal Cancer Risk Factors, 2024).

Barrett's Esophagus and GERD represent the most significant risk pathway for esophageal adenocarcinoma. When stomach acid repeatedly refluxes into the lower esophagus over a prolonged period, it damages the inner lining and causes the normal squamous cells to be replaced by gland cells - a condition known as Barrett's esophagus. This is a precancerous condition that increases the risk of developing esophageal adenocarcinoma by 30-125 times compared to people without the condition (MSK, Barrett's Esophagus, 2024). People with GERD have a higher risk of adenocarcinoma, with risk increasing in proportion to the frequency and duration of reflux symptoms. The annual risk of progression from Barrett's esophagus to esophageal adenocarcinoma is approximately 0.25% for patients without dysplasia and rises to approximately 6% in the presence of high-grade dysplasia (ACS, Esophageal Cancer Risk Factors, 2024). Most people with Barrett's esophagus have a history of heartburn, but many have no symptoms at all, underscoring the importance of endoscopic screening in high-risk individuals.

Risk factors for esophageal cancer include tobacco use - the more a person smokes and the longer they smoke, the higher the risk - and alcohol consumption, which disproportionately affects the squamous cell type. The combination of smoking and drinking raises risk substantially more than either alone. Obesity increases the risk of adenocarcinoma primarily through its association with GERD and Barrett's esophagus. Dietary factors including high consumption of processed meat, very hot liquids, and low intake of fruits and vegetables are also associated with increased risk -particularly for ESCC (ACS, Esophageal Cancer Risk Factors, 2024). Achalasia - a condition in which the lower esophageal sphincter fails to relax properly - causes food and liquid to collect in the esophagus, leading to chronic cellular irritation; cancers in this setting typically appear 15-20 years after the achalasia diagnosis. HPV infection has been identified in up to one-third of esophageal cancers in parts of Asia and South Africa but has not been consistently found in esophageal cancers in the United States or Western countries (ACS, Esophageal Cancer Risk Factors, 2024).

Symptoms of esophageal cancer include progressive difficulty swallowing - initially with solids and later with liquids - along with sensations of pressure, burning, or pain in the upper middle chest, hoarseness, persistent cough, fever, and choking. These symptoms may come and go in the early stages and are frequently attributed to other conditions, contributing to late-stage diagnosis.

Procedures:

- **Esophagectomy –** the surgical removal of part or all of the esophagus with reconstruction of the gastrointestinal tract, most commonly using the stomach as a conduit. It is used with curative intent for resectable esophageal cancer, usually after neoadjuvant chemoradiotherapy or chemotherapy. Surgical approach is selected based on tumor location, stage, histology, patient physiology, and institutional expertise, with minimally invasive techniques now standard in many centers.

1. Transthoracic Esophagectomy (TTE) – involves resection of the esophagus through the chest in combination with an abdominal approach, allowing formal mediastinal lymph node dissection

When it's used:

- Mid or distal esophageal cancer
- Locally advanced disease requiring extensive mediastinal lymphadenectomy
- Patients with good cardiopulmonary reserve
- Curative-intent surgery after neoadjuvant therapy

2. Ivor Lewis Esophagectomy – involves an abdominal phase to mobilize the stomach followed by a right thoracic phase to resect the esophagus, with an intrathoracic anastomosis

When it's used:

- Distal esophageal or gastroesophageal junction adenocarcinoma
- Tumors located below the carina
- Standard approach following neoadjuvant chemoradiotherapy

3. McKeown (three-field) Esophagectomy – involves abdominal, thoracic, and cervical phases, with a cervical esophagogastric anastomosis. It allows greater proximal margin control and more extensive lymphadenectomy but is associated with higher morbidity.

When it's used:

- Mid-esophageal squamous cell carcinoma
- Tumors with proximal extension requiring cervical margins
- Need for three-field lymph node dissection

4. Transhiatal Esophagectomy – removes the esophagus through abdominal and cervical incisions without thoracotomy. Mediastinal dissection is blunt and less extensive, and its use has declined but remains appropriate in selected patients.

When used:

- Distal esophageal or gastroesophageal junction cancer
- Patients with poor pulmonary reserve
- Situations where avoiding thoracotomy is desirable

5. Minimally Invasive Esophagectomy (MIE) - uses laparoscopic and thoracoscopic techniques to perform transthoracic or transhiatal resections. In 2025, MIE is standard of care in many high-volume centers due to reduced pulmonary complications and faster recovery.

When it's used:

- Most resectable esophageal cancers
- Patients fit for surgery
- Availability of experienced minimally invasive teams

6. Robot-Assisted Esophagectomy – is an extension of minimally invasive surgery, offering enhanced visualization and precision, particularly in confined mediastinal spaces.

When it's used:

- Complex mediastinal dissections are required
- High-volume specialist centers
- Squamous cell carcinoma requiring meticulous lymphadenectomy

7. Salvage Esophagectomy – is performed after failure of definitive chemoradiotherapy. It is associated with higher morbidity and mortality and requires careful patient selection.

When it's used:

- Persistent or recurrent localized disease after definitive CRT
- No distant metastases
- Patient remains physiologically fit

8. Esophagectomy with Alternative Conduits (Colon or Jejunal Interposition) – when the stomach is unavailable or unsuitable for reconstruction, colon or jejunum may be used as an alternative conduit.

When it's used:

- Prior gastrectomy
- Nonviable gastric conduit
- Selected salvage or redo cases

After an esophagectomy, recovery follows a predictable but prolonged course that reflects the magnitude of the operation, regardless of whether the approach was open, minimally invasive, robotic, transthoracic, transhiatal, or salvage. Most patients remain in the hospital for about 1-2 weeks, although stays may extend to 2-3 weeks after open or salvage procedures or if complications occur. The first few days are usually spent in a high-dependency or intensive care setting. Because pulmonary complications are a major risk, chest physiotherapy and assisted ambulation begin early. Oral intake is withheld initially, and nutrition is provided through a jejunostomy day 5-7, a contrast swallow study is often performed to assess the anastomosis before oral intake is cautiously introduced. During this period, patients are closely monitored for complications such as pneumonia, anastomotic leak, atrial fibrillation, chylothorax, and delayed gastric emptying.

The first month after discharge is typically the most challenging phase of recovery. Fatigue is prominent, stamina is markedly reduced, and patients must adapt to major changes in eating. Meals are small and frequent, with careful attention to posture and pacing to reduce reflux, regurgitation, and dumping symptoms.

Weight loss is common, even when tube feeding is continued, and nutritional support remains a central focus. Swallowing may feel slow or uncomfortable at first, especially in patients with a cervical anastomosis. Reflux, early satiety, bloating, diarrhea, and sleep disturbance are frequent complaints. Pain and stiffness in the chest, upper abdomen, neck, or shoulders are common, particularly after open or transthoracic surgery, and emotional adjustment can be significant as patients come to terms with the physical and lifestyle changes imposed by the operation.

Between the 2-3 postoperative months, recovery becomes more gradual and incremental. Energy levels slowly improve, oral intake increases, and reliance on tube feeding is often reduced or discontinued as tolerated. Diet variety expands, although portion sizes remain limited and patients often continue to avoid large meals. Exercise tolerance improves, but many patients still fatigue easily and require frequent rest. Gastroesophageal reflux, dumping syndrome, and altered bowel habits may persist. If adjuvant chemotherapy or immunotherapy is required, progress may be slower, with additional fatigue, nausea, and reduced physical capacity.

Exercise plays a critical role in recovery but must be approached cautiously and progressively. Mobilization begins in the hospital with sitting out of bed and short walks, aimed at reducing pulmonary complications and venous thromboembolism. After discharge, patients are encouraged to walk daily, gradually increasing distance and pace according to tolerance. During the first 4-6 weeks, exercise should focus on low-intensity aerobic activity, breathing exercises, posture, and gentle shoulder and upper back range-of-motion work, particularly after thoracic surgery.

From 6-23 weeks, moderate aerobic activities such as longer walks or stationary cycling can be introduced, and light resistance exercises may be added using low weights and high repetitions, guided by fatigue levels and nutritional status.

Certain precautions are essential during early recovery. Heavy lifting, strenuous upper-body exercise, and activities that markedly increase intra-abdominal or intrathoracic pressure should be avoided for at least 6-8 weeks to protect the anastomosis and abdominal incisions. Contact sports and activities that risk chest or abdominal trauma are contraindicated. Patients are advised not to lie flat soon after meals and to elevate the head of the bed to reduce reflux. Swimming should be avoided until all wounds are fully healed, and strenuous exercise immediately after eating should be avoided because of the risk of reflux, dizziness, or dumping symptoms. Smoking is strictly contraindicated, and alcohol intake should be minimized, as both impair healing and exacerbate reflux.

Potential Side-effects of all Esophagectomies:

- Dysphagia or sensation of food sticking
- Need for small, frequent meals
- Prolonged or permanent changes in eating patterns
- Gastroesophageal reflux
- Regurgitation, especially when lying flat
- Risk of aspiration, particularly at night
- Dumping syndrome with dizziness, sweating, palpitations
- Diarrhea, bloating, and abdominal cramping
- Late hypoglycemia after meals
- Unintended weight loss
- Malnutrition or vitamin and micronutrient deficiencies
- Early satiety and reduced appetite
- Pneumonia
- Atelectasis
- Chronic shortness of breath or reduced lung capacity
- Anastomotic leak
- Anastomotic stricture requiring dilation
- Delayed gastric emptying
- Atrial fibrillation
- Other postoperative cardiac arrhythmias
- Chest, abdominal, or neck pain
- Shoulder and upper back stiffness
- Reduced range of motion
- Prolonged fatigue
- Reduced exercise tolerance
- Hoarseness from recurrent laryngeal nerve injury
- Chronic cough
- Wound infection or delayed wound healing
- Incisional hernia
- Chylothorax
- Anxiety or depression

Reconstructive Procedures:

1. **Gastric Pull-up –** is the standard and most commonly used method of reconstruction after esophagectomy. The stomach is mobilized, shaped into a narrow conduit, and brought up into the chest or neck to replace the resected esophagus, where it is anastomosed to the remaining esophagus or pharynx. The stomach's robust blood supply, primarily from the right gastroepiploic artery, makes it reliable and technically efficient. This method allows a single anastomosis and avoids the need for additional bowel resections, resulting in shorter operative time and lower complication rates compared with alternative conduits. Long-term issues may include reflux, delayed gastric emptying, and dumping syndrome, but overall it provides good swallowing outcomes and durability.

2. **Colon Interposition –** is used when the stomach is unavailable or unsuitable as a conduit, such as after prior gastrectomy, gastric cancer, or inadequate gastric blood supply. A segment of colon is mobilized and interposed between the pharynx or remaining esophagus and the stomach or small bowel. The colon provides sufficient length and durability for long-term reconstruction but requires multiple anastomoses and careful vascular planning, making it a more complex operation. Colon interposition is associated with higher operative time and morbidity compared with gastric pull-up but can provide excellent long-term swallowing function in selected patients.

3. **Right Colon Interposition –** uses the ascending colon and part of the transverse colon, typically supplied by the middle colic artery. This technique offers reliable length and a consistent blood supply, making it suitable for reconstruction to the neck. The right colon's diameter and peristaltic characteristics are favorable for esophageal replacement. However, the operation is technically demanding and requires careful preservation of vascular pedicles. It is most often used in high-volume centers with expertise in complex esophageal reconstruction.

4. **Left Colon Interposition –** uses the descending colon, usually based on the left colic artery. It provides excellent length and is often favored for cervical reconstructions because of its predictable blood supply and orientation. The left colon may have more consistent marginal artery anatomy than the right colon, but it still requires meticulous preoperative vascular assessment. Like all colon interpositions, it involves multiple anastomoses and carries risks of ischemia, anastomotic leak, and late redundancy or dysmotility.

5. **Jejunal Interposition –** uses a segment of small intestine to reconstruct the esophagus. The jejunum closely resembles the esophagus in diameter and peristaltic function, which can result in excellent swallowing outcomes. However, its limited length restricts its use to short-segment reconstruction, such as cervical or upper thoracic defects. Jejunal interposition is less commonly used than gastric or colonic conduits but remains valuable in selected cases, particularly for proximal reconstructions.

6. **Pedicled Jejunal Flap –** involves mobilizing a segment of jejunum while preserving its native blood supply and transposing it into the chest or neck without microvascular anastomosis. This approach avoids the complexity of microsurgery but is limited by the length of the mesentery, which restricts how far the jejunum can be advanced. It is most commonly used for cervical esophageal or pharyngoesophageal reconstruction and offers good functional outcomes when anatomy permits.

7. **Free Jejunal Flap –** involves harvesting a segment of jejunum and transferring it to the neck with microvascular anastomosis to cervical vessels. It is most commonly used for pharyngoesophageal reconstruction, particularly after total laryngopharyngectomy. The jejunum's mucosa closely resembles the native pharynx and esophagus, providing excellent swallowing outcomes and low stricture rates. However, this technique requires microsurgical expertise, longer operative time, and carries risks related to vascular thrombosis and flap failure. It is typically reserved for specialized centers.

Recovery after esophageal reconstruction - whether using a gastric pull-up, colon interposition (right or left), a pedicled jejunal flap, or a free jejunal flap - is substantial and prolonged, reflecting the complexity of these operations. While the specific conduit influences complication risk and pace of recovery, the overall postoperative course is broadly similar across procedures.

Hospitalization typically lasts around 10-14 days after gastric pull-up reconstruction and closer to 14-21 days after colon or jejunal interposition, particularly when microsurgical techniques are used. Most patients spend the first 1-3 in a high-dependency or intensive care unit for close monitoring of respiratory function, cardiovascular stability, and conduit or flap perfusion. Early priorities include effective pain control, aggressive pulmonary physiotherapy, prevention of venous thromboembolism, and vigilant monitoring for complications such as anastomotic leak, conduit ischemia, or flap compromise. Oral intake is withheld initially, and nutrition is provided through a jejunostomy feeding tube. A contrast swallow study is usually performed around postoperative day 5-7 to confirm anastomotic integrity before oral intake is cautiously introduced. Patients with free jejunal flaps undergo particularly close monitoring in the early postoperative period to ensure adequate blood supply.

The first month after discharge is often the most challenging phase of recovery. Fatigue is pronounced, physical stamina is limited, and patients must adapt to major and often permanent changes in eating habits. Oral intake is reintroduced gradually, beginning with liquids and progressing to soft foods. Meals need to be small, frequent, and taken slowly, with patients remaining upright afterward to reduce reflux and regurgitation. Weight loss is common despite tube feeding support, especially after colon or jejunal reconstruction. Swallowing may feel slow or effortful, and symptoms such as reflux, early satiety

Between the 2-3 postoperative months, recovery becomes more gradual and incremental. Energy levels slowly improve, oral intake increases, and reliance on tube feeding is often reduced or discontinued as tolerated. Diet variety expands, although portion sizes typically remain limited, and many patients continue to experience reflux or altered bowel habits, particularly after gastric pull-up or colon interposition. Exercise tolerance improves but remains reduced compared with baseline, and fatigue is still common. If adjuvant chemotherapy or immunotherapy is required, progress may be slower, with additional tiredness and reduced physical capacity. By three months, many patients are able to resume light daily activities, although full recovery frequently takes 6-12 months. Exercise is a crucial component of rehabilitation but must be introduced in a structured and progressive manner. Mobilization begins in hospital with sitting out of bed and short walks to reduce pulmonary complications and deconditioning.

After discharge, daily walking is encouraged, with gradual increases in distance and pace based on tolerance. During the first 4-6 weeks, exercise should focus on low-intensity aerobic activity, breathing exercises, posture, and gentle shoulder and upper-back range-of-motion work, particularly after thoracic surgery. From 6-12 weeks, moderate aerobic exercise such as longer walks or stationary cycling can be added, along with light resistance training using low weights and high repetitions, guided by fatigue levels and nutritional status.

Certain precautions are essential during early recovery. Heavy lifting, strenuous upper-body exercise, and activities that markedly increase intra-abdominal or intrathoracic pressure should be avoided for at least 6-8 weeks to protect the anastomosis and abdominal incisions.

Contact sports and activities that risk trauma to the chest, abdomen, or neck are contraindicated. Patients are advised to avoid lying flat soon after meals and to elevate the head of the bed to reduce reflux. Swimming should be avoided until all wounds are fully healed, and strenuous exercise immediately after eating should be avoided because of the risk of reflux, dizziness, or dumping symptoms. Smoking is strictly contraindicated, and alcohol intake should be minimized.

Potential Side-effects of Reconstruction:

- Difficulty swallowing or sensation of food sticking
- Need for lifelong small, frequent meals
- Gastroesophageal or bile reflux
- Regurgitation, especially when lying flat or at night
- Aspiration risk
- Dumping syndrome with dizziness, sweating, palpitations
- Diarrhea, abdominal cramping, bloating
- Late hypoglycemia after meals
- Early satiety and reduced appetite
- Unintended weight loss
- Malnutrition and vitamin or micronutrient deficiencies
- Atelectasis
- Reduced lung capacity or chronic shortness of breath
- Atrial fibrillation or other cardiac arrhythmias
- Chest, abdominal, neck, or shoulder pain
- Shoulder stiffness or reduced range of motion
- Hoarseness from recurrent laryngeal nerve injury
- Chronic cough
- Wound infection or delayed wound healing
- Incisional hernia
- Chylothorax
- Prolonged fatigue
- Reduced exercise tolerance
- Anxiety or depression

Types of Treatment Used:

- Radiation therapy
- Chemoradiation
- Immunotherapy
- Targeted therapy
- Monoclonal antibodies
- Intensity modulated radiation therapy
- Radiofrequency ablation
- Photodynamic therapy
- Laser ablation
- Argon plasma coagulation
- Electrocoagulation (electrofulguration)
- Laser therapy

LEUKEMIA

Leukemia is a cancer of the body's blood-forming tissues, including the bone marrow and the lymphatic system. There were 486,777 new cases and 305,033 deaths worldwide in 2022 (Bray et al., CA: A Cancer Journal for Clinicians, 2024). In the United States, an estimated 62,770 new cases and 23,670 deaths were projected for 2024, representing approximately 2.4% of all newly diagnosed cancers and 3.1% of all cancer deaths (NCI, SEER Cancer Stat Facts: Leukemia, 2024). Although overall age-standardized incidence and mortality rates have declined over recent decades due to advances in prevention, early diagnosis, and targeted therapies, substantial geographic, socioeconomic, and sex-related disparities persist (Chen et al., Frontiers in Medicine, 2025).

Leukemia is categorized based on which type of white blood cell is involved - lymphocytes or myeloid cells - and whether the disease is developing very quickly (acute) or slowly over time (chronic). Whether leukemia is myeloid or lymphocytic depends on which bone marrow cells the cancer starts in. Myeloid leukemias (also known as myelocytic, myelogenous, or non-lymphocytic leukemias) start in early myeloid cells - the cells that become white blood cells (other than lymphocytes), red blood cells, or platelet-making cells (megakaryocytes). Lymphocytic leukemias (also known as lymphoid or lymphoblastic leukemias) start in cells that become lymphocytes.

People with leukemia have many treatment options depending on the type and subtype of leukemia, their age, general health, and whether leukemia cells are present in the cerebrospinal fluid. The goal of treatment for acute leukemia is to achieve remission - eliminating detectable disease and becoming symptom-free. Consolidation or maintenance therapy may follow to prevent relapse. Many people with acute leukemia can be cured. For chronic leukemia, treatment often controls the disease and its symptoms effectively, though cure with chemotherapy alone is rarely achieved; allogeneic stem cell transplantation offers the best chance of cure for eligible patients (ACS, Treating Leukemia, 2024).

Supportive care is essential throughout treatment and includes antibiotics and antifungals to prevent and treat infections, flu and pneumonia vaccines, blood transfusions of red blood cells and platelets to manage anemia and reduce bleeding risk, and nutritional support, as leukemia and its treatment frequently cause oral mucositis that impairs the ability to eat (ACS, Treating Leukemia, 2024).

Types of Leukemia:

- **Acute Lymphocytic Leukemia (ALL) –** about 25 percent of adults with ALL have a subtype called “Ph-positive ALL” (also known as “Ph+ ALL” or “Philadelphia chromosome-positive ALL”). The leukemia cells of these patients have the Philadelphia chromosome, which is formed by a translocation between parts of chromosomes 9 and 22. A piece of chromosome 9 breaks off and attaches to chromosome 22, and a piece of chromosome 22 similarly breaks off and attaches to chromosome 9. The abnormal chromosome 22 is known as the Philadelphia chromosome. This chromosomal alter ation creates a fusion gene called BCR-ABL1. This gene produces a protein called a tyrosine kinase that causes the leukemia cells to grow and divide out of control.Doctors don't know why some cells become leukemic cells and others don't. Usually, DNA mutations associated with ALL occur during a person's lifetime rather than being inherited from a parent. For most people who have acute lymphoblastic leukemia (ALL), there are no obvious reasons why they developed the disease.

Types of Treatment Used:

- Chemotherapy
- Intrathecal chemotherapy
- CNS radiation
- Tyrosine kinase inhibitors (TKIs) for Philadelphia chromo some-positive (BCR-ABL1)
- BCL-2 inhibition
- Immunotherapy

- **Acute Myelogenous Leukemia (AML) –** the most common acute leukemia in adults, with approximately 22,720 new cases and 11,5000 deaths estimated in the United States in 2026 (ACS, Key Statistics for Acute Myeloid Leukemia, 2026). It arises from DNA damage in developing myeloid progenitor cells in the bone marrow - the cells that normally differentiate into red blood cells, white blood cells, and platelets. This damage drives the uncontrolled proliferation of immature, non-functional white blood cells called myeloblasts, which accumulate in the bone marrow and peripheral blood, crowding out normal hematopoietic cells and impairing their production. Symptoms include fever, frequent infections, easy bruising, bleeding from the gums, frequent nosebleeds, bone pain, pale skin, fatigue, lethargy, and shortness of breath - reflecting the combined effects of neutropenia, thrombocytopenia, and anemia resulting from bone marrow failure. Established risk factors include prior chemotherapy or radiation therapy, increasing age - with an average age at diagnosis of 69 and uncommon occurrence before age 45 - male sex, exposure tobenzene and other chemical solvents, cigarette smoking, prior myelodysplastic syndrome or myeloproliferative neoplasm, and exposure to high-dose ionizing radiation (ACS, Risk Factors for Acute Myeloid Leukemia, 2024).

Types of Treatment Used:

- Induction chemotherapy
- Consolidation chemotherapy
- FLT3 inhibitors
- IDH1 inhibitors
- IDH2 inhibitors
- BCL-2 inhibitor
- Menin inhibitors
- Hypomethylating agents
- Immunotherapy
- Stem cell transplantation

- **Acute Promyelocytic Leukemia (APL) –** most APL cells carry a specific chromosomal abnormality - a balanced translocation between chromosomes 15 and 17 - resulting in the abnormal fusion gene PML/RARα, (Blood Cancer United, Acute Promyelocytic Leukemia, 2024). Among adults over age 20, APL represents approximately 7%of all AML cases, with 600-800 new cases diagnosed annually in the United States (ACEP, Acute Promyelocytic Leukemia, January 2025. According to NCI SEER data (2000-2021), APL occurs equally among males and females, with a median age of diagnosis of 51 years and an age-adjusted incidence rate of approximately 0.32 per 100,000 persons compared to AML, which primarily affects older adult with a median diagnosis age of 69 years (NCI, SEER Cancer Stat Facts: Acute Myeloid Leukemia, 2024).

  Symptoms include petechiae, nosebleeds, easy bruising, bleeding gums, excessive menstrual bleeding, bloody urine, fever, fatigue, loss of appetite, frequent infections, and pallor. Risk factors include inherited genetic syndromes - Fanconi anemia, Bloom syndrome, Ataxia-telangiectasia, Diamond-Blackfan anemia, Shwachman-Diamond syndrome, Li-Fraumeni syndrome, Neurofibromatosis type 1, and Kostmann syndrome - as well as myelodysplastic syndrome, prior exposure to radiation or certain chemotherapy drugs, increasing age, male sex, smoking, and exposure to benzene or formaldehyde (ACS, Risk Factors for Acute Myeloid Leukemia, 2024).

Types of Treatment Used:

- ATRA + arsenic trioxide (ATO) – for low-risk patients
- ATRA + ATO + cytoreduction - for high-risk patient

Associated Conditions

- **Differentiation Syndrome –** a potentially life-threatening complication occurring in approximately 10-25% of patients during initial treatment with ATRA and ATO (Woods and Norsworthy, Cancers, 2023). Symptoms include fluid retention, labored breathing, fever, fluid accumulation around the heart or lungs, and episodes of low blood pressure. Close monitoring is essential, as early recognition and prompt initiation of corticosteroid therapy are critical for management.

- **Fatigue –** is one of the most commonly reported and debilitating side effects of APL treatment, often persisting long after therapy has ended. A gradual, progressive exercise program has been shown to reduce fatigue over time and should be a central component of rehabilitation (ACS, Treating Leukemia, 2024) .

- **Hyperleukocytosis –** markedly elevated white blood cell counts can affect circulation and increase the risk of serious complications during physical exertion. Exercise should be temporarily suspended during episodes of hyperleukocytosis and only resumed under medical guidance.

- **Thrombocytopenia –** low platelet counts are common in APL and significantly impact exercise safety, particularly for activities involving contact, impact, or heavy resistance training. Exercise programming should be modified based on current platelet counts, with certain activities restricted until counts reach safe thresholds.

- **Anemia –** reduced red blood cell counts impair the body's oxygen-carrying capacity, resulting in fatigue, shortness of breath, and decreased exercise tolerance. Exercise intensity and duration should be adjusted accordingly, with close attention to the patient's response during activity.

- **Neutropenia –** a dangerously low white blood cell count increases the risk of serious infection, requiring careful consideration of the exercise environment. Public gyms and group settings may need to be avoided during periods of severe neutropenia.

- **Coagulopathy –** impaired clotting ability places APL pa tients at risk for prolonged or excessive bleeding, even from minor trauma. High-impact activities, contact sports, and exercises with fall risk should be avoided or carefully modified during periods of active coagulopathy.

- **Nausea and Loss of Appetite –** can compromise nutritional status and energy availability, reducing the patient's capacity to tolerate and recover from exercise. Attention to adequate hydration and nutrition before and after activity is an important part of supporting exercise participation.

- **QT Interval Prolongation –** ATO therapy can disrupt electrolyte balance and cause QT interval prolongation, a heart rhythm disorder that may be triggered or worsened by vigorous exercise. Heart rate monitoring during exercise is essential, and high-intensity exercise should be approached with caution until cardiac function is confirmed stable (ACEP, Acute Promyelocytic Leukemia, January 2025).

- **Peripheral Neuropathy –** damage to the peripheral nerves from APL treatment can cause numbness, tingling, and weakness in the hands and feet, affecting balance, coordination, and lower extremity strength. Exercise programming should incorporate balance training and fall prevention strategies, with modifications made for reduced grip strength or foot sensation.

- **Chronic Lymphocytic Leukemia (CLL) –** affects lymphocytes - white blood cells that help the body fight infection. Specific genomic alterations cause the body to produce abnormal, ineffective lymphocytes that continue to live and multiply long after healthy lymphocytes would die, gradually crowding healthy cells out of the bone marrow and interfering with normal blood cell production. CLL is the most frequent type of leukemia in Western countries, primarily a disease of older adults, with a median age at diagnosis of approximately 70 years and male patients affected nearly twice as often as female patients (Hallek, American Journal of Hematology, 2025). Approximately 22,760 new cases of CLL are estimated in the United States for 2026, accounting for about 1 in 3 new leukemia cases (ACS, Key Statistics for Chronic Lymphocytic Leukemia, 2026).

Associated Conditions

- **Neutropenia –** a dangerously low white blood cell count increases the risk of serious infection, requiring careful consideration of the exercise environment. Public gyms and group settings may need to be avoided during periods of severe neutropenia.

- **Thrombocytopenia –** low platelet counts are common in APL and significantly impact exercise safety, particularly for activities involving contact, impact, or heavy resistance training. Exercise programming should be modified based on current platelet counts, with certain activities restricted until counts reach safe thresholds.

- **Autoimmune Cytopenias –** CLL is frequently complicated by autoimmune cytopenias, in which the immune system attacks the body's own blood cells. The most common forms are autoimmune hemolytic anemia (AIHA), immune thrombocytopenia (ITP), pure red cell aplasia (PRCA), and autoimmune neutropenia (AIN). Bone marrow testing is used to confirm these conditions and distinguish them from cytopenias caused directly by leukemic bone marrow infiltration or chemotherapy.

  AIHA is the most common form, in which autoantibodies target and destroy the patient's own red blood cells, worsening already low red blood cell counts.

- **Tumor Flare –** is a painful enlargement of the lymph nodes that may be accompanied by elevated lymphocyte counts, enlarged spleen, low-grade fever, rash, and bone pain. These reactions are commonly seen in CLL patients treated with lenalidomide (Revlimid®). Use of steroid medications to control the inflammation and antihistamines to manage the rash are recommended.

- **Chronic Myelogenous Leukemia (CML) –** is an uncommon blood cancer that typically affects older adults, though it can occur at any age. Approximately 9,650 new cases are estimated in the United States for 2026, accounting for around 15% of all new leukemia cases (Jabbour and Kantarjian, American Journal of Hematology, 2024). CML is driven by the Philadelphia chromosome - a genetic translocation that fuses the BCR and ABL1 genes, producing an overactive tyrosine kinase that causes uncontrolled growth of white blood cells. These abnormal cells accumulate in massive numbers, crowding out healthy blood cells and damaging the bone marrow. Since the introduction of tyrosine kinase inhibitors in 2000, annual mortality has decreased from 10-20% to approximately 1%, transforming CML from a fatal disease into a manageable chronic condition (Jabbour and Kantarjian, American Journal of Hematology, 2024).

Types of Treatment Used:

- Hodroxyurea
- Targeted therapy
- Interferon
- Stem cell transplant

- **Hairy Cell Leukemia –** is a rare, slow-growing B-cell blood cancer in which the bone marrow produces too many abnormal B cells - so named because their irregular cytoplasmic projections give them a "hairy" appearance under a microscope. As these leukemia cells accumulate, production of healthy white blood cells, red blood cells, and platelets declines. HCL accounts for approximately 2% of all lymphoid leukemias, with an estimated 1,100-1,300 new cases diagnosed in the United States each year (NCCN, Hairy Cell Leukemia, Version 2.2026). It affects men more commonly than women and occurs most often in middle-aged or older adults. HCL is considered a chronic disease, as it may never completely disappear; however, treatment can produce remissions lasting many years. Prognosis has improved significantly over time, with a 10-year overall survival of approximately 90% with purine nucleoside analog treatment (Troussard, Maître, and Paillassa, American Journal of Hematology, 2024). There is also an increased risk of secondary malignancies and non-Hodgkin lymphoma in HCL patients. Symptoms include a feeling of fullness in the abdomen, fatigue, easy bruising, frequent infections, weakness, and weight loss. Risk factors include farming, exposure to pesticides, petroleum derivatives, diesel, and ionizing radiation.

Types of Treatment Used:

- Chemotherapy
- Monoclonal antibodies
- Stem cell transplant
- Splenectomy

- **Chronic Myelomonocytic Leukemia (CMML) –** is a clonal he matopoietic stem cell disorder with overlapping features of both myelodysplastic syndromes and myeloproliferative neoplasms, characterized by prominent monocytosis and an inherent risk of transformation to acute myeloid leukemia of approximately 15-15% over 3-5 years (Patnaik and Tefferi, American Journal of Hematology, 2024). CMML is rare, affecting approximately 1-2 people per 100,000 annually, and occurs more often in men than women. The median age at diagnosis is between 73-75 years. CMML originates in blood-forming cells in the bone marrow and invades the blood. A defining feature is a sustained elevation of monocytes - a type of white blood cell - resulting in reduced production of healthy red blood cells, platelets, and other white blood cells. Newly revised diagnostic criteria require sustained monocytosis of at least 3 months' duration, with monocytes comprising 10% or more of the total leukocyte count, along with bone marrow morphology consistent with CMML and fewer than 20% blasts (Patnaik and Tefferi, American Journal of Hematology, 2024). Symptoms include fatigue, weakness, fever, night sweats, weight loss, easy bruising or bleeding, frequent infections, and abdominal fullness due to an enlarged spleen or liver. Risk factors include increasing age, male sex, and prior treatment with chemotherapy or radiation therapy.

Types of Treatment Used:

- Chemotherapy
- Stem cell transplant

- **Juvenile Myelomonocytic Leukemia (JMML) –** is a rare but aggressive childhood leukemia that typically affects children of approximately 2 years. JMML is caused by excessive proliferation of monocytic and granulocytic cells, with approximately 90% of patients carrying somatic or germline mutations in one of five canonical RAS pathway genes - PTPN11, KRAS, NRAS, CBL, or NF1 - which are largely mutually exclusive (NCI, Juvenile Myelomonocytic Leukemia Treatment PDQ, updated 2024).

Types of Treatment Used:

- Chemotherapy
- Targeted therapy
- Stem cell transplant

- **Blastic Plasmacytoid Dendritic Cell Neoplasm (BPDCN) –** is a rare and clinically aggressive hematologic malignancy originating from precursors of plasmacytoid dendritic cells. Originally categorized by the World Health Organization as a subtype of AML in 2008, BPDCN was later recognized as a distinct entity in the 2016 revision, and in the updated 5th edition WHO C`assification of Hematolymphoid Tumors (2022) is placed in the category of histiocytic and dendritic neoplasms - separate from AML, ALL, and other myeloid or lymphoid neoplasms. It was previously known as natural killer (NK) cell leukemia/lymphoma.

  BPDCN is estimated to account for approximately 0.44% of all hematologic malignancies, with an incidence of approximately 500-1,000 cases per year in the United States (Karki et al., Blood, American Society of Hematology, 2023). It occurs more commonly in men than women at a ratio of approximately 3.5:1, is most common among Caucasians, and is generally considered a disease of older patients with a median age at diagnosis of 65-70 years, though approximately 10% of cases occur in children. The overall median survival is 22 months, with a 1-year overall survival of 62.2%, a 3-year overall survival of 42%, and a 5-year overall survival of approximately 37% (EPR26-157, Journal of the National Comprehensive Cancer Network, 2026).

Types of Treatment Used:

- Targeted therapy
- Chemotherapy
- Radiation
- Stem cell therapy
- Immunotherapy

- **Large Granular Lymphocytic (LGL) Leukemia –** is a rare chronic leukemia affecting lymphocytes - white blood cells that fight infection. It is characterized by the clonal expansion of enlarged lymphocytes containing visible granules when examined under a microscope. There are two main subtypes: T-cell LGL (T-LGL), accounting for more than 85% of cases, and NK-cell LGL, accounting for approximately 10-15% of cases. A rare aggressive form of NK-LGL leukemia, associated with Epstein-Barr virus infection, represents approximately 5% of cases and carries a poor prognosis due to its resistance to chemotherapy. LGL leukemia represents 2-5% of chronic lymphoproliferative disorders in North America and Europe (Marchand, Lamy, and Loughran, Blood, 2024).

The incidence of LGL leukemia is approximately 0.2-0.72 cases per million individuals, with a slight male predominance and a median age at diagnosis of 67 years. More than 75% of patients are over the age of 50 at diagnosis, and approximately one-third have no symptoms at diagnosis - with the condition discovered incidentally through routine blood tests showing abnormally low red blood cell or neutrophil counts (Marchand, Lamy, and Loughran, Blood, 2024).

LGL leukemia is associated with specific molecular features, particularly STAT3 and STAT5 mutations, and activation of the JAK-STAT3, Fas/Fas-L, and NF-κB signaling pathways. Disease-related deaths are mainly due to recurrent infections linked to severe neutropenia (Marchand et al., Hematology: American Society of Hematology Education Program, 2024). When symptoms are present, they include low blood cell counts, recurrent infections, fever, night sweats, weight loss, fatigue, and enlargement of the spleen, liver, and lymph nodes. LGL leukemia is also linked to autoimmune disorders - most commonly rheumatoid arthritis - in approximately 20% of cases, and patients with STAT5B mutations tend to experience a more aggressive clinical course (Marchand, Lamy, and Loughran, Blood, 2024).

Types of Treatment Used:

- Immunosuppresive therapy
- Corticosteroids
- Targeted therapy
- Biologic therapy
- Splenectomy (rare)
- Stem cell transplant (very rare)

- **B-cell Prolymphocytic Leukemia (B-PLL) –** is a very rare and typically aggressive malignancy characterized by uncontrolled growth of B-cells - a type of white blood cell that is part of the immune system. B-PLL is a rare, aggressive leukemic B-cell malignancy historically associated with poor outcomes, with a median overall survival of approximately 2.8 years in real-world studies (Ermann et al., eJHaem, 2026). A recent National Cancer Database analysis reported a median age at diagnosis of 72 years, with 72% requiring systemic therapy at diagnosis (Ermann et al., eJHaem, 2026) It is slightly more common in men than women.

In the updated 2022 WHO Fifth Edition Classification, B-PLL is no longer recognized as a separate disease. Instead, cases previously diagnosed as B-PLL are now placed into one of three other categories: variant mantle cell lymphoma, a progression of CLL, or a related condition called splenic B-cell lymphoma/leukemia with prominent nucleoli. However, another major classification system - the International Consensus Classification - continues to recognize B-PLL as its own distinct disease, so the term remains in use in clinical practice. In most cases, B-PLL does not arise on its own but develops as a transformation or progression of a slower-growing B-cell cancer, most commonly CLL (Ermann et al., eJHaem, 2026).

Symptoms include high lymphocyte count, low blood cell counts, markedly enlarged spleen, fevers, night sweats, and weight loss. Risk factors include increasing age, male sex, prior diagnosis of CLL, smoking, and exposure to certain chemicals. B-PLL is not currently considered curable with standard treatments, with the exception of hematopoietic stem cell transplantation in select younger and fitter patients, and enrollment in clinical trials is strongly encouraged (Blood Cancer United, B-cell Prolymphocytic Leukemia, 2024).

Types of Treatment Used:

- Targeted therapy
- Monoclonal antibodies
- Chemo-immunotherapy
- Stem cell transplant
- Splenectomy (rare)

- **T-cell Prolymphocytic Leukemia (T-PLL) –** is a rare, aggressive T-cell leukemia characterized by the proliferation of small to medium-sized prolymphocytes of post-thymic T-cell origin. It comprises approximately 2% of mature lymphocytic leukemias in adults, with a median age at onset of 65 years and an age range of 30-94 years (Kaseb, Madan, Killeen, and Hozayen, StatPearls, updated 2023). With an incidence of approximately 2.0 per million per year, T-PLL is the most common mature T-cell leukemia in Western countries. Data from the National Cancer Database and SEER have revealed an increasing incidence in recent years, likely reflecting improved recognition and diagnostic criteria, with greater prevalence in males and individuals with a history of other neoplasms (González-Rodríguez et al., Oncology Research, 2025).

  T-PLL is often widespread at diagnosis, involving the peripheral blood, bone marrow, lymph nodes, liver, spleen, and skin. Clinical presentation typically involves progressive lymphocytosis, hepatosplenomegaly, lymphadenopathy, and extramedullary symptoms, although up to 20-30% of patients may initially present with a stable disease course (Kaseb, Madan, Killeen, and Hozayen, StatPearls, updated 2023). Those with initially inactive disease always progress to an active form within 2 years. The disease has a rapid doubling time and a median survival of approximately 1 year without effective treatment (Kaseb, Madan, Killeen, and Hozayen, StatPearls, updated 2023).

  The pathogenesis of T-PLL is primarily driven by overexpression of the TCL1 oncogene, with chromosomal abnormalities involving the TCL1 locus on chromosome 14q32 present in the majority of cases. Additional genomic aberrations include mutations in the JAK/STAT signaling pathway, particularly JAK1, JAK3, and STAT5B, which are identified in up to 76% of T-PLL genomes and represent an important therapeutic target (González-Rodríguez et al., Oncology Research, 2025). TP53 abnormalities are also frequently present and are associated with chemotherapy resistance and poor prognosis.

  Symptoms include rapidly rising lymphocyte counts, anemia, thrombocytopenia, enlarged spleen and liver, lymphadenopathy, skin rashes or infiltration, fatigue, fever, night sweats, and weight loss. Risk factors include increasing age, male sex, and a history of prior malignancy.

Types of Treatment Used:

- Immunotherapy
- Chemotherapy
- Targeted therapy
- Stem cell transplant

LYMPHOMA

Lymphoma is a type of cancer that starts in white blood cells called lymphocytes. Infection-fighting lymphocytes are part of our lymphatic system. The lymphatic system is part of the vascular as well as the immune systems in our bodies and is responsible for the removal of interstitial fluid from tissues, absorption and transportation of fatty acids and fats (as chyle) from the digestive system, and transportation of white blood cells to and from the lymph nodes into the bones. Lymph is the fluid that is formed when interstitial fluid enters the initial lymphatic vessels of the lymphatic system. The lymph is then moved along the lymphatic vessel network by either intrinsic contractions of the lymphatic passages or by extrinsic compression of the lymphatic vessels via external tissue forces such as contractions of skeletal muscles.

The lymphatic system plays a major role in the body's immune system, as the primary site for cells relating to adaptive immunity including T cells and B cells. Cells in the lymphatic system react to antigens presented or found by the cells directly or by other dendritic cells. When an antigen is recognized, an immunological response begins involving the activation and recruitment of more cells, the production of antibodies and cytokines, and the recruitment of other immunological cells such as macrophages.

Understanding lymphatic drainage of various organs is important in the diagnosis, prognosis, and treatment of cancer. The lymphatic system, because of its closeness to many tissues of the body, is responsible for carrying cancerous cells between various parts of the body in a process called metastasis. The intervening lymph nodes can trap cancer cells, but if they are not successful in destroying them, the nodes may become sites of secondary tumors.

Lymphoma, by contrast, is considered a primary cancer of the lymphatic system. People with lymphoma become increasingly vulnerable to infection as the disease progresses and normal immune function is compromised. According to GLOBOCAN 2022 estimates, non-Hodgkin lymphoma (NHL) alone accounted for approximately 553,389 new cases and 250,679 deaths worldwide in 2022, with the total lymphoma burden exceeding 635,000 new cases annually when Hodgkin lymphoma is included (Bray et al., CA: A Cancer Journal for Clinicians, 2024).

NHL accounts for approximately 90% of all malignant lymphomas and encompasses a diverse group of cancers arising from B cells, T cells, or natural killer cells at various stages of development (Bray et al., CA: A Cancer Journal for Clinicians, 2024). More than half of NHL patients are aged 65 or older at diagnosis, reflecting a risk that rises steadily throughout adult life (ACS, Key Statistics for Non-Hodgkin Lymphoma, 2024). The risk of Hodgkin lymphoma, by contrast, follows a bimodal pattern, peaking first during adolescence and early adulthood and again after the age of 55 (ACS, What Is Hodgkin Lymphoma?, 2024).

Most risk factors for lymphoma are linked to an altered or compromised immune system. Weakened immunity - whether from HIV infection, organ transplantation, autoimmune disease, or long-term immunosuppressive therapy - certain viral infections including Epstein-Barr virus and hepatitis C, and a family history of lymphoma all place individuals at particularly elevated risk (ACS, Non-Hodgkin Lymphoma Risk Factors, 2024).

Types of Lymphoma:

Non-Hodgkin (NHL) – is one of the most common cancers in the United States, accounting for approximately 4% of all cancers, with an estimated 79,320 new cases and 19,970 deaths projected for 2026 (ACS, Key Statistics for Non-Hodgkin Lymphoma, 2026). Although NHL can develop at any age and is among the more prevalent cancers in children, teenagers, and young adults, more than half are over 65, with a male predominance across all age groups and a median age at diagnosis of 68 years (Aslani et al., Cancer Reports, 2025; NCI, SEER Cancer Stat Facts: Non-Hodgkin Lymphoma, 2024).

NHL forms in lymphatic tissue throughout the body and is grouped according to how aggressively it spreads. Compared to Hodgkin lymphoma, NHL malignancies tend to advance rapidly and follow a less predictable course. NHL develops whan a cell mutates in a lymph node or lymphatic structure, grows out of control, and produces more abnormal cells that accumulate into tumors. Left untreated, cancerous cells crowd out normal white blood cells, impairing immune function. NHL originates in one of three lymphocyte types - B cells (which produce antibodies), T cells (which support immune function), or Natural Killer (NK) cells (which attack infected or tumor cells). B-cell NHL accounts for more than 85% of all cases, with T-cell and NK-cell lymphomas comprising the remaining 10-15% (Bray et al., CA: A Cancer Journal for Clinicians, 2024). When NHL spreads to extranodal sites - such as the spleen, digestive tract, bone marrow, or central nervous system - it is called extranodal lymphoma, occurring in nearly 25% of cases (Aslani et al., Cancer Reports, 2025).

NHL comprises more than 70 subtypes, divided into two broad prognostic groups - indolent (slow-growing) and aggressive (fast-growing) - based on the speed of disease progression. Approximately 60% of NHL cases are aggressive and 40% are indolent (Aslani et al., Cancer Reports, 2025).

Indolent subtypes progress slowly, may cause few early symptoms, and sometimes require only watchful waiting. The most common include follicular lymphoma (22%), marginal zone lymphoma (8%), and CLL/SLL (7%). Some indolent NHLs can transform over time into aggressive disease.

Aggressive subtypes grow and spread quickly, requiring prompt treatment. The most common include diffuse large B-cell lymphoma (DLBCL, approximately 30% of all NHL), mantle cell lymphoma (3%), Burkitt lymphoma (2%), lymphoblastic lymphoma (2%), and primary mediastinal B-cell lymphoma (2.5%). Despite its aggressive nature, approximately 60-70% of DLBCL patients are cured with first-line R-CHOP immunochemotherapy, with complete remission rates of 75-86% reported across patient populations - though 30-40% of patients experience relapse or refractory disease, underscoring the ongoing need for novel therapeutic strategies (Amengual et al., American Journal of Hematology, 2026).

Common symptoms include painless lymph node swelling, fatigue, fever, night sweats, unexplained weight loss, and frequent infections. The presence of fever, drenching night sweats, and significant weight loss - collectively known as "B symptoms" - is associated with more advanced or aggressive disease and carries prognostic significance. The overall 5-year relative survival rate for NHL in the United States is approximately 74.3%, though outcomes vary widely by subtype, stage, and patient health. (Blood Cancer United, 2025) Advances in immunotherapy, targeted therapy, and CAR-T cell therapy have significantly improved outcomes over the past decade.

Types of Treatment Used:

- Chemotherapy
- Immunotherapy
- Stem cell transplant
- Targeted therapy
- Radiation therapy
- Car-T cell therapy

Hodgkin (HL) – is one of the most curable forms of cancer. It is distinguishable from non-Hodgkin lymphoma under the microscope by the presence of Reed-Sternberg cells - large, abnormal B lymphocytes that often display two mirror-image nuclei. The disease is highly treatable because it generally travels slowly and predictably down the body from the lymph nodes in the neck to the chest, then to the abdomen and pelvis. The 5-year relative survival rate has improved to 88.5%, reflecting transformative advances in immunotherapy and precision oncology (Precision Oncology in Hodgkin's Lymphoma, 2025), with early-stage disease achieving cure rates exceeding 90% (NCI SEER Program / American Cancer Society, 2025).

One of the important features of HL is a compromised immune system that increases the risk of infection. One viral disease that occurs frequently in HL patients is herpes zoster (shingles). Both chemotherapy and radiation weaken immune function, making patients more susceptible to infection throughout and after treatment. HL is an uncommon B-cell lymphoid malignancy affecting approximately 8,570 new patients annually in the United States, representing approx imately 10% of all lymphomas. (Ansell, American Journal of Hematology, 2025)

HL is composed of two distinct disease entities, each with different clinical behavior, treatment approaches, and outcomes. Overall, HL is one of the most curable cancers, with a 5-year relative survival rate of approximately 89%, and treatment selection is guided by disease stage, risk stratification, and PET scan response assessment. (Ansell, American Journal of Hematology, 2025; NCCN Guidelines Version 1.2026)

Classical Hodgkin Lymphoma (cHL) accounts for approximately 95% of all HL cases and is the more common and well-recognized form of the disease (Ansell, American Journal of Hematology, 2024). It is further divided into four subtypes based on microscopic appearance and cellular composition:

- Nodular Sclerosis is the most common subtype, representing approximately 70% of all cHL cases (Ansell, American Journal of Hematology, 2024). It most frequently affects young adults and typically involves the lymph nodes in the neck and chest. It is strongly associated with the bimodal age distribution of HL - peaking in young adulthood and again after age 55.

- Mixed Cellularity accounts for approximately 20-25% of cHL cases and is more common in older adults and in individuals with HIV infection (Ansell, American Journal of Hematology, 2024). It tends to present at a more advanced stage than nodular sclerosis but generally responds well to treatment.

- Lymphocyte-Rich is a less common subtype, representing approximately 5% of cHL cases (Ansell, American Journal of Hematology, 2024). It is associated with a favorable prognosis and tends to be diagnosed at an earlier stage.

- Lymphocyte-Depleted is the rarest and most aggressive subtype, representing less than 1% of all cHL cases. It is more common in older adults and immunocompromised patients, tends to present at an advanced stage, and carries the least favorable prognosis among cHL subtypes.

Nodular Lymphocyte Predominant Hodgkin Lymphoma (NLPHL) accounts for approximately 5% of all HL cases and differs meaningfully from classical HL in its biology and clinical behavior. It is now also referred to as nodular lymphocyte predominant B-cell lymphoma in the updated WHO classification. NLPHL is considered an indolent disease - meaning it grows slowly - and carries an excellent long-term prognosis. However, late relapses are more common with NLPHL than with classical HL, requiring long-term monitoring even after successful treatment.

The first signs of HL often include painless swelling of the lymph nodes - most commonly in the neck, upper chest, underarm, or groin - along with cough, shortness of breath, fatigue, and itchy skin. In addition to these localized symptoms, some patients experience a group of systemic symptoms known as "B symptoms." These are three specific warning signs that doctors look for: a persistent unexplained fever, drenching night sweats that soak clothing and bedding, and significant unintentional weight loss of more than 10% of body weight within a six-month period. B symptoms are not unique to HL - they can also occur in non-Hodgkin lymphoma - but their presence or absence carries important meaning. When B symptoms are present, it generally indicates that the disease is more advanced or more active, and this is reflected in how the disease is staged and how aggressively it is treated (Ansell, American Journal of Hematology, 2024).

Types Of Treatment Used:

- Chemotherapy
- Immunotherapy
- Stem cell transplant
- Targeted therapy
- Radiation therapy
- Car-T cell therapy

MULTIPLE MYELOMA

Multiple myeloma is a cancer of plasma cells - white blood cells that manufacture antibodies. It often begins as a harmless condition known as monoclonal gammopathy of undetermined significance (MGUS). The higher the number of abnormal plasma cells in the bone marrow and the higher the level of the M protein, the greater the risk that MGUS will progress to multiple myeloma or lymphoma. According to the Global Burden of Disease Study 2021, the global incidence of multiple myeloma involved approximately 148,755 new cases and 116,360 deaths worldwide, with a consistent upward trend in incidence, prevalence, and mortality projected to continue through 2050 (Zhuge et al., Frontiers in Medicine, 2025; Frontiers in Epidemiology, 2025).

Multiple myeloma causes plasma cells to reproduce uncontrollably, accumulate in the bone marrow, and crowd out healthy cells. These abnormal plasma cells produce an excess of a unique antibody known as the M protein - whose presence in the blood or urine is one of the primary ways multiple myeloma is diagnosed. Myeloma cells typically collect in the bone marrow and the outermost layer of bones, creating multiple tumors and disrupting normal bone cell activity.

There are two major types of bone cells that normally work together to keep bones healthy. Osteoblasts lay down new bone, while osteoclasts break down old bone. Myeloma cells produce substances that instruct osteoclasts to accelerate bone breakdown while suppressing the activity of osteoblasts - resulting in bones becoming progressively weaker and fracturing easily. Fractured bones are therefore one of the most significant complications of multiple myeloma.

There is a rare, related cancer called plasmacytoma, in which the malignant cells accumulate in one bone to form a single mass. Rather than multiple tumors in different locations as in multiple myeloma, there is only one tumor - called a solitary plasmacytoma. Solitary plasmacytoma usually develops in a bone, where it may be called an isolated plasmacytoma of bone. When a plasmacytoma starts in other tissues such as the lungs or the lining of the sinuses, throat, or other organs, it is called an extramedullary plasmacytoma. Solitary plasmacytomas are most often treated with radiation therapy, and sometimes surgery may be used for a single extramedullary plasmacytoma. If no other plasmacytomas are found later, the patient's prognosis is usually very good. However, since many people with a solitary plasmacytoma will develop multiple myeloma, these patients are watched closely for signs of the disease.

If a patient has smoldering multiple myeloma or precancerous MGUS, the hematologist may recommend no treatment, with close monitoring for signs of progression to myeloma. Patients whose myeloma is not stable will usually require immediate treatment. Initial treatment choices will depend on the severity of the patient's condition and eligibility for a stem cell transplant, determined by the patient's age and general health. For those who do not qualify for a transplant, combination chemotherapy or novel agent-based regimens will be recommended.

The majority of multiple myeloma cases occur in adults over 65, with an average age at diagnosis of 69 years, and it rarely occurs in people under age 50 (ACS, Cancer Facts & Figures 2026). Black Americans are more than twice as likely to develop multiple myeloma as white Americans, and the risk is slightly higher in men than women. Multiple myeloma seems to run in some families - someone who has a sibling or parent with myeloma is more likely to develop it - however, most patients have no affected relatives, so this accounts for only a small number of cases (ACS, Risk Factors for Multiple Myeloma, 2025).

Myeloma cells may show abnormalities in their chromosomes. Although normal human cells contain 46 chromosomes, some cancer cells may have extra chromosomes or have all or part of a chromosome missing (deletion). One common finding in myeloma cells is that parts of chromosome 13 are missing. These deletions appear to make the myeloma more aggressive and resistant to treatment. In approximately half of all people with myeloma, part of one chromosome has switched with part of another chromosome in the myeloma cells - a process called translocation. When this occurs in a crucial area next to an oncogene, it can activate that oncogene. Certain cells in the bone marrow release interleukin-6 (IL-6), a cytokine that stimulates normal plasma cells to grow, and excessive IL-6 production appears to be an important factor in the development of plasma cell tumors (Rajkumar, American Journal of Hematology, 2024).

Symptoms include bone pain - most commonly in the spine, chest, and hips - broken bones, weakness, fatigue, nausea, vomiting, constipation, loss of appetite, excessive thirst, mental fogginess or confusion, and problems with urination. Repeated infections are also common, as myeloma cells crowd out healthy white blood cells, leaving the body less able to fight infection. Spinal cord compression can cause weakness or numbness in the legs and requires immediate medical attention (ACS, Signs and Symptoms of Multiple Myeloma, 2024).

Surgery is sometimes used to remove single plasmacytomas, however, it is rarely used to treat multiple myeloma. When spinal cord compression causes paralysis, severe muscle weakness, or numbness, emergency surgery may be needed. Non-emergency surgery using metal rods and plates can help support weakened bones and may be needed to prevent or treat fractures. Several minimally invasive procedures are now established, guideline-endorsed standards of care - recommended by the International Myeloma Working Group - to relieve pain, restore lost height due to collapsing vertebrae, and strengthen the spine. Kyphoplasty involves inserting a small balloon into the fractured vertebra, inflating it to create space, then removing the balloon and injecting bone cement to stabilize the spine. Vertebroplasty achieves similar stabilization by injecting bone cement directly into the fractured vertebra without the use of a balloon (ACS, Surgery for Multiple Myeloma, 2024; IMWG, Treatment Guidelines, 2024).

Complications:

1. Multiple myeloma's primary effect is on the bones, particularly the spine and rib cage. As the cancerous plasma cells grow, they stimulate osteoclasts - the cells responsible for breaking down bone - to accelerate bone resorption while simultaneously suppressing the activity of osteoblasts, which are responsible for building new bone. The result is progressive bone destruction that appears on skeletal X-rays as gaping dark areas known as lytic lesions. These lesions leave the bones structurally weakened and highly prone to fracture. The earliest indicators of the disease are often bone pain in the back or ribs and broken bones occurring with minimal trauma (Rajkumar, American Journal of Hematology, 2024).

2. Because multiple myeloma erodes bone, calcium is released into the bloodstream in large amounts - a condition known as hypercalcemia - causing nausea, fatigue, excessive thirst, confusion, and frequent urination. Staying well hydrated is important, as adequate fluid intake helps the kidneys flush excess calcium and reduces the risk of kidney damage. Weight-bearing exercise, where medically appropriate and physician-approved, plays an important role in preserving bone density and reducing fracture risk, and a cane or walker can provide added stability when balance or mobility is compromised. Bone-modifying agents are a cornerstone of myeloma bone disease management, reducing skeletal-related events, stabilizing bone, and providing pain relief. Two bisphosphonates are approved for this purpose - zoledronate (Zometa®) and pamidronate (Aredia®) - both reducing osteoclast activity and lowering blood calcium levels. Denosumab (Xgeva®), a non-bisphosphonate RANK ligand inhibitor, is also FDA-approved and is preferred in patients with significant renal dysfunction, as it is not renally excreted (Rajkumar, American Journal of Hematology, 2024).

3. As malignant plasma cells invade the bone marrow, they crowd out normal blood-producing cells - reducing the production of red blood cells, white blood cells, and platelets. A shortage of red blood cells causes anemia, resulting in fatigue, shortness of breath, and lethargy. A shortage of platelets - known as thrombocytopenia - impairs the blood's ability to clot, leading to excessive bleeding and bruising. For patients with anemia, erythropoietin-stimulating agents such as Procrit® or Aranesp® may be prescribed to help boost red blood cell production; in more severe cases, a blood transfusion may be required. Neupogen® (filgrastim), a granulocyte colony-stimulating factor, stimulates the production of neutrophils to help prevent infection when white blood cell counts fall dangerously low during treatment.

4. In multiple myeloma, myeloma cells crowd out normal plasma cells, impairing the body's ability to produce antibodies needed to fight infection. Common infections include those caused by Streptococcus pneumoniae, coagulase-negative staphylococci, S. aureus, and Haemophilus influenzae, as well as herpes zoster (shingles). To help prevent infections, inactivated influenza and pneumococcal vaccines are recommended for multiple myeloma patients, with live vaccines contraindicated. The recombinant zoster vaccine (Shingrix) is also recommended, particularly after autologous stem cell transplantation. COVID-19 vaccination is recommended and can help lower the risk of serious infections, even though the immune response may not be as strong as in healthy individuals. Prophylactic levofloxacin is recommended for the first 2-3 months of initial therapy to reduce the risk of serious infection (Rajkumar, American Journal of Hematology, 2024). Patients should consume plenty of fluids, maintain a diet high in calories and protein, and get adequate rest.

5. In approximately 50-70% of patients, abnormal proteins known as Bence-Jones proteins are produced by the malignant plasma cells. These proteins pass through the kidneys and can clog the narrow tubules, causing organ damage and impaired kidney function. In some cases, patients may require dialysis while undergoing cancer treatment. Although kidney damage can sometimes be permanent, it is often reversible with prompt treatment, particularly when detected early (ACS, Signs and Symptoms
6. of Multiple Myeloma, 2024).

   Orthopedic surgery may be used to insert metal rods or plates to repair or reinforce bones weakened by myeloma. When vertebrae in the spine are damaged, they can press on the spinal cord or surrounding nerves, causing pain, weakness, or numbness - in which case emergency surgery may be needed to relieve the pressure and prevent permanent damage. Two minimally invasive procedures are also used to treat painful spinal fractures in multiple myeloma. Kyphoplasty involves inflating a small balloon inside the damaged vertebra to restore its shape, then filling the space with bone cement to stabilize the bone and relieve pain. Vertebroplasty achieves similar stabilization by injecting bone cement directly into the fractured vertebra without the use of a balloon. Both procedures offer better and faster pain control with likely lower morbidity compared with non-operative interventions, and approximately 90% of myeloma patients experience significant osseous pain during their lifetime that may require such intervention (Eseonu, Panchmatia, Streetly, Grauer, and Fakouri, Hematological Oncology, 2023).

7. Spinal cord compression is one of the most severe and potentially life-altering complications of multiple myeloma. Spinal involvement of some form - including symptomatic lytic lesions, vertebral fractures, and compression syndrome - occurs in up to 50-60% of all MM patients, while clinically significant spinal cord compression affects approximately 5% of patients, with the thoracic spine being the most commonly involved site (Amato et al., SN Comprehensive Clinical Medicine, 2025).

   The clinical presentation of spinal cord compression in MM is variable and depends on the location and degree of compression. Back pain is the most common and typically the earliest symptom, reported in approximately 83% of cases, and is often present for weeks or months before neurological deficits develop - making it a critical warning sign that warrants prompt imaging. Motor deficits, including weakness or paralysis of the limbs, and sensory deficits such as numbness, tingling, or loss of sensation develop in a significant proportion of patients as compression progresses. Bowel and bladder dysfunction - including urinary retention or incontinence - are later manifestations that typically reflect more advanced cord involvement. When compression occurs at cervical levels, upper extremity weakness and sensory changes may also be present (Amato et al., SN Comprehensive Clinical Medicine, 2025).

Types of Treatment Used:

- Monoclonal antibodies
- Targeted therapy
- Bispecific antibody therapy
- CAR-T cell therapy
- Stem cell transplant
- Chemotherapy

BONE AND SOFT TISSUE CANCER

Bone and soft tissue sarcomas are cancers of the structural and connective tissues of the body, including bone, cartilage, nerves, fibrous connective tissue, fat, muscle, and blood vessels. They can also be found in the trunk, head and neck, internal organs, and the retroperitoneum - the area behind the abdominal cavity. Primary bone sarcoma accounts for less than 1% of all cancers. In the United States, an estimated 4,110 new cases of primary bone sarcoma will be diagnosed in 2026, with approximately 2,210 deaths projected (SFA, 2026 Sarcoma Statistics, 2026). An estimated 13,590 new cases of soft tissue sarcoma were diagnosed in the United States in 2024, with approximately 7,250 total sarcoma-related deaths, with an overall 5-year relative survival rate of approximately 65% for soft tissue sarcoma and 70% for bone cancer (NFCR, Sarcoma Cancer, 2024).

Primary bone cancers - those that originate in the bone itself - are extremely rare. By contrast, many cancers that begin elsewhere in the body, such as breast, prostate, or lung cancer, may spread to the bone and cause secondary tumors there. Symptoms of bone cancer include pain, fever, swelling or mass, stiffness or tenderness in the affected area, loss of bladder or bowel function if the cancer involves the pelvic bones or base of the spine, and pathological bone fractures.

Risk factors include chronic lymphedema of the arms or legs, exposure to certain chemicals such as thorium dioxide (Thorotrast), vinyl chloride, or arsenic, infection with HIV and human herpesvirus 8 - which have been linked to Kaposi sarcoma - advancing age, and inherited genetic syndromes.

Types of Bone Cancer:

- **Adamantinoma –** an extremely rare, low-grade primary bone cancer that almost exclusively occurs in the tibia (shinbone). It predominantly affects young adults and tends to follow an indolent course, though local recurrence after surgery is common.

- **Chondrosarcoma –** the most common primary bone cancer in adults, accounting for approximately 40% of adult bone cancer cases. It originates in cartilage cells and tends to grow slowly. Subtypes include dedifferentiated, mesenchymal, and clear cell chondrosarcoma, each varying in aggressiveness and age of onset. It is more common in males and is generally treated with surgery, as it is largely resistant to chemotherapy and radiation (ACS, What Is Bone Cancer?, 2026).

- **Chordoma –** a rare, slow-growing primary bone cancer that develops from remnants of the notochord - the embryonic precursor to the spine. It most commonly occurs at the base of the skull and the sacrum. Chordomas primarily affect adults over 30 and are more common in men. They are locally aggressive, have a high rate of local recurrence, and are largely resistant to conventional chemotherapy. Treatment is primarily surgical, with proton beam radiation used for residual or inoperable disease.

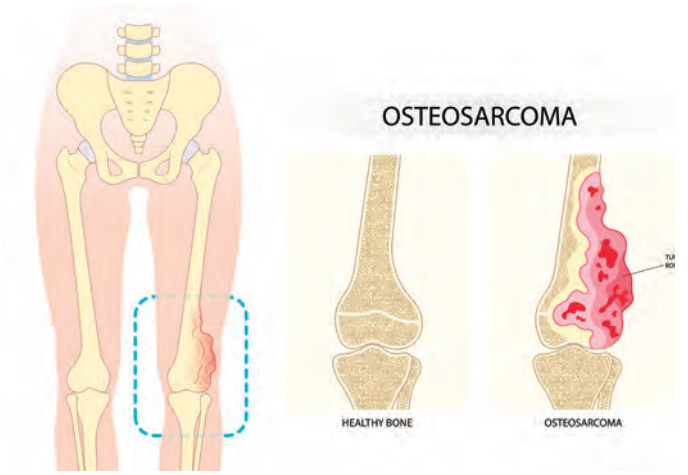
- **Ewing's Sarcoma –** the second most common primary bone cancer, constituting 10-15% of all bone sarcomas, predominantly affecting adolescents and young adults. It frequently occurs in the pelvis, femur, and tibia, with a slight male predominance. A National Cancer Database analysis of pediatric Ewing sarcoma in the United States reported an aggregated 5-year survival rate of 74.5%, with localized disease achieving 84.7% and macrometastatic disease at presentation achieving 50.4% (Wells et al., JAAOS Global Research & Reviews, 2024).

- **Fibrosarcoma –** a rare tumor arising from fibrous connective tissue within the bone. It most commonly affects adults between 30-60 years of age and tends to occur in the long bones of the extremities. Treatment involves surgery with wide excision, often combined with radiation therapy (ACS, What Is Bone Cancer?, 2024).

- **Giant Cell Tumor –** a locally aggressive but rarely metastatic tumor arising in the ends of long bones, most commonly around the knee. It predominantly affects adults in their 20s to 40s and is slightly more common in women. Treatment typically involves surgery, and denosumab (Xgeva®) is FDA-approved for unresectable or recurrent giant cell tumor of bone (Roitman et al., Revista Brasileira de Ortopedia, 2024; ACS, What Is Bone Cancer?, 2024).

- **Multiple Exostoses (sometimes called Multiple Osteochondromas) Syndrome –** is a rare hereditary condition caused by mutations in the EXT1 or EXT2 tumor suppressor genes, characterized by the growth of multiple benign cartilage-capped bone tumors called osteochondromas on the metaphyses of long bones. It affects approximately 1 in 50,000-100,000 people worldwide, follows an autosomal dominant inheritance pattern giving an affected parent a 50% chance of passing the mutation to each child, and is typically diagnosed by age 12 with a median age of diagnosis of three years (WHO Classification of Tumors, 5th Edition, 2020). The lifetime risk of malignant transformation to secondary peripheral chondrosarcoma is approximately 1-5%, with EXT1 mutations and axial skeleton lesions carrying the greatest risk, making regular surveillance essential (WHO Classification of Tumors, 5th Edition, 2020).

- **Osteosarcoma** – the most common primary bone cancer overall, accounting for approximately 28% of all primary bone cancers. It typically affects children, adolescents, and young adults, most often arising in the long bones of the limbs dur ing periods of rapid bone growth. The 5-year survival rate for localized osteosarcoma is approximately 68%, dropping to 20-30% for metastatic disease (ACS, Survival Rates for Osteosarcoma, 2026).



Soft Tissue Sarcomas – uncommon cancers that can develop in any of the connective tissues that support and connect the body. Symptoms include an enlarging, non-tender swelling or mass and pressure against nearby nerves and muscles. Risk factors include family history of sarcoma; occupational exposure to chlorophenols in wood preservatives; exposure to dioxin and herbicides containing phenoxyacetic acid at high doses; vinyl chloride - a chemical used in making plastics particularly linked to liver sarcomas; damage to the lymphatic system; Paget's disease of bone; prior radiation therapy; and inherited genetic syndromes including Von Recklinghausen disease (Neurofibromatosis Type 1), Li-Fraumeni syndrome, Gardner syndrome, inherited retinoblastoma, Werner syndrome, Gorlin syndrome, and Bourneville disease. For many individuals, no specific cause is ever identified (ACS, Soft Tissue Sarcoma Risk Factors, 2024).

Both children and adults can develop sarcoma. Sarcomas account for approximately 1% of all adult cancers and 15% of all pediatric cancers, with between 1,500-1,700 children diagnosed with bone or soft tissue sarcoma in the United States each year (NFCR, Sarcoma Cancer, 2024). Because the WHO classifies soft tissue sarcomas into over 70 subtypes based on tissue origin, it is more accurate to describe them as a family of related diseases rather than a single disease. Soft tissue sarcomas can begin in the following connective tissues:

- Fat tissue
- Smooth and skeletal muscle
- Blood and lymph vessels
- Peripheral nerves
- Synovial tissue
- Fibrous connective tissue
- Gastrointestinal tract

Types of Soft Tissue Sarcomas:

- **Adult Fibrosarcoma –** usually affects fibrous tissue in the legs, arms, or trunk. It is most common in people between the ages of 20 -60, but can occur in people of any age, even in infants.

- **Alveolar Soft-Part Sarcoma –** is a rare cancer that mostly affects young adults.These tumors most commonly occur in legs.

- **Angiosarcoma –** can develop either from blood vessels (hemangiosarcomas) or from lymph vessels (lymphangiosarcomas). These tumors sometimes start in a part of the body that has been treated with radiation. Angiosarcomas are sometimes seen in the breast after radiation therapy and in limbs with lymphedema

- **Clear Cell Sarcoma –** is a rare cancer that often develops in tendons of the arms or legs. Under the microscope, it has some features of malignant melanoma, a type of cancer that develops from pigment-producing skin cells.

- **Dermatofibrosarcoma Protuberans –** is a very rare type of skin cancer that begins in connective tissue cells in the mid dle layer of the skin (dermis). It may at first appear as a bruise or scar, but as it grows, lumps of tissue (protuberans) may form near the surface of the skin. This cancer often forms on the arms, legs, and trunk. It grows slowly and rarely spreads beyond the skin.

- **Desmoplastic Small Round Cell Tumor –** is a rare sarcoma of adolescents and young adults, found most often in the abdomen.

- **Epithelioid Sarcoma –** most often develops in tissues under the skin of the hands, forearms, feet, or lower legs. Adolescents and young adults are often affected.

- **Fibromyxoid Sarcoma, Low-Grade –** is a slow growing cancer that most often develops as a painless growth in the trunk or arms and legs (particularly the thigh). It is more common in young to middle aged adults.

- **Gastrointestinal Stromal Tumor (GIST)** – is a type of sarcoma that develops in the digestive tract.

- **Leiomyosarcoma –** is a rare soft tissue sarcoma arising from smooth muscle cells. It can develop anywhere in the body where smooth muscle is found - most commonly in the abdomen, but also in the uterus, blood vessels including the inferior vena cava, and the skin. Abdominal tumors can grow to over 10 centimeters and may cause pain, weight loss, nausea, or vomiting.

- **Liposarcomas –** are malignant tumors of fat tissue. They can develop anywhere in the body, but they most often develop in the thigh, behind the knee, and inside the back of the abdomen. They occur mostly in adults between 50 and 65.

- **Malignant Mesenchymoma –** is a rare type of sarcoma that shows features of fibrosarcoma and features of at least 2 other types of sarcomas.

- **Malignant Peripheral Nerve Sheath Tumors –** are sarcomas that develop from the cells that surround a nerve.

- **Myxofibro Sarcoma (low-grade) –** are most often found in the arms and legs of elderly patients. They are most common in or just under the skin and there might be more than one tumor nodule.

- **Rhabdomyosarcoma –** is a rare type of cancer that forms in soft tissue. It can occur at any age but is the most common type of soft tissue sarcoma seen in children. Although it can arise anywhere in the body, it's more likely to start in the head and neck area, urinary and reproductive systems, and arms and legs.

- **Solitary Fibrous Tumors –** are rare growths of soft tissue cells that can form nearly anywhere in the body. They most often occur in the lining around the outside of the lungs but have also been found in the head and neck, breast, kidney, prostate, spinal cord, and other sites. Most of the time they are noncancerous (benign) and tend to grow slowly.

- **Synovial Sarcoma –** is a malignant tumor of the tissue around joints. The most common locations are the hip, knee, ankle, and shoulder. This tumor is more common in children and young adults, but it can occur in older people.

- **Undifferentiated Pleomorphic Sarcoma –** is a high-grade soft tissue sarcoma that is one of the most common sarcoma subtypes in adults. It most often occurs in the deep soft tis sues of the extremities, particularly the thigh, though it can also develop in the trunk or retroperitoneum. It predominantly affects adults over 60 and is an aggressive malignancy, with metastases - most commonly to the lungs.

- **Leiomyosarcoma –** is a rare soft tissue sarcoma arising from smooth muscle cells. It can develop anywhere in the body where smooth muscle is found - most commonly in the abdomen, but also in the uterus, blood vessels including the inferior vena cava, and the skin. Abdominal tumors can grow to over 10 centimeters and may cause pain, weight loss, nausea, or vomiting.

- **Kaposi Sarcoma –** is a type of sarcoma that develops from the cells lining lymph or blood vessels.

Procedures:

Surgical Excision Techniques

- **Conservative Surgical Excision –** removes the tumor with a narrow margin of surrounding normal tissue, with the primary focus on preserving nearby muscles, nerves, and joint function.

  When it's used:
  - Small, slow-growing, low-grade tumors
  - Low-grade tumors or when the diagnosis is uncertain and tissue needs to be removed for evaluation
  - In areas where more aggressive surgery would cause significant disability

- **Wide Local Excision –** is the most common excisional approach for soft-tissue sarcomas. The surgeon removes the tumor along with a cuff of healthy tissue surrounding it to reduce the risk of recurrence. This method balances cancer control with preservation of limb function and often allows patients to avoid amputation or radical surgery.

  When it's used:
  - For localized tumors where imaging shows the cancer can be removed with clear margins

- **Radical or Compartmental Excision –** removes the entire anatomical compartment containing the tumor, such as a whole muscle group or deep tissue plane. This approach improves the chance of complete tumor removal, it can significantly affect strength and movement

  When it's used:
  - When tumors extend beyond a single structure or when previous surgeries have failed to control the disease

- **En Bloc Resection –** refers to removing the tumor and all involved surrounding tissues in one piece without cutting into the tumor itself. The goal is to prevent tumor cells from spreading during surgery and to achieve clean margins.

  When it's used:
  - When sarcomas involve bone, deep muscles, or nearby organs, particularly in the pelvis, chest wall, or trunk

Hospital stay following all of these procedures varies depending on the depth of the tumor and the amount of tissue removed, but most patients remain in the hospital between 1-5 days, with longer stays required when reconstruction, large muscle removal, or complex wound care is involved. Pain, fatigue, and temporary weakness are common, particularly when muscles or structural tissue have been removed, and early rehabilitation may begin in the hospital to guide posture, gait, and safe limb use.

During the first two weeks after discharge, activity should be limited to gentle walking and light daily movement, avoiding lifting more than 10-15 pounds, sudden directional changes, high-impact activity, or stretching that places tension across the incision. Because excision surgeries often involve muscle removal or soft-tissue disruption, aggressive strengthening, deep stretching, or resistance training near the surgical area is contraindicated. Swelling management, elevation when appropriate, and gentle range-of-motion work in nearby joints help prevent stiffness without stressing healing tissues.

From weeks 2-6, walking duration and general activity can gradually increase as long as there is no sharp pain, excessive swelling, or wound irritation. Light mobility exercises and low-intensity neuromuscular work may be introduced to restore coordination and prevent compensatory movement patterns. Resistance exercise can begin cautiously using very light loads away from the surgical site, with strict attention to controlled breathing and avoidance of strain. High-impact exercise, running, jumping, and loaded unilateral work are typically postponed during this stage, especially after radical or en bloc excisions where deeper tis sues are still healing.

Between 6-12 weeks after surgery, many individuals can begin a gradual transition back to more structured exercise if healing is stable and cleared by the medical team. Low-impact cardiovascular activity such as brisk walking, elliptical training, or stationary cycling is usually appropriate. Progressive strength training may be added slowly, emphasizing symmetry, joint stability, and controlled tempo rather than heavy resistance.

Bone tumor resection, radical or compartmental resection, and pelvic, axial skeleton, or complex en bloc resection represent progressively more extensive surgical approaches used to treat aggressive or deeply invasive bone and soft-tissue sarcomas.

- **Segmental Bone Tumor Resection –** removal of the cancerous portion of bone along with a margin of healthy tissue to achieve clear oncologic boundaries while preserving as much limb function as possible. This may involve removing part of a long bone such as the femur, tibia, or humerus and often requires reconstruction using metal implants, bone grafts, or joint replacements to restore stability.

When it's used:

- Osteosarcoma, Ewing sarcoma, chondrosarcoma
- Tumors localized to a segment of bone

- **Radical or Compartmental Resection –** is more extensive and involves removing an entire anatomical compartment, such as a muscle group or deep tissue plane, when tumors spread beyond a single structure or when prior surgeries have failed to achieve adequate margins.

When it's used:

- High-grade or recurrent sarcoma
- Tumors spanning multiple tissue layers

- **Pelvic, Axial Skeleton, or Complex En Bloc Resections –** these are among the most technically demanding sarcoma surgeries and are used when tumors occur in the pelvis, spine, chest wall, or trunk. In these cases, the tumor and surrounding tissues are removed in one piece to avoid cutting through cancer, sometimes involving partial removal of bone, muscle, or adjacent organs.

When it's used:

- Deep pelvic or trunk sarcomas
- Tumors near vital structures but still surgically removable

Hospital stay following these resections varies widely depending on complexity but typically ranges from 3-7 days for isolated segmental bone resections and may extend to 7-14 days or longer for radical or en bloc pelvic and axial surgeries, especially when reconstruction or intensive monitoring is required. Patients are usually encouraged to begin assisted sitting and short walking within the first 1-2 days, although weight-bearing restrictions may be necessary depending on the surgical site and reconstruction stability.

During the first two weeks after discharge, exercise programming should emphasize protection and gentle mobility. Walking with assistive devices, breathing exercises, and light range-of-motion work in unaffected joints are appropriate, while lifting more than 10-15 pounds, high-impact activity, twisting movements, or deep stretching across the surgical site are contraindicated. Because these surgeries often involve significant structural changes, aggressive strengthening, running, or unilateral loading should be avoided. Swelling, fatigue, and muscle weakness are common during this phase, and pacing is essential.

From weeks 2-6, walking tolerance and general activity can gradually increase as healing progresses, but resistance training should remain very light and focused on restoring coordination and postural stability rather than strength gains. Low-load neuromuscular exercises and gentle core stabilization may be introduced under supervision, particularly after pelvic or spinal resections where balance and alignment are affected. High-impact exercise, jumping, heavy lifting, and rapid directional changes remain contraindicated during this period, and weight-bearing may still be limited based on surgical guidance.

Between 6-12 weeks after surgery, many individuals can begin transitioning toward more structured rehabilitation if cleared by their surgical team. Low-impact cardiovascular activity such as stationary cycling, elliptical training, or aquatic walking may be introduced cautiously when wounds are fully healed. Strength training can progress slowly using light to moderate resistance, emphasizing symmetrical movement patterns, joint stability, and gradual load progression to protect reconstructed bone and soft tissue. Even at this stage, maximal lifting, contact sports, and high-impact activities are typically avoided, particularly after pelvic or axial skeleton resections where healing timelines are longer. Any increase in deep pain, instability, swelling, redness, warmth, or sudden decline in function should

prompt immediate reduction in activity and medical evaluation, as these may indicate complications with healing, hardware, or tumor recurrence

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- **Amputation or Disarticulation –** amputation and disarticulation are major surgical procedures sometimes required in the treatment of aggressive bone or soft-tissue sarcomas when limb-sparing surgery cannot achieve safe cancer margins or would leave a painful, unstable, or nonfunctional extremity. Amputation involves removing part of a limb through the bone, such as above-knee, below-knee, above elbow, or below-elbow removal, while disarticulation refers to removal of the limb through a joint, such as at the hip, shoulder, knee, or ankle, without cutting through the bone shaft itself. The goal of either procedure is complete tumor removal while creating a stable residual limb that can heal well and potentially support a prosthesis. Surgeons carefully plan the incision location to preserve muscle balance, protect nerves, and shape the residual limb to tolerate pressure and move ment during future rehabilitation. In many cases, modern techniques include targeted muscle reattachment and nerve management to reduce long-term pain and improve prosthetic control. Although these procedures are more aggressive than limb-salvage surgery, they can provide excellent cancer control and may allow a faster return to functional mobility when reconstruction would otherwise be unreliable.

  When it's used:

  - Tumor involves major arteries or nerves
  - Failed limb salvage or recurrent disease
  - Severe infection or structural instability

Hospital stay after amputation or disarticulation typically ranges from 3-7 days for lower-limb procedures and may extend longer for higher-level amputations or when complications, infection risk, or complex wound care are present. Patients are usually encouraged to sit upright and begin gentle transfers and short assisted mobility within the first 24-48 hours, often guided by physical therapy to maintain balance, posture, and safe movement patterns. Education on residual limb positioning is important early on to prevent joint contractures, particularly avoiding prolonged hip or knee flexion in lower-limb amputations.

During the first two weeks after discharge, exercise programming should emphasize gentle mobility, breathing exercises, and light strengthening of the remaining limbs and core without stressing the incision. Walking may begin with assistive devices depending on the level of amputation and surgical clearance, but high-impact activity, lifting more than 10-15 pounds, and movements that place shear or pressure across the healing limb are contraindicated. Elevation, compression (if prescribed), and careful skin monitoring are essential to manage swelling and support wound healing. Phantom limb sensations and fatigue are common during this stage, and pacing of activity is critical.

From weeks 2-6, activity can gradually increase as healing progresses and sutures are removed. Gentle strengthening exercises for the hips, shoulders, and trunk are introduced to support balance and future prosthetic use, while range-of-motion work helps prevent stiffness in nearby joints. Resistance training should remain low load and controlled, avoiding sudden directional changes, jumping, or heavy pushing and pulling. Early prosthetic fitting may begin during this period for some individuals, which shifts exercise focus toward weight shifting, balance training, and gait re-education. High-impact exercise, running, and uneven terrain remain contraindicated until the residual limb is fully healed and cleared by the surgical and rehabilitation team.

Between 6-12 weeks after surgery, many individuals begin more structured rehabilitation and progressive conditioning if healing is stable. Low-impact cardiovascular activities such as stationary cycling, upper-body ergometry, or supported walking may be introduced, and strength training can progress gradually with emphasis on symmetry, core stability, and controlled movement patterns. Even at this stage, maximal lifting, plyometrics, or rapid pivoting movements are typically avoided because the residual limb, surrounding muscles, and surgical tissues are still adapting to new biomechanical demands.

Types of Reconstruction:

- **Bone Reconstruction - Non-Vascularized Bone Graft (traditional bone graft) –** in this approach, bone taken either from the patient (autograft) or from a donor source (allograft) is shaped to fill the gap left after the cancerous bone has been removed. The graft itself does not carry its own blood supply, so healing depends entirely on the surrounding bone and soft tissue gradually growing into the graft and re-establishing circulation over time. The graft is typically secured in place with plates, rods, screws, or nails to provide mechanical stability while biological healing occurs. This method is most commonly used for moderate-sized bone defects in long bones when the surrounding soft tissue is healthy, blood supply is adequate, and the patient can tolerate a longer healing timeline. It is less commonly used in previously irradiated areas or in very large defects, where graft healing and durability are less predictable.

When it's used:

- Segmental bone loss after tumor removal with good surrounding soft-tissue support
- Moderate-size defects where biologic healing is preferred
- Patients who can tolerate slower bone healing time lines

> Weight-bearing and loading through the reconstructed bone are usually restricted for weeks to months, depending on the size and location of the graft and the stability of fixation. High-impact activities, jumping, running, or heavy resistance exercise involving the affected limb are contraindicated early on and often delayed well beyond three months. Even basic strengthening must progress cautiously, as excessive stress can lead to graft fracture, nonunion, or hardware failure. Range-of-motion exercises for nearby joints are encouraged early to prevent stiffness, but they must avoid placing torsional or bending forces across the graft site. Fatigue, localized pain, and muscle weakness are common during recovery, and return to full loading is typically guided by imaging confirmation of graft incorporation rather than symptoms alone. For many patients, activity modification remains necessary long-term, especially for high-load or contact activities, to protect the reconstructed bone and reduce the risk of late complications.

- **Bone Reconstruction - Vascularized Bone Graft –** this is a more advanced reconstructive technique in which a segment of living bone - most commonly the fibula - is transferred along with its own blood vessels and surgically connected to new vessels at the tumor site. Because the graft retains its blood supply, it behaves more like living tissue rather than a passive structural filler, allowing it to heal faster, remodel over time, and tolerate long-term stress better than traditional non-vascularized grafts. This approach is frequently used for large bone defects, in younger or more active patients, or in situations where prior radiation, infection risk, or poor local blood supply would make standard graft healing unreliable. The transferred bone may be used alone or combined with plates, rods, or even prosthetic components to provide immediate stability while the biological graft strengthens. Over months to years, the vascularized graft can thicken and adapt to mechanical load, making it particularly valuable for long-bone reconstructions or areas where durability is critical.

When it's used:

- Large defects requiring durable biologic reconstruction
- Pediatric or younger patients needing long-term structural remodeling
- Situations where healing risk is high and living bone improves outcomes

> Weight-bearing is often restricted or only partially allowed for several weeks to months, depending on surgical location and fixation stability, and excessive loading too soon can compromise both the graft and the microsurgical blood vessel connections. High-impact activities, running, jumping, or heavy resistance training involving the reconstructed limb are contraindicated during early recovery, and even routine strengthening must progress gradually to avoid stress fractures or delayed union. Early rehabilitation typically emphasizes gentle range-of-motion exercises for surrounding joints, postural control, and low-load muscle activation rather than force production. Fatigue, localized swelling, and altered biomechanics are common while the graft integrates, and return to higher-level activity is usually guided by imaging evidence of bone consolidation rather than symptom resolution alone. Long-term, many individuals can achieve excellent functional outcomes, but training programs often continue to prioritize controlled loading, balanced muscle development, and avoidance of sudden high-force movements that could jeopardize graft integrity.

- **Endoprosthetic Reconstruction (megaprosthesis and custom implants) –** a widely used method for restoring limb structure after removal of large segments of bone affected by sarcoma, particularly when the tumor involves or is close to a joint. In this approach, the diseased bone is removed and replaced with a metal implant designed to immediately restore length, alignment, and joint function. Megaprostheses are modular systems that can be assembled intraoperatively to match the patient's anatomy, while custom implants are designed preoperatively using advanced imaging to fit complex or irregular defects such as those in the pelvis, shoulder girdle, or scapula. These reconstructions allow for faster structural stability compared with biologic grafts and often enable earlier mobilization, making them especially useful for older adults, patients with high functional demands, or those who cannot tolerate prolonged non-weight-bearing. Endoprosthetic reconstruction is commonly used around the knee, hip, shoulder, and elbow, and may be combined with soft-tissue flaps to ensure adequate coverage and reduce infection risk.

When it's used:

- Limb-sparing surgery around joints (knee, hip, shoulder)
- Large structural defects requiring immediate stability
- Older adults or those needing faster functional recovery

> Although endoprosthetic reconstruction allows earlier movement, physical limitations remain significant and often lifelong. Early recovery emphasizes protection of the implant and surrounding soft tissues, as muscles, tendons, and ligaments have been disrupted during tumor removal. High-impact activities such as running, jumping, contact sports, and heavy lifting are typically contraindicated permanently because they increase the risk of implant loosening, mechanical failure, or fracture of the remaining bone. Even in the long term, strength training must be carefully dosed, avoiding maximal loads, explosive movements, or deep joint angles that place excessive stress on the prosthetic components. Range of motion is often reduced compared with a native joint, and compensatory movement patterns can develop if rehabilitation is not carefully guided. Fatigue, joint stiffness, and a sense of instability are common early on, and patients are often advised to prioritize low-impact activities such as walking, cycling, swimming (when cleared), and controlled resistance exercise. Lifelong activity modification is usually required, with training programs focused on joint protection, muscular balance, and maintaining functional independence rather than performance maximization.

- **Composite Reconstruction (biologic + prosthetic) –** also called hybrid reconstruction, combines biologic and prosthetic techniques to rebuild large or complex skeletal defects following sarcoma resection. This approach most commonly involves pairing a metal endoprosthesis with a biologic element such as an allograft or a vascularized bone graft, allowing surgeons to achieve both immediate structural stability and long-term biological integration. For example, a prosthetic joint component may restore movement and alignment right away, while a living or donor bone segment is used to support load sharing, encourage bone remodeling, and improve long-term durability. Composite reconstructions are often selected for massive defects, revision surgeries after failed reconstructions, pelvic or periacetabular tumors, or cases where neither a purely biologic nor purely prosthetic solution would be sufficient on its own. These procedures are technically demanding and require careful coordination between orthopedic oncology, reconstructive surgery, and rehabilitation teams.

When it's used:

- Massive defects requiring both strength and biological healing
- Complex revisions or salvage situations
- Pelvic or long-bone reconstructions needing hybrid solutions

> Because composite reconstruction relies on both mechanical fixation and biological healing, physical limitations are substantial and recovery is often longer and more complex than with prosthetic reconstruction alone. Early weight-bearing is frequently restricted or only partially allowed to protect the biologic component while it incorporates, even though the prosthetic portion may feel stable. High-impact activities, running, jumping, heavy lifting, and sudden directional changes are contraindicated during early recovery and often discouraged long term due to the risk of graft fracture, nonunion, or implant failure. Rehabilitation initially emphasizes gentle range-of-motion exercises, postural control, and low-load muscle activation while avoiding torsional or bending forces across the reconstruction. Strength training must progress slowly and is typically guided by imaging confirmation of graft healing rather than symptom improvement alone. Even after successful integration, patients are usually advised to avoid high-force or impact-based activities permanently and to focus on controlled, low-impact movement patterns that protect both the prosthetic and biologic components of the reconstruction.

- **Fusion (Arthrodesis) –** a reconstructive surgical approach in which a joint is intentionally fused into a single solid bone after tumor removal, eliminating movement at that joint to provide long-term stability and pain control. This procedure is typically used when a sarcoma involves critical joint structures and preserving a functional joint with a prosthesis is not feasible or would be unreliable due to infection risk, poor soft-tissue coverage, high mechanical demands, or patient age and activity level. During arthrodesis, the joint surfaces are removed, and the remaining bone ends are fixed together using plates, rods, screws, or external fixation devices until they heal into one continuous bone. Fusion is most commonly performed in the ankle, knee, wrist, or spine, and in selected cases around the hip or shoulder when stability is prioritized over mobility. Although joint motion is sacrificed, the procedure can provide a strong, durable limb capable of weight-bearing and functional use, particularly for standing and walking tasks.

When it's used:

- Tumor removal destabilizes a joint but mobility can be sacrificed for strength
- Infection risk makes prosthetic replacement less ideal
- Younger patients needing durable load-bearing

> Physical limitations following arthrodesis are significant and permanent because the fused joint no longer moves. Early recovery involves prolonged protection of the fusion site, with restricted or non-weight-bearing for several weeks to months depending on location and fixation stability. High-impact activities, running, jumping, and activities that require joint flexibility are contraindicated both during recovery and long term. Even after solid fusion is achieved, movement demands are transferred to adjacent joints, increasing the risk of overuse, stiffness, or degenerative changes in those areas. Rehabilitation focuses on maintaining strength and mobility in neighboring joints, improving balance and gait mechanics, and developing compensatory movement strategies that minimize strain. Strength training must avoid excessive torque across the fused segment, and exercises that require deep bending, twisting, or sudden directional changes are typically restricted. Most individuals can return to low-impact functional activities such as walking, cycling (when appropriate), and controlled resistance training, but athletic or high-demand activities are usually limited permanently to protect the fusion and surrounding structures.

- **Rotationplasty –** a specialized limb-reconstruction procedure most commonly used for aggressive bone tumors around the knee, particularly in children, adolescents, or highly active adults when traditional limb-salvage or joint replacement would not provide durable function. During this surgery, the diseased section of the limb - often the distal femur or proximal tibia - is removed along with the knee joint. The lower leg is then rotated 180 degrees and reattached so that the ankle functions biomechanically as a new knee joint within a prosthetic limb. Although the appearance is unconventional, the procedure allows preservation of important nerves and blood vessels, enabling strong muscle control and excellent long-term mobility. The ankle joint becomes the primary hinge for walking, running, and climbing, and many patients achieve a high level of functional independence compared with above-knee amputation or repeated prosthetic revisions. Rotationplasty is typically chosen when long-term durability, high activity potential, or growth considerations out weigh cosmetic concerns, and it is avoided when vascular supply is inadequate, infection risk is high, or when patients are not psychologically prepared for the visual changes associated with the surgery.

When it's used:

- Tumor removal destabilizes a joint but mobility can be sacrificed for strength
- Infection risk makes prosthetic replacement less ideal
- Younger patients needing durable load-bearing

> In the first several weeks to months, weight-bearing is gradually introduced to protect bone healing and allow the reattached limb to stabilize. Exercises initially focus on gentle range-of-motion work at the ankle (future knee), hip strengthening, and balance training while avoiding high-impact loading, deep squatting, or sudden rotational movements that could stress healing tissues. Because the ankle now functions as a knee, mobility patterns must be retrained carefully to prevent compensatory gait mechanics and muscle imbalances. Running, jumping, and high-load strength work are contraindicated during early rehabilitation and only introduced once bone healing is confirmed and prosthetic training is advanced. Long term, many individuals regain remarkable endurance and functional capacity, but activity programs still emphasize controlled loading, strong hip and core stability, and avoidance of uncontrolled impact or torsion that could strain the reconstructed limb. Fatigue, altered proprioception, and temporary balance challenges are common as the nervous

system adapts to the new joint orientation, making progressive neuromuscular training a central component of recovery and lifelong exercise programming.

- **Soft-tissue Reconstruction –** refers to a group of surgical techniques used to rebuild or cover areas where muscle, skin, fat, or connective tissue has been removed during bone or soft-tissue sarcoma surgery. After tumor resection, there may be large open spaces, exposed bone, implants, or areas with poor blood supply that cannot heal safely without additional tissue. Surgeons address this by moving nearby tissue (local or regional flaps) or transferring tissue from another part of the body using microsurgery (free flaps). The goal is not only cosmetic closure but also improved circulation, protection of underlying structures, reduced infection risk, and restoration of contour and function. Soft-tissue reconstruction is often performed at the same time as bone reconstruction or prosthetic implantation, especially in areas previously exposed to radiation or where extensive muscle removal has occurred.

When it's used:

- Bone or implant is exposed after tumor removal
- Large soft-tissue loss or radiation-damaged tissue
- Infection risk needs to be minimized through robust coverage

Physical limitations following soft-tissue reconstruction vary widely depending on the size of the flap, the donor site, and whether muscle or nerve function was altered, but early protection of both the reconstructed area and the donor site is critical. In the first weeks after surgery, excessive stretching, pressure, or compression over the flap must be avoided because it can compromise blood flow and threaten tissue survival. Activities that increase swelling - including prolonged standing, heavy lifting, high-intensity cardiovascular work, or rapid limb movements - are typically restricted. Range-of-motion exercises may be limited initially to prevent tension on surgical sutures, particularly when muscle flaps cross joints. Strength training is delayed or modified because transferred muscles may temporarily lose power or need time to relearn new roles within the body. Even after healing, certain long-term limitations may remain, such as reduced endurance in the donor muscle, altered sensation, or decreased flexibility around scar tissue. Exercise programs usually emphasize gradual mobility, postural control, and progressive low-load strengthening while avoiding high-impact activities, aggressive stretching, or contact pressure directly over the reconstructed site until cleared by the surgical team.

- **Osseointegration –** an advanced reconstructive option used primarily after limb amputation in which a titanium implant is surgically anchored directly into the remaining bone and extends through the skin to attach to an external prosthetic limb. Unlike traditional socket-based prostheses that rely on soft tissue for support, osseointegration creates a direct skeletal connection, allowing improved stability, more natural weight transfer, and greater proprioceptive feedback during movement. The procedure is usually performed in one or two stages. First, the implant is inserted into the marrow cavity of the bone and allowed to fuse through a biological process called osseointegration, where bone cells grow into the implant surface. After adequate healing, a connector is attached that allows the prosthetic limb to lock directly onto the implant. While it can significantly improve gait efficiency and comfort, it requires lifelong hygiene, careful monitoring of the skin-implant interface, and ongoing collaboration with a multidisciplinary rehabilitation team.

When it's used:

- Traditional socket prostheses fail or cause severe skin issues
- High-functioning amputees seeking improved mobility

Immediately after surgery, activity focuses on gentle mobility, posture, and upper-body conditioning while avoiding direct loading through the implant site. A staged loading program is typically introduced, beginning with very light axial pressure and gradually increasing weight-bearing over several weeks under clinical supervision. High-impact activity, running, jumping, contact sports, and heavy resistance training are contraindicated during early recovery because excessive force can disrupt bone integration or cause implant loosening. Even long term, individuals are usually advised to avoid repetitive high-impact loading and sudden torsional movements that could stress the bone-implant interface. Exercise programming emphasizes controlled gait training, balance work, progressive strength development in the hips and core, and careful monitoring for signs of infection, irritation, or mechanical overload. Because the implant exits through the skin, friction, sweating, and poor hygiene can increase infection risk, so training environments and equipment must be managed carefully. Many individuals achieve excellent functional outcomes, but successful long-term use depends on gradual load progression, consistent maintenance routines, and thoughtful activity modification.

Targeted Muscle Reinnervation and Advanced Nerve Reconstruction – advanced nerve reconstruction are specialized surgical techniques used during or after sarcoma-related limb resections or amputations to improve long-term function, reduce nerve pain, and enhance prosthetic control. In targeted muscle reinnervation, surgeons reroute severed peripheral nerves that once controlled the removed limb into nearby healthy muscles. Instead of leaving the nerve end isolated - which can lead to painful neuromas or phantom limb pain - the nerve is given a new biological target, allowing it to transmit signals and maintain more normal neural activity. Advanced nerve reconstruction may also include nerve grafting, nerve transfers, or regenerative interfaces designed to restore motor control or sensation. These procedures are increasingly used during amputations, complex limb-sparing surgeries, or revision procedures, especially in patients expected to use advanced prosthetics or those at high risk for chronic neuropathic pain. Over time, the reinnervated muscles can generate electrical signals that allow improved prosthetic responsiveness, more intuitive movement control, and reduced reliance on compensatory strategies.

When it's used:

- Amputations or major resections risk neuroma or phantom pain
- Advanced prosthetic training is planned

Physical limitations after targeted muscle reinnervation and nerve reconstruction focus on protecting delicate nerve healing while gradually retraining neuromuscular coordination. During early recovery, excessive stretching, aggressive strengthening, or direct pressure over the surgical region must be avoided because regenerating nerves are vulnerable to traction and inflammation. Heavy resistance training, high-impact activity, and rapid repetitive movements are typically contraindicated during the first several weeks, particularly when the surgery involves major muscle groups of the shoulder, thigh, or trunk. As healing progresses, exercise programming emphasizes gentle activation, posture, and controlled motor relearning rather than force production. Because nerves regenerate slowly - often millimeters per day - sensory changes, tingling, or altered muscle activation patterns are common, and training must progress cautiously to prevent overuse or compensatory strain. Even long term, individuals may experience changes in strength, endurance, or coordination depending on which muscles were reinnervated, and certain activities that place repetitive pressure on the surgical site may need modification. Successful rehabilitation typically integrates balance work, proprioceptive training, and gradual functional strengthening to help the nervous system adapt to new signal pathways while minimizing the risk of chronic pain or nerve irritation.

Hospital stay and early recovery following bone and soft-tissue sarcoma reconstruction vary depending on the extent of tumor removal, reconstruction type, and overall health, but most individuals remain in the hospital between 3-7 days, with longer stays possible after pelvic, axial skeleton, or complex composite procedures. Early care focuses on pain control, swelling management, protection of surgical repairs, and safe mobility. Patients are usually encouraged to sit upright and begin short, assisted walking within the first 1-2 days to support circulation and reduce the risk of blood clots and pulmonary complications. Weight-bearing status is determined by the reconstruction method; biologic grafts and fusion procedures often require more protection, while endoprosthetic reconstruction may allow earlier controlled loading. Education on positioning, limb protection, and safe transfers begins immediately to prevent contractures, protect nerve healing, and reduce strain on reconstructed tissues.

During the first two weeks after discharge, exercise programming centers on gentle movement rather than strength or performance. Walking is typically limited to short, frequent bouts on level surfaces, combined with breathing exercises, posture work, and light range-of-motion activities for nearby joints that do not stress the surgical site. Lifting more than 10-15 pounds, high-impact activities, aggressive stretching, or twisting motions are contraindicated across all reconstruction types during this phase. For individuals with soft-tissue flaps or nerve reconstruction, direct pressure, excessive stretching, or compression over the surgical area must be avoided to protect blood flow and nerve healing. Those with osseointegration follow structured loading progression rather than unrestricted weight-bearing, while patients with arthrodesis or rotationplasty begin adapting to altered joint mechanics and balance demands.

From weeks 2-6, walking tolerance and daily activity can gradually increase if swelling, pain, and incision healing remain stable. Low-intensity neuromuscular exercises may be introduced to improve coordination and reduce compensatory movement patterns, particularly after limb-sparing surgeries or rotationplasty where biomechanics have changed. Resistance training during this phase should remain very light and focus on unaffected areas or core stability rather than loading the reconstruction directly. Individuals with vascularized grafts or composite reconstructions may still have significant weight-bearing restrictions, while endoprosthetic reconstructions often emphasize controlled movement to protect surrounding soft tissues rather than the implant itself. High-impact exercise, running, jumping, rapid directional changes, and heavy resistance remain contraindicated. Between 6-12 weeks after surgery, many patients can transition toward a more structured exercise routine if cleared by their surgical team. Low-impact cardiovascular activities such as brisk walking, upright stationary cycling, or aquatic walking (once wounds are healed) are generally appropriate. Progressive strengthening can begin with light to moderate resistance, emphasizing symmetrical movement patterns, joint stability, and gradual load progression. However, impact-based training, maximal lifting, explosive movements, and torsional stress are typically restricted during this period across all reconstruction types. Long-term considerations vary: biologic grafts and fusion procedures often require extended protection from heavy loading, megaprostheses usually carry permanent restrictions on high-impact activity, and osseointegration requires ongoing hygiene and careful load monitoring. Throughout recovery, warning signs such as increasing pain, redness, swelling, drainage, instability, sudden weakness, or neurological changes should prompt immediate reduction in activity and medical evaluation.

Potential Side-effects:

- Surgical site pain or tenderness
- Phantom limb pain or phantom limb sensations
- Swelling or persistent edema
- Infection or delayed wound healing
- Bleeding or hematoma formation
- Seroma or fluid accumulation
- Scar tissue formation and adhesions
- Skin irritation, breakdown, or pressure sores
- Neuroma formation or nerve pain
- Numbness, tingling, or altered sensation
- Hypersensitivity at incision or graft sites
- Muscle weakness or loss of muscle mass
- Joint stiffness or reduced range of motion
- Contractures (especially hip, knee, or shoulder)
- Overuse injuries in adjacent joints
- Chronic pain syndromes
- Altered balance and coordination
- Gait changes or compensatory movement patterns
- Difficulty with prosthetic fitting or tolerance
- Prosthetic-related skin issues or friction injuries

- Difficulty with prosthetic fitting or tolerance
- Prosthetic-related skin issues or friction injuries
- Bone nonunion or delayed union (graft reconstructions)
- Stress fractures or graft fracture
- Implant loosening, wear, or mechanical failure
- Joint instability (prosthetic reconstructions)
- Hardware irritation or prominence
- Reduced flexibility or mobility around reconstruction
- Donor-site pain or weakness (bone graft or flap procedures)
- Flap failure or compromised blood flow
- Lymphedema or chronic limb swelling
- Deep vein thrombosis or blood clots
- Fatigue and reduced stamina
- Changes in posture or spinal alignment
- Nerve regeneration discomfort or dysesthesia
- Infection risk at skin-implant interface (osseointegration)
- Skin drainage or irritation around implants
- Emotional or psychological distress
- Body image concerns or adjustment challenges
- Fear of movement or reduced confidence during activity

Types of Treatment Used:

- Chemotherapy
- Targeted therapy
- Immunotherapy
- Radiation therapy
- Proton beam therapy
- Hormonal therapy (select subtypes)
- Bone-modifying agents
- Radiofrequency ablation
- Cryoablation (cryosurgery)
- Microwave ablation
- High-intensity focused ultrasound (HIFU)
- Hyperthermia therapy
- Isolated limb perfusion / isolated limb infusion
- Transarterial embolization (selected bone tumors)

SKIN CANCER

The skin is the body's largest organ, serving as a protective barrier that regulates temperature and stores water, fat, and vitamin D. The skin has two main layers: the epidermis (outer layer) and the dermis (inner layer). Skin cancer begins in the epidermis, which is composed of three main cell types: squamous cells - thin flat cells forming the top layer; basal cells - round cells lying beneath the squamous cells; and melanocytes - pigment-producing cells in the lower epidermis.

Skin cancer is the most common type of cancer worldwide. Non-melanoma skin cancer ranks as the fifth most common cancer globally, with 1,234,533 new cases and 69,416 deaths worldwide in 2022. An estimated 2-3 million additional non-melanoma skin cancer cases occur each year that are not captured in GLOBOCAN data due to underreporting. Incidence is highest in Oceania, North America, and Europe, with Australia ranking first globally, while rates in Africa and Asia remain comparatively low (Wang, Gao, and Zhang, Chinese Medical Journal, 2025 ; WHO, 2024).

The two most common types of skin cancer are basal cell carcinoma and squamous cell carcinoma, both classified as non-melanoma skin cancers. Basal cell carcinoma grows slowly and rarely spreads but can damage nearby tissue; it typically appears as a pink or white pearly bump or irritated patch that bleeds and crusts in a repeating cycle. Squamous cell carcinoma is less common but more dangerous because it grows more quickly and may spread; it often appears as a raised pink bump or scaly patch with an open sore in the center. Neither type is likely to become life-threatening when detected and treated early (ACS, What Is Basal and Squamous Cell Skin Cancer?, 2024). Actinic keratosis is a precancerous skin condition that can progress to squamous cell carcinoma if left untreated.

Melanoma is the most serious and deadly form of skin cancer, accounting for approximately 2% of all skin cancers but causing the greatest number of skin cancer deaths due to its propensity to spread to distant organs. There were 331,722 new cases of melanoma and approximately 58,667 deaths worldwide in 2022, making it the 17th most commonly diagnosed cancer globally (Wang, Gao, and Zhang, Chinese Medical Journal, 2025). Melanoma develops in melanocytes and can arise in the skin, eye, and in rare cases in internal organs. Incidence rates are higher in women than men below age 45, but by age 60 rates in men more than double those in women, and by age 80 they nearly triple (ACS, Key Statistics for Melanoma Skin Cancer, 2024). Warning signs of melanoma follow the ABCDE rule - Asymmetry, Border irregularity, Color variation, Diameter greater than 6mm, and Evolving changes - and include changes in the size, shape, or color of a mole, the appearance of a new growth, or a sore that does not heal. Any such changes persisting beyond one month should be evaluated by a physician.

Risk factors for all types of skin cancer include fair skin, blonde or red hair, tendency to burn easily in the sun, excessive sun exposure, a history of sunburns, tanning bed use, prior radiation therapy, arsenic exposure, and a suppressed immune system (ACS, Skin Cancer Risk Factors, 2024). Major risk factors specific to melanoma include a personal or family history of melanoma and the presence of atypical, large, or numerous moles (more than 50). Protective measures including sunscreen, UV-protective clothing and eyewear, avoiding peak sun hours between 10 AM and 2 PM, and seeking shade are all effective in reducing skin cancer risk.

Several hereditary syndromes are associated with elevated skin cancer risk (NCI, Genetics of Skin Cancer PDQ, updated 2024):

Basal Cell Carcinoma - Basal Cell Nevus Syndrome, caused by pathogenic variants in PTCH1 and PTCH2, is associated with a significantly increased risk of basal cell carcinoma as well as other tumors.

Squamous Cell Carcinoma - Oculocutaneous albinism, epidermolysis bullosa, and Fanconi anemia are associated with substantially increased squamous cell carcinoma risk. Xeroderma pigmentosum, an autosomal recessive condition caused by defective DNA repair, is associated with elevated risk of basal cell carcinoma, squamous cell carcinoma, and melanoma.

Melanoma - CDKN2A is the major germline tumor suppressor gene associated with familial melanoma, with pathogenic variants accounting for 35-40% of all familial melanoma cases. Germline variants in CDK4, MITF, and BAP1 are also associated with elevated melanoma risk.

- **Melanoma of the Eye (Ocular Melanoma) –** is the second most prevalent form of melanoma and manifests as a malignant growth of melanocytes in the uveal tract or conjunctiva of the eye. Approximately 5-6 people per million are diagnosed with ocular melanoma in the United States each year, accounting for approximately 3-5% of all melanomas (Hou, Rokohl, Li, Guo, Ju, Fan, and Heindl, Advances in Ophthalmology Practice and Research, 2024). The median age at diagnosis is approximately 62 years, and men have a 30% higher incidence compared to women (Hou, Rokohl, Li, Guo, Ju, Fan, and Heindl, Advances in Ophthalmology Practice and Research, 2024). Like melanoma of the skin, ocular melanoma often begins with a cluster of melanocytes called a nevus. Different types of nevi and pigmented areas in the eye - including choroidal, giant choroidal, and iris nevi, as well as ocular dermal melanocytosis - have been linked with an increased risk of ocular melanoma. Additional risk factors include light eye color (blue or grey), fair skin, inability to tan, family history of ocular melanoma, and occupational UV exposure such as arc welding.

  When metastasis occurs, it spreads hematogenously, most commonly to the liver (89%), followed by the lungs (29%) and bones (17%). While up to 20% of ciliary body and choroidal melanomas spread to other parts of the body within five years, only approximately 5% of iris melanomas become metastatic within the same period - making iris melanomas significantly less likely to spread and generally associated with a more favorable prognosis (Hou et al., Advances in Ophthalmology Practice and Research, 2024; ACS, Ocular Melanoma, 2024).

Procedures:

- **Shave Biopsy / Shave Excision –** during the procedure, a clinician uses a sterile surgical blade or specialized razor-like instrument to carefully shave off a thin layer of tissue that includes the visible lesion and a small portion of surrounding skin. The depth can vary depending on the goal - a superficial shave removes only the outermost layers, while a deeper "saucerization" shave removes tissue extending into the upper dermis to capture the full lesion for diagnosis or treatment. Local anesthetic is typically used, and stitches are usually not required because the wound heals gradually from the bottom up. The removed tissue is sent to a pathology laboratory where specialists examine it under a microscope to determine whether cancer or abnormal cells are present and whether additional treatment is needed.

  When it's used:

  - Diagnostic evaluation of suspicious skin lesions
  - Removal of superficial, non-pigmented lesions
  - Selected low-risk basal cell cancers (complete shave excision)

- **Cryosurgery (Cryotherapy) –** is one of the least invasive surgical approaches and involves freezing abnormal skin cells using liquid nitrogen. The extreme cold destroys cancerous tissue, which then blisters and sheds as new skin forms. The procedure is typically done in a clinic setting without incisions or stitches.

  When it's used:

  - Precancerous lesions such as actinic keratosis
  - Very superficial basal cell or squamous cell cancers
  - Patients who cannot tolerate traditional surgery

- **Dermabrasion –** mechanically removes the top layers of skin using a rotating abrasive instrument.

  When it's used:

  - Treating widespread precancerous lesions (field treatment) such as actinic keratoses
  - Managing superficial skin cancers in very select cases
  - Improving surface irregularities after cancer treatment

- **Electrodesiccation and Curettage –** the tumor is physically removed and then the remaining cancer cells are destroyed using controlled electrical energy. During the procedure, the clinician first numbs the area with local anesthetic. A specialized loop-shaped instrument called a curette is then used to gently scrape away the soft cancerous tissue. Because many superficial skin cancers are more fragile than normal skin, the surgeon can often feel the difference between healthy and abnormal tissue while scraping. After the visible tumor is removed, an electrodesiccation device delivers a small electrical current to the area. This current generates heat that destroys remaining cancer cells, seals small blood vessels to control bleeding, and helps reduce the chance of recurrence. The scraping and cauterization steps may be repeated several times during the same session to improve clearance of the lesion.

  The wound created by curettage and electrodesiccation is typically left open rather than stitched closed, allowing it to heal gradually from the bottom up over several weeks. This healing process forms a flat or slightly depressed scar that often becomes less noticeable with time, although cosmetic outcomes vary depending on location and skin type.

  When it's used:
  - Small, low-risk basal cell carcinomas
  - Superficial squamous cell cancers
  - Tumors on the trunk or limbs

- **Conservative (Simple) Surgical Excision –** a procedure used to remove a skin lesion with a relatively small border of surrounding healthy tissue while preserving as much normal skin and underlying structure as possible. During the procedure, the area is numbed with local anesthetic and the surgeon uses a scalpel to carefully cut around the lesion, removing it in one piece. The depth and size of the excision depend on whether the goal is diagnosis, treatment of an early cancer, or removal of a suspicious growth. Because the margins are smaller than those used in wide local excision, conservative excision is typically chosen when the lesion appears superficial, well defined, and unlikely to have spread microscopically into surrounding tissue. The removed specimen is sent to pathology to confirm the diagnosis and determine whether the edges are free of cancer cells; if margins are not clear, a second procedure may be recommended.

  When it's used:
  - Suspicious moles requiring biopsy
  - Early melanoma in situ
  - Small, well-defined basal cell cancers

- **Standard Surgical Excision / Wide Local Excision –** this is one of the most commonly performed procedures for skin cancer worldwide and is considered the primary surgical approach for many melanomas as well as moderate- to high-risk basal cell and squamous cell carcinomas. During this procedure, the surgeon removes the visible tumor along with a measured border of normal-looking skin, known as a surgical margin, to ensure that microscopic cancer cells surrounding the lesion are also eliminated. The width of the margin is carefully determined based on the cancer type, size, depth, and location; for example, melanomas require wider margins than most non-melanoma skin cancers to reduce the risk of recurrence. The procedure is typically performed under local anesthesia in an outpatient setting, though larger or more complex excisions may be done in an operating room with sedation.

  Once the tumor and margin are removed, the wound may be closed directly with stitches if enough surrounding skin is available, or reconstructed using skin grafts or local tissue flaps when the defect is larger or located in cosmetically sensitive areas. The removed tissue is sent to a pathology laboratory where the margins are examined to confirm that no cancer cells remain at the edges. If cancer is found at the margin, an additional excision may be required. Healing time varies depending on wound size and location, and scars are expected but often fade over time. Wide local excision is favored because it provides strong cancer control while remaining less technically complex than Mohs surgery, making it widely accessible across healthcare systems. However, it is not always the best option for tumors on the face or other delicate areas where tissue preservation is critical, or for superficial lesions that can be treated with less invasive methods.

  When it's used:
  - Most melanomas
  - Squamous cell carcinoma
  - Many basal cell cancers
  - Tumors of the trunk, arms, or legs

- **Mohs Micrographic Surgery –** removes cancer layer by layer while each layer is examined under a microscope during the procedure. This allows the surgeon to stop once margins are clear, preserving as much healthy tissue as possible while achieving very high cure rates.

  When it's used:
  - Facial or cosmetically sensitive areas (nose, eyelids, lips, ears)
  - Recurrent or aggressive basal and squamous cell cancers
  - Tumors with irregular borders

- **Sentinel Lymph Node Biopsy (SLNB) –** this is a staging surgery rather than a tumor-removal procedure. A tracer dye identifies the first lymph node that drains the tumor area, which is removed and analyzed to see if cancer has spread.

  When it's used:
  - Intermediate- or high-risk melanoma
  - Selected high-risk squamous cell carcinoma

- **Lymph Node Dissection –** if cancer has spread to lymph nodes, surgeons may remove multiple nodes from the neck, armpit, or groin to control disease and guide further treatment.

  When it's used:
  - Node-positive melanoma
  - Advanced squamous cell carcinoma

- **Reconstructive Surgery (Skin Grafts and Flaps) –** after large tumor removal, reconstruction restores skin coverage, contour, and function. This may involve moving nearby tissue or transplanting skin or muscle from another body area.

  When it's used:
  - Large facial or scalp tumors
  - Deep excisions exposing bone or cartilage
  - Areas requiring cosmetic or functional restoration

- **Amputation –** amputation is the most aggressive surgical option and involves removing part of a finger, toe, or limb when cancer invades bone, joints, or critical structures and cannot be safely removed otherwise.

  When it's used:
  - Advanced melanoma or aggressive skin cancers invading deep tissue
  - Recurrent tumors resistant to other treatments

Most skin cancer surgeries are performed on an outpatient basis, and the majority of patients return home the same day. Hospital admission is uncommon and typically limited to extensive wide excisions, large reconstructive procedures using flaps or grafts, lymph node surgery, or operations requiring general anesthesia. When hospitalization is necessary, stays are usually short, ranging from overnight observation to 1-2 days. Early recovery focuses on wound protection, bleeding control, swelling management, and prevention of wound disruption.

During the first 1-2 weeks after surgery, exercise should prioritize gentle movement rather than structured training. Walking at an easy pace is encouraged to support circulation and reduce stiffness, but activities that significantly elevate heart rate or blood pressure should be avoided. Heavy lifting, high-impact exercise, running, jumping, vigorous strength training, and any activity that causes straining are contraindicated, as they increase the risk of bleeding or wound separation. Stretching or movements that pull directly on the incision site should be avoided. For procedures involving the head, face, neck, or scalp, inverted positions, forceful breathing, and contact activities are discouraged because of higher bleeding risk. Sweating directly over healing wounds, swimming, and water submersion are also contraindicated until the incision has fully closed.

From weeks 2–6, activity can gradually increase as long as the surgical site is healing well and there are no signs of infection, bleeding, or excessive swelling. Walking duration and pace may increase, and light resistance training may be introduced for body regions away from the surgical site. Exercises should remain low load, controlled, and non-straining. Direct pressure, friction, or repetitive movement over scars, grafts, or flap sites should still be avoided. Overhead lifting, aggressive stretching, and high-intensity cardiovascular exercise may need modification depending on the location of surgery. For patients who underwent reconstruction or lymph node procedures, swelling management and scar protection remain priorities during this phase.

Between 6-12 weeks after surgery, most individuals can transition back toward a more structured exercise routine if cleared by their healthcare provider. Low-impact cardiovascular exercise such as brisk walking, stationary cycling, or elliptical training is generally appropriate. Strength training can progress gradually with light to moderate resistance, emphasizing controlled movements, proper breathing, and avoidance of excessive strain across healed scars. High-impact exercise, contact sports, or activities that repeatedly traumatize the surgical area may still require modification, particularly after large excisions, grafts, flap reconstruction, or lymph node surgery. Scar sensitivity, tightness, numbness, or altered sensation may persist and should guide exercise progression.

Potential Side-effects of all Skin Cancer Procedures:

- Pain or tenderness at the surgical site
- Redness, swelling, or bruising
- Bleeding or oozing from the wound
- Infection or delayed healing
- Scabbing and temporary skin discoloration
- Scar formation (flat, raised, or indented scars)
- Changes in skin texture or thickness
- Numbness, tingling, or altered sensation near the incision
- Tightness or pulling sensation as the skin heals
- Itching during the healing process
- Sensitivity to sun exposure over the treated area
- Temporary weakness or limited movement if surgery was near a joint
- Fluid buildup or mild drainage
- Cosmetic changes depending on size and location of removal
- Skin graft or flap complications (if reconstruction was performed)
- Swelling that lasts longer after lymph node procedures
- Risk of lymphedema when lymph nodes are removed

Type of Treatment Used:

- Topical chemotherapy (fluorouracil, imiquimod)
- Immunotherapy (checkpoint inhibitors)
- Targeted therapy (BRAF/MEK inhibitors for melanoma)
- Systemic chemotherapy
- Radiation therapy
- Proton beam therapy
- Photodynamic therapy (PDT)
- Cryotherapy
- Laser therapy
- Intralesional injections (immune or chemotherapeutic agents)

CHILDHOOD CANCERS

The term "childhood cancer" most commonly designates cancer arising in children from 0-14 years, though the definition sometimes includes adolescents aged 15-19 years. Childhood cancers are rare, representing approximately 1% of all cancers globally. In 2023, there were 377,000 new cases of childhood cancer and 144,000 deaths worldwide. Since 1990, new cases have remained relatively stable globally, while deaths have decreased by 27% though the majority of childhood cancer burden falls on low- and middle-income countries, which account for 85% of new cases and 94% of deaths. The cancer types with the greatest global burden in 2023 were leukemias, brain and central nervous system cancers, and non-Hodgkin lymphoma - together accounting for nearly half of all childhood cancer deaths (GBD 2023 Childhood Cancer Collaborators, The Lancet, 2026).

In high-income countries, where comprehensive services are generally accessible, more than 80% of children with cancer are cured. In most low- and middle-income countries, fewer than 30% are cured, with avoidable deaths resulting from lack of diagnosis, misdiagnosis or delayed diagnosis, obstacles to accessing care, abandonment of treatment, death from toxicity, and relapse (WHO, Childhood Cancer Fact Sheet, 2024). Children in low human development index settings face mortality rates more than 50% higher than their counterparts in very high human development index countries. This disparity is driven by underdiagnosis, late or incorrect diagnosis, difficulties accessing healthcare, advanced-stage disease at the time of diagnosis, lack of access to treatments and supportive care, treatment abandonment due to the financial burden on families, and inadequate numbers of health professionals with specialized training (WHO Global Initiative for Childhood Cancer, 2024; GBD 2023 Childhood Cancer Collaborators, The Lancet, 2026).

With more than 500,000 survivors of childhood cancer living in the United States alone, this population represents one of the most medically complex and underserved groups in oncology rehabilitation. Despite remarkable improvements in survival, childhood cancer survivors are frequently overlooked in acute and long-term rehabilitation planning - in part because their cancer was diagnosed and treated years or decades earlier, and in part because the late effects of treatment may not manifest until adulthood. Among long-term adult survivors of childhood cancer, the cumulative incidence of chronic health conditions by 25 years from diagnosis is approximately 66.8%, with the most common late effects including cardiovascular disease, subsequent malignant neoplasms, endocrinopathies, metabolic syndrome, and neurocognitive deficits (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). Survivors exposed to anthracycline-based chemotherapy or chest-directed radiotherapy face a nearly six-fold increased risk of cardiomyopathy and a seven-fold increased risk of death from cardiovascular disease compared to the general population - risks that are dose-dependent and may not become clinically apparent for 10-20 years after treatment (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). The risk of developing a subsequent malignant neoplasm is elevated approximately six-fold compared to the general population, with a cumulative incidence exceeding 20% at 30 years from the primary diagnosis.

For oncology exercise specialists, childhood cancer survivors represent a uniquely challenging but critically important population. Physical inactivity - common in this group due to fatigue, functional impairment, fear of injury, and lack of tailored programming - further compounds their cardiometabolic risk. Exercise has been shown to promote positive effects on cardiac function, reduce treatment-related cardiovascular dysfunction, improve neurocognitive outcomes, and reduce psychological burden in this population, yet clinical exercise programs specifically designed for childhood cancer survivors remain scarce (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). Oncology exercise specialists should be prepared to screen for and accommodate the full spectrum of late effects - including reduced cardiopulmonary reserve, musculoskeletal fragility, neuropathy, endocrine dysfunction, and neurocognitive changes -when designing individualized exercise programs for adult survivors of childhood cancer.

The types of cancer differ between children and adults. Nearly half of childhood cancers worldwide are cancers of the blood - leukemia and lymphoma - though leukemias, central nervous system tumors, and lymphomas together account for more than 60% of childhood cancer cases globally (GBD 2023 Childhood Cancer Collaborators, The Lancet, 2026). Leukemia, the most common form of childhood cancer, is rarely diagnosed in sub-Saharan Africa. There is a notable correlation between some childhood cancers and infectious diseases. Burkitt lymphoma occurs with the highest frequency in equatorial Africa, where exposure to Epstein-Barr virus and malaria is also prevalent. Kaposi sarcoma has a higher rate of diagnosis in countries with a high prevalence of HIV infection.

The most common types of cancer in children and adolescents under the age of 20 are leukemia (25.7%), cancers of the brain and other nervous tissue (16.1%), non-Hodgkin lymphoma (6.7%), Hodgkin lymphoma (6.3%), and thyroid cancer (5.8%) (NCI, Cancer in Children and Adolescents Fact Sheet, updated 2024). Distribution varies by age group: leukemia predominates in children aged 1-4, while lymphoma is more common in adolescents aged 15-19, among whom brain tumors and thyroid cancer also represent a significant proportion of cases (Siegel et al., CA: A Cancer Journal for Clinicians, 2024). Five-year survival rates for childhood cancer have improved dramatically over recent decades, rising from 63% in the 1970s to 85% in 2010-2019, with particularly notable gains in acute lymphoblastic leukemia - from 57% in 1975 to approximately 92% today - and non-Hodgkin lymphoma, which now exceeds 91% (NCI, Cancer in Children and Adolescents Fact Sheet, updated 2024).

The CDC recommends Gardasil 9 (HPV vaccine) for routine vaccination at ages 11 or 12 for both girls and boys, with vaccination available as early as age 9. Catch-up vaccination is recommended for all individuals through age 26 who were not adequately vaccinated earlier. It is ideal to receive the vaccine before sexual contact and exposure to HPV, as the vaccine prevents new infections but does not treat existing ones. Cervical, vulvar, vaginal, anal, oropharyngeal, and other head and neck cancers are all linked to HPV (CDC, HPV Vaccination Recommendations, 2024).

Think back to childhood - the games of hide-and-seek, tag, dodgeball, and jump rope; riding bikes, playing catch, roller skating, and ice skating; school recess and organized sports. Physical activity was simply part of everyday life, something most of us never thought twice about.

What we may not have realized at the time is that those moments of play were doing far more than keeping us busy. Sport and exercise are important because they:

1. Maintain and improve our overall level of physical fitness

2. Help us achieve and sustain a healthy weight

3. Strengthen self-confidence and enhance our overall sense of wellbeing

4. Foster a sense of connection and belonging when we participate in team sports and group activities

The benefits of making exercise a part of everyday life are well established. Physical activity naturally stimulates the production of endorphins - hormones that contribute to an overall sense of well-being -and can meaningfully reduce feelings of depression and lethargy. For a child diagnosed with cancer, these benefits take on even greater importance. Unlike adults, children have not yet developed the emotional coping skills needed to navigate the fear, uncertainty, and loss that come with a serious illness, and long hospital stays strip away the routines that define childhood - school, recess, friends, and the freedom to simply be a kid. A compromised immune system can make even ordinary outings impossible. Exercise can help bridge that gap - improving sleep patterns, reducing pain, stimulating appetite, and supporting both the physical and emotional well-being of children whose bodies are working hard to heal. For this reason, incorporating age-appropriate physical activity into a child's care plan is increasingly recognized as an essential component of pediatric cancer treatment and recovery.

DURING CANCER TREATMENT

Caring for a child who has been diagnosed with cancer and is undergoing cancer treatment is difficult for the entire family. Psychosocial support is available for parents as well as other family members and is an important component of care. The care team can address practical issues such as insurance and education issues (NCI, Children with Cancer: A Guide for Parents, 2024).

During cancer treatment there are several side-effects that parents will be made aware of:

- Anemia (low red blood cell counts)
- Pallor
- Dizziness
- Weakness
- Lack of energy
- Headaches
- Thrombocytopenia (low platelet counts)
- Neutropenia (low white blood cell counts)
- Immunocomprimization
- Gastrointestinal issues
- Irritation and sores in the mouth
- Diarrhea, Constipation, Nausea and vomiting
- Malnourishment, Weight loss, Delayed growth
- Pain

Like adults undergoing cancer treatment, a child's bone density may also be compromised due to certain treatments. Weight-bearing exercise will help to increase bone density. Many parents will feel a need to protect their children and may be overly anxious about their child playing sports and the potential for injury. Sometimes this will result in parents taking an overly cautious approach. On the other hand, there are parents who are determined that their child lead a "normal" life and be allowed to participate in "normal" activities, and they fail to take the necessary precautions reflecting the changes in the child's health and life.

It is best to take a balanced approach in which sport and exercise may become a family activity, something everyone can do together. Some examples might be walking, light hiking (minimizing obstacles that could lead to tripping and falling), cycling, playing catch, kicking a ball, etc. Precautions may need to be considered as far as the intensity and duration of the activity. Just like an adult, there will be good days and bad days—days where they will have energy and others in which they may not even want to get out of bed. They should be encouraged and supported, but not pushed to participate when they truly are not up for it. It is always best for the parents to discuss their questions and concerns with the medical team prior to beginning something new.

There will be times when the child will be at high risk for infection, and contact of any kind with other children should be avoided during periods of significant neutropenia. Overwhelming infection or sepsis in the setting of a dangerously low white blood cell count is one of the most serious and potentially life-threatening complications of cancer treatment in children, requiring emergent evaluation of any new fever (NCI, Children with Cancer: A Guide for Parents, 2024; Lanser et al., Current Oncology Reports, 2022).

If a child has been treated for a brain tumor, swimming may be permitted once recovery is sufficiently advanced, but diving, jumping into water, and any activity that risks direct head impact should be avoided for several weeks after surgery. Return to aquatic activity should only occur with explicit clearance from the child's physician or neurosurgeon, who will assess whether the surgical wound is fully healed and the risk of water entry to the incision site has passed (NCI, Children with Cancer: A Guide for Parents, 2024).



It is critical that a child's medical team be consulted regarding when physical activity may safely begin or resume. Physical activity and exercise are now recognized as safe and beneficial for children and adolescents affected by cancer regardless of stage along the cancer continuum. The ActiveOncoKids consensus-based guidelines for movement and exercise in pediatric oncology support the integration of physical activity as a central therapeutic strategy throughout treatment and survivorship, and the International Pediatric Oncology Exercise Guidelines (iPOEG) toolkit has been co-produced with end-users to facilitate implementation across clinical and community settings (Götte et al., Pediatric Blood & Cancer, 2022; McLaughlin, Wurz, Guilcher, Zwicker, and Culos-Reed, Communications in Kinesiology, 2024).

The ultimate goal is to return the child to their previous level of fitness and normal daily activities. Where longer-term disabilities exist, appropriate adaptations will need to be made. Even when a child cannot participate directly, staying connected to teammates - receiving updates on team progress and attending games from the sidelines - can help preserve a sense of belonging and involvement.

The key exception is when blood counts are low and infection risk is elevated, during which time participation in group or contact activities should be avoided.

TEAM SPORTS

Being diagnosed with cancer as a child certainly may impact their ability to participate in sports now or in the future. Things that will need to be considered include, but are not limited to:

- **What type of cancer do they have?**
- **What stage of treatment are they in?**
- **What type of sport they are considering participating in?**

If a child has a central line, their parents may be understandably reluctant to allow participation in physical education or sports. A central line - formally known as a central venous access device (CVAD) - is surgically placed into a large blood vessel to administer chemotherapy, medications, and fluids, and to facilitate blood sampling, eliminating the need for repeated needle insertions. Common devices used in pediatric oncology include tunneled catheters such as Hickman or Broviac lines, peripherally inserted central catheters (PICC lines), and totally implantable venous access devices (TIVADs), commonly known as ports (Wais et al., Pediatric Neonatology, 2024).

Hickman and Broviac catheters are tunneled under the skin with an external portion protruding from the chest wall. PICC lines are inserted in the arm and also have an external component. Ports are surgically implanted entirely within the subcutaneous tissue, with nothing externally visible - an advantage that places no restriction on the child's activity and helps preserve body image, which is particularly important in children and adolescents. When a Hickman, Broviac, or PICC line is accessed, a syringe is attached to the external portion in a generally painless procedure. When a port is accessed, a needle is inserted through the skin, causing brief discomfort that can be minimized with EMLA cream applied beforehand. For a child who is an avid swimmer, the medical team should be consulted about whether a port may be the most appropriate device.

Swimming with a PICC line or Hickman central line is not recommended due to the significantly elevated risk of infection and potential dislodgement associated with external catheter - confirmed studies show tunneled catheters carry an infection hazard ratio of 3.2 times and a dislodgement hazard ratio of nearly 4 times that of fully implanted ports (Nürnberger et al., European Journal of Pediatrics, 2025). Swimming may be possible with an implanted port once the incision has fully healed and no needle is in place, subject to medical team clearance.

Many other games and activities may be possible with limited or no restrictions, though guidance on safe participation will always need to be tailored to the individual child. Securing the central line before any physical activity is essential. The child's doctor or nurse may recommend a snug-fitting T-shirt or an elastic tubular support bandage - such as a Tubigrip - to provide added security and help the child feel confident enough to take part.

It is important to recognize that not every child will want to be physically active, and for some, that reluctance may have nothing to do with their diagnosis. For others, low energy from treatment, muscle weakness due to poor appetite, disrupted sleep, or ongoing pain may be significant barriers. Regardless of a child's prior interest in sport, physical activity is now recognized as a central therapeutic strategy across the cancer continuum - not simply an optional add-on - making it a critical component of rehabilitation and recovery for all children with cancer (Caru, Dandekar, and Schmitz, American Journal of Lifestyle Medicine, 2025).

It is important to acknowledge that returning to sport or group activity may not always be a seamless experience. If a child is unable to fully participate, or if teammates and peers do not yet understand their condition, feeling accepted and welcomed may take time and patience. Open communication between parents, the child's medical team, coaches, and teammates can help bridge that gap.

During this transitional period, meaningful involvement can still be fostered through alternative roles - such as referee, scorekeeper, judge, or commentator. These roles keep the child connected to the sporting environment, maintain their sense of belonging and purpose, and allow them to contribute to the team in a visible and valued way. Research highlights that maintaining social connection and a sense of involvement are key facilitators of physical activity engagement in children with cancer, and even participation from the sidelines can play a meaningful role in supporting emotional well-being and motivating gradual return to full activity when the child is ready (Caru and Sholler, Psychology Research and Behavior Management, 2025).



GOAL SETTING

Helping a child set realistic and achievable goals is one of the most important things a parent, caregiver, or clinician can do during recovery. These goals will likely look very different from those the child had before their diagnosis - and that is not only acceptable, it is expected.

Where a child once dreamed of climbing a mountain or swimming a great distance, their goal may now be a hike through a local park or laps in a community pool when permitted. For some, the goal may simply be to walk unassisted. Whatever the target, it helps to establish an "ultimate" goal and then break it down into smaller, more immediately achievable steps - each one a building block toward the larger vision.

Goals will need to be regularly assessed and adjusted. Cancer treatment, side effects, and unexpected setbacks will sometimes require the plan to change, and this should be normalized. It is not uncommon to take two steps forward and one step back - and the child should never interpret this as failure. Keep them focused on how far they have come, celebrate every gain no matter how small, and help them maintain sight of what lies ahead. Research shows that parental encouragement and positive reinforcement are among the most powerful facilitators of physical activity in children with cancer (Gu, Yu, Li, Pan, Ma, Cui, Cui, and Guo, Frontiers in Pediatrics, 2025)- though parents should also be mindful that a child may be far more self-critical than the situation warrants. Consistent praise and encouragement gov a long way.

Sport and physical play will be an important part of both the psychological and physiological recovery of a child with cancer. Before sport even becomes a realistic consideration, however, a number of physical challenges will need to be addressed. One of the most common problems experienced by children during and after cancer treatment is muscle wasting and generalized weakness (den Hartog, Tissing, Bon, van der Torre, and Verwaaijen, JMIR Pediatrics and Parenting, 2025), which may result from:

- **Extended periods of bed rest**
- **Prolonged inactivity during treatment**
- **The effects of steroids and other chemotherapy agents on muscle tissue**
- **The direct impact of the tumor type itself on the musculoskeletal system**

FOLLOWING TREATMENT

As of 2022, more than 521,000 pediatric cancer survivors were living in the United States - approximately 1 in 530 young adults between the ages of 20-39 - a number projected to exceed 580,000 by 2040 (ACS, Cancer Facts & Figures, 2025). More than 95% of childhood cancer survivors will have a significant health-related issue by the time they are 45 years of age, most commonly as a result of their treatment rather than the cancer itself. Childhood cancer survivors are at a 15-fold increased risk of developing congestive heart failure and a 7-fold higher risk of premature deatvh due to cardiac causes compared with the general population (Ryan et al., Circulation, 2025). These survivors have unique healthcare needs requiring lifelong, risk-based monitoring of late effects - yet most young adult survivors do not currently receive adequate risk-based care, and adherence to recommended cardiac surveillance remains inconsistent (Ackerman, Dabour, Rodgers, et al., JACC: CardioOncology, 2025).

The American Heart Association's 2025 Scientific Statement on cardiovascular toxicity in childhood cancer survivors recommends that two-dimensional echocardiography remains the preferred imaging modality for cardiotoxicity surveillance, with individualized screening based on clinical signs and symptoms, modifiable cardiovascular risk factors, and medical judgment (Ryan et al., Circulation, 2025). Childhood cancer survivors and their physicians should maintain awareness of all prior treatments received, as cardiac complications may not emerge until many years - or even decades - after treatment has concluded.

Anthracyclines - including doxorubicin, daunorubicin, epirubicin, and idarubicin - are among the most widely used chemotherapy agents in pediatric oncology, essential in chemotherapy regimens for nearly 60% of childhood cancers, contributing to dramatic improvements in five-year survival rates. However, this therapeutic success comes at a significant cardiac cost. Anthracycline-induced cardiotoxicity is a dose-dependent adverse effect resulting from oxidative stress, disrupted iron homeostasis, and impaired contractility, and can present acutely as reversible myocardial injury or chronically as irreversible left ventricular dysfunction and cardiomyopathy, manifesting either within one year (early-onset) or years to decades after treatment (late-onset) (Ryan et al., Circulation, 2025).

The dose-dependent nature of anthracycline cardiotoxicity is well established. The incidence of anthracycline-related heart failure is less than 5% with cumulative exposure below 250 mg/m²; approaches 15% at doses between 250-500 mg/m²; and exceeds 30% for doses above 600 mg/m². Individuals treated at a younger age - particularly under 5 years - face in-

creased risk due to cardiotoxic insult to a growing myocardium (Armenian et al., Lancet, 2024). Critically, because of individual variations in anthracycline metabolism, there is no confirmed risk-free dose, and diagnosing anthracycline-induced cardiomyopathy in the symptomatic phase is associated with poor treatment response - making early and systematic cardiac evaluation essential (Ryan et al., Circulation, 2025).

In long-term childhood cancer survivors, systolic dysfunction has been detected in 5.8%, and abnormal global longitudinal strain and diastolic dysfunction in 28% and 8.7% respectively, underscoring that subclinical cardiac dysfunction is far more prevalent than clinically overt heart failure in this population. The estimated risk of symptomatic heart failure 40 years after treatment with cardiotoxic chemotherapy is 10.5%, rising to 27.8% when mediastinal radiotherapy is added to anthracyclines. The compounding effect of concurrent chest radiation represents one of the most significant amplifiers of cardiac risk in childhood cancer survivors, as radiation independently damages the coronary vasculature, pericardium, and myocardium in ways that synergize destructively with anthracycline-induced cardiomyocyte injury (Ryan et al., Circulation, 2025).

Given the prevalence of cardiac, pulmonary, musculoskeletal, and neurocognitive late effects, a comprehensive medical evaluation - including echocardiography for those with anthracycline exposure, pulmonary function testing for those with bleomycin or chest radiation exposure, and bone density assessment for those with steroid or methotrexate exposure - should guide exercise prescription before initiating a structured program (Ryan et al., Circulation, 2025).

Childhood cancer survivors frequently present with markedly reduced baseline fitness, fatigue, and reduced exercise tolerance. Initial exercise sessions should be low in intensity and duration, progressing gradually as tolerance improves. The "start low, go slow" principle is particularly important for survivors with cardiotoxic exposure, where sudden increases in cardiac demand may be poorly tolerated. Current evidence supports a combination of moderate-intensity aerobic exercise - targeting 150-300 minutes per week as tolerated - and resistance training two to three times per week, consistent with general cancer survivorship exercise recommendations. In childhood cancer survivors with reduced cardiorespiratory fitness, even small increases in VO_2peak carry significant cardiovascular survival benefit (Weinkauf et al., European Journal of Preventive Cardiology, 2024).

LIFELONG EXERCISE

The evidence in favor of lifelong exercise for childhood cancer survivors is both compelling and deeply consequential, particularly as the global population of survivors continues to grow. Although more than 85% of childhood cancer survivors will achieve a five-year survival, they are at excess risk of late mortality even 40 years out from a cancer diagnosis - and chronic health conditions such as cardiovascular disease will often be the cause of that mortality, not the primary cancer itself (Ryan et al., Circulation, 2025). It is within this sobering context that regular physical activity emerges not merely as a lifestyle recommendation, but as one of the most powerful, evidence-based interventions available to this population.

The late effects of childhood cancer treatment are wide-ranging and persistent. Chemotherapy, radiation, and surgery frequently leave survivors vulnerable to cardiovascular disease, obesity, insulin resistance, osteoporosis, neurocognitive impairment, chronic fatigue, depression, and reduced quality of life - many of which can worsen progressively throughout adulthood in the absence of intervention. Published studies have consistently demonstrated the benefits of regular physical activity for childhood cancer survivors, including improvements in physical fitness and the prevention of late adverse effects, with cross-sectional data showing that those with high physical activity levels exhibit lower fat mass, reduced abdominal subcutaneous and visceral fat, greater lean body mass, and improved insulin sensitivity compared to survivors reporting lower activity levels (Caru, Dandekar, and Schmitz, American Journal of Lifestyle Medicine, 2025).

The cardiovascular benefits of exercise are particularly significant in this population. Among adult survivors of childhood Hodgkin lymphoma - who are at elevated risk for coronary artery disease secondary to chest irradiation - vigorous physical activity was associated with a lower risk of cardiovascular events in a dose-dependent manner, independent of cardiovascular risk profile and treatment history (Caru, Dandekar, and Schmitz, American Journal of Lifestyle Medicine, 2025). These findings are especially important given that anthracycline-based chemotherapy and thoracic radiation - both widely used in pediatric oncology - are known to cause lasting cardiac dysfunction that can manifest decades after treatment ends

Beyond the cardiovascular system, the neurological benefits of exercise for childhood cancer survivors are increasingly well documented. There is moderate-certainty evidence that physical activity and exercise improve cognitive function among individuals affected by childhood cancer, supporting the use of physical activity for managing cancer-related cognitive impairment (Bernal et al., The Lancet Child & Adolescent Health, 2023). Many survivors treated with cranial radiation, intrathecal chemotherapy, or high-dose systemic agents experience deficits in attention, memory, processing speed, and executive function that can impair academic achievement, occupational functioning, and quality of life well into adulthood. Regular aerobic exercise has been shown to promote neuroplasticity, increase hippocampal volume, and support the regeneration of white matter pathways - offering a non-pharmacological strategy to buffer these treatment-induced cognitive changes over time.

The psychosocial dimension of exercise is equally profound. An umbrella review of systematic reviews demonstrated a beneficial impact of exercise on fatigue, muscle strength, aerobic capacity, activity and participation levels, psychosocial health, cardiovascular and cardiorespiratory fitness, physical function, and bone mineral density, with limited and non-serious adverse effects (Koutoukidis et al., BMC Cancer, 2023). Survivors who engage in regular physical activity consistently report lower rates of depression and anxiety, stronger social connectedness, improved body image, and a greater sense of agency over their health. The SURfit study- a randomized controlled trial conducted among adult and adolescent childhood cancer survivors - demonstrated that a structured one-year exercise intervention produced measurable improvements in physical fitness and clinically assessed disease burden, reinforcing the case for integrating exercise as a formal, ongoing component of survivorship care (Mayr, Zürcher, Bänteli, et al., Cancer, 2025; Rueegg, Zürcher, Schindera, et al., British Journal of Cancer, 2023).

High physical activity and low sedentary time may reduce the risk of treatment-induced late effects among childhood cancer survivors, including cardiovascular diseases and associated risk factors, osteoporosis, fatigue, depression, and cognitive decline (Bratteteig et al., Journal of Cancer Survivorship, 2024). Critically, pediatric patients who engage in regular physical activity demonstrate reduced all-cause mortality, with current research continuing to advance knowledge around mental and physical health, cardiac function, survival outcomes, and overall care (Caru, Dandekar, and Schmitz, American Journal of Lifestyle Medicine, 2025). The evidence collectively points to a clear and urgent imperative: exercise must be prescribed, supported, and monitored as a cornerstone of long-term survivorship care for every individual who has survived childhood cancer, regardless of age, cancer type, or time since treatment. The goal is not simply to extend life, but to ensure that the life extended is one of health, function, independence, and vitality.

Radiation therapy is one of the most effective tools in pediatric oncology, yet its impact on the developing body is profound, far-reaching, and often lifelong. The most serious late effects are observed after radiotherapy, including growth disturbances, bone deficits, dental and muscle deformation, dysfunction of organs located in the radiation area, secondary cancers, and neurocognitive impairments (Vassantachart et al., Pediatric Blood & Cancer, 2023). Because children's tissues and organ systems are still actively developing at the time of treatment, they are uniquely vulnerable to radiation-induced damage in ways that differ substantially from adult patients - and the younger the child at the time of exposure, the greater the long-term consequence across virtually every do main of health.

Cranial radiation - used historically for brain tumors, leukemia prophylaxis, and total body irradiation prior to stem cell transplantation - carries some of the most significant and enduring consequences of all radiation fields. Areas of learning that may be affected include mathematics, spatial relationships, problem solving, attention span, reading and spelling, processing of information, planning and organizing, and concentration, along with difficulties with fine motor coordination such as poor handwriting (Blood Cancer United, Childhood Cancer Late Effects, 2024). Neurocognitive toxicity is a common sequela of cancer and its treatment, with 40-60% of childhood cancer survivors experiencing cancer-related cognitive impairment, with the risk greatest in those who received direct CNS-directed radiation. Deficits in processing speed, memory, executive function, and attention frequently worsen over time rather than improving, significantly affecting academic achievement, occupational functioning, and independent living in adulthood (Bernal et al., The Lancet Child & Adolescent Health, 2023).

- **Endocrine and Hormonal Effects –** endocrinologic complications are common in childhood cancer survivors treated with surgery or radiation involving hormone-producing organs, with the more frequent sequelae including hypothalamic-pituitary dysfunction, thyroid dysfunction, obesity, diabetes mellitus, metabolic syndrome, and decreased bone mineral density (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). Hypothalamic-pituitary injury following cranial radiation is particularly consequential, frequently causing growth hormone deficiency - the most common endocrine late effect - leading to short stature and impaired physical development. Some children who receive radiation to the brain may not reach puberty at the normal age, with a small percentage experiencing premature puberty, while in others puberty is significantly delayed (Blood Cancer United, Childhood Cancer Late Effects, 2024). Thyroid dysfunction, including hypothyroidism, hyperthyroidism, and secondary thyroid malignancy, is a well-recognized consequence of neck and cranial radiation that requires lifelong monitoring (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Cardiovascular Effects –** radiation to the chest, mediastinum, or total body is strongly associated with a spectrum of serious cardiovascular late effects that may not become clinically apparent until decades after treatment. These include accelerated coronary artery disease, pericarditis, pericardial effusion, valvular heart disease, cardiac fibrosis, and cardiomyopathy. Radiation therapy has been associated with increased risk for late mortality, development of second neoplasms, obesity, and pulmonary, cardiac, and thyroid dysfunction, as well as an increased overall risk for chronic health conditions (PMC, CCSS). Survivors treated with thoracic radiation - particularly those who received mantle field radiation for Hodgkin's lymphoma - face a substantially elevated lifetime risk of fatal cardiac events, often compounded by the concurrent cardiotoxicity of anthracycline chemotherapy.

- **Pulmonary Effects –** respiratory late effects of radiation include restrictive or obstructive chronic lung disease, pulmonary fibrosis, and spontaneous pneumothorax (PMC, 2025). Radiation to the thoracic cavity during critical periods of lung development can permanently impair lung growth, reduce vital capacity, and result in chronic breathlessness that limits exercise tolerance and quality of life in adulthood. Radiation pneumonitis - an acute inflammatory response to lung irradiation - can progress to irreversible fibrotic changes over time.

- **Reproductive and Fertility Effects –** radiation to the pelvis, abdomen, or gonads carries serious implications for future fertility. Ovarian radiation can precipitate premature ovarian insufficiency, early menopause, and infertility in female survivors, while testicular radiation - even at relatively low scatter doses - can impair spermatogenesis and testosterone production. Uterine radiation can reduce uterine volume, impair blood flow, and increase the risk of pregnancy complications including miscarriage, preterm birth, and intrauterine growth restriction in female survivors who do conceive (Vassantachart et al., Pediatric Blood & Cancer, 2023; NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). Fertility preservation discussions and referrals should be initiated before treatment begins wherever possible.

- **Secondary Malignancies –** one of the most serious and feared long-term consequences of childhood radiation therapy is the development of secondary malignancies - new cancers arising in or near previously irradiated tissues, somet imes decades after the original treatment. Radiation therapy has been associated with increased risk for the development of second neoplasms (PMC, CCSS), including secondary breast cancer in female survivors of Hodgkin's lymphoma who received chest irradiation, secondary thyroid cancer, brain tumors, sarcomas of bone and soft tissue, and skin cancers - all arising within or adjacent to the original radiation field. The latency period for secondary solid tumors can range from 10-30 years or more, making lifelong surveillance an essential component of survivorship care (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 202).

- **Renal and Gastrointestinal Effects –** radiation to the abdomen can cause a range of gastrointestinal late effects including chronic enteritis, bowel strictures, malabsorption, and adhesion formation leading to bowel obstruction. Renal radiation can result in radiation nephropathy, hypertension, and chronic kidney disease, while hepatic radiation can cause fibrosis and impaired liver function over time. The severity of these effects is directly related to the radiation dose delivered, the volume of organ irradiated, and the age of the child at the time of treatment (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Immune System Effects –** radiation to areas containing significant lymphoid tissue - including the spleen, thymus, and lymph node chains - can cause lasting immune dysfunction, leaving survivors more vulnerable to infections and with impaired immune surveillance capacity. Higher frequency of respiratory problems and immune disorders has been observed in male childhood cancer survivors following abdominal and pelvic radiation, and total body irradiation used prior to stem cell transplantation carries the most extensive immunological consequences of any radiation approach (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Hearing and Auditory Effects –** radiation therapy to the head can cause hearing and vision problems, and children who receive radiation therapy for retinoblastoma or pituitary gland tumors can have vision problems such as cataracts or dry eyes (ACS, Late Effects of Childhood Cancer Treatment, 2024). Specifically regarding hearing, radiation to the skull base and temporal bone can cause sensorineural hearing loss, tinnitus, and chronic otitis media due to damage to the cochlea and auditory nerve pathways. Hearing loss in childhood carries cascading consequences for language development, academic achievement, and social communication that persist well into adulthood and require ongoing audiological monitoring and intervention.

- **Amputation: Physical, Psychological, and Functional Considerations –** amputation - whether of a limb, digit, or other body part - is one of the most physically and psychologically transformative surgical interventions a person can undergo, and its consequences extend far beyond the operating room into virtually every dimension of daily life, identity, and long-term health. In the context of cancer, amputation most commonly occurs as a result of primary bone tumors such as osteosarcoma and Ewing's sarcoma, soft tissue sarcomas, or as a last resort following failed limb-salvage surgery, uncontrolled infection, or vascular compromise secondary to treatment. Regardless of the cause, the physical, emotional, rehabilitative, and social implications of amputation demand a comprehensive, individualized, and multidisciplinary approach to care.



- **Dental and Oral Effects –** children who receive radiation to the head and neck are at substantial risk of long-term dental and oral complications, including impaired tooth development, root stunting, enamel hypoplasia, xerostomia (dry mouth) due to salivary gland damage, trismus (restricted jaw opening), mandibular growth impairment, and significantly elevated risk of dental caries. These effects can begin during treatment and worsen over time, requiring lifelong dental surveillance and proactive oral health management (Broder et al., Pediatric Dentistry, 2025).

- **Urinary and Bladder Effects –** radiation to the pelvis and lower abdomen - used in the treatment of Wilms tumor, bladder rhabdomyosarcoma, and pelvic sarcomas - can cause radiation cystitis, bladder fibrosis and reduced capacity, urethral stricture, and chronic hematuria. Long-term urinary dysfunction, incontinence, and elevated risk of secondary bladder malignancy are recognized consequences of pelvic irradiation in childhood that require ongoing urological surveillance (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Chronic Sinusitis –** when the sinuses are in the field of radiation treatment, patients may develop chronic sinusitis - a swelling of the sinus tissues causing post-nasal drip, nasal discharge, and facial pain - that may require ongoing ENT management (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024). This is a particularly common and bothersome yet frequently overlooked late effect in survivors of head and neck tumors treated during childhood.

- **Vision and Ocular Effects –** vision can be impaired either by damage to the retina or optic nerve, or more frequently by the development of radiation-induced cataracts and keratoconjunctivitis (PMC). Radiation-induced cataracts can develop years after treatment, while damage to the lacrimal glands can cause chronic dry-eye syndrome. Children treated for orbital or periorbital tumors may also experience impaired orbital bone growth, facial asymmetry, and diplopia depending on the degree of orbital irradiation received during critical developmental periods (NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Functional Asplenia –** is a condition in which the spleen is either physically present but no longer working properly, or has been surgically removed - leaving the body without one of its most important infection-fighting organs. Think of the spleen as the body's natural filter and security checkpoint: it normally screens the bloodstream for harmful bacteria, flags them for destruction, and produces specialized antibodies that help the immune system mount a rapid response. When the spleen is absent or non-functional, that checkpoint is gone, and the body loses a critical layer of defense that cannot be fully replaced by other parts of the immune system. In childhood cancer survivors, functional asplenia can develop as a consequence of surgical removal of the spleen during tumor staging or resection, radiation directed at the spleen, or as a complication of chronic graft-versus-host disease following bone marrow or stem cell transplantation - a condition in which the donor immune cells attack the recipient's organs including the spleen (COG, Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent, and Young Adult Cancers, Version 6.0, October 2023).

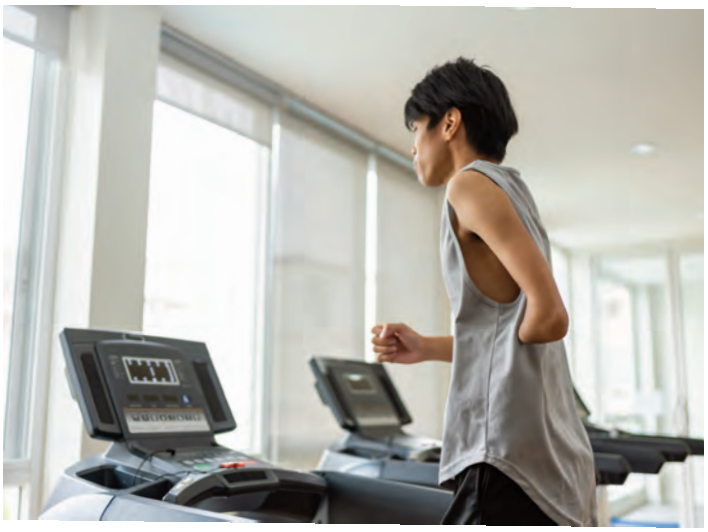
  Without a functioning spleen, the body becomes significantly more vulnerable to infections caused by encapsulated bacteria - including Streptococcus pneumoniae, Haemophilus influenzae type b, and Neisseria meningitidis - all of which can spread through the bloodstream with devastating speed in the absence of a functioning spleen. The risk for sepsis is lifelong, with infections occurring as late as 40 years after splenectomy (Rubin et al., Pediatric Clinics of North America, 2024). The Children's Oncology Group Long-Term Follow-Up Guidelines, Version 6.0, released in October 2023, benchmark the standard of care for long-term survivors of childhood cancer and provide specific guidance on infection prevention and management for survivors with functional asplenia (Landier et al., JAMA Oncology, 2024).

- **Musculoskeletal Effects –** growing bones and soft tissues are among the most radiosensitive structures in the pediatric body. Radiation to the skeleton can cause growth arrest, scoliosis, kyphosis, limb length discrepancy, avascular necrosis, pathological fractures, and permanently impaired muscle development in the irradiated field. Children who receive spinal radiation face a particularly significant risk of vertebral growth failure and spinal deformity - with scoliosis rates of any grade exceeding 30% in children irradiated at doses above 20 Gy between ages 2-6 - while radiation to the pelvis can affect hip joint integrity and long-term mobility (Vatner et al., International Journal of Radiation Oncology, Biology, Physics, 2024; Vassantachart et al., Pediatric Blood & Cancer, 2023).

- **Lymphedema –** lymphedema is a problem in which lymph fluid does not drain as it should, builds up in tissues, and causes swelling - and can develop many years after treatment in patients whose lymphatic system was damaged by radiation therapy to areas with large numbers of lymph nodes (NCI, Lymphedema PDQ, updated 2024). In children who received radiation to the head, neck, axilla, or groin, chronic lymphedema can cause significant functional impairment, recurrent infections, and psychological distress related to visible swelling and altered body image.

- **Facial and Craniofacial Development –** radiotherapy to the head and neck area has been shown to impact facial disfigurement, growth hormone deficiency, cataracts, hearing loss, and dental problems. Children who receive radiation to the face during periods of active craniofacial growth - such as those treated for rhabdomyosarcoma of the head and neck or orbital tumors - can experience profound asymmetry, soft tissue and bony hypoplasia, and permanent cosmetic disfigurement that carries substantial psychosocial consequences throughout life (Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).

- **Raynaud's Phenomenon –** when exposed to cold or strong emotions, the fingers, toes, ears, or nose can become white and then turn blue, sometimes accompanied by pain or tingling - a phenomenon that occurs in childhood cancer survivors who received certain radiation or chemotherapy treatments (NCI PDQ, 2024). This vascular sensitivity, known as Raynaud's phenomenon, is a recognized but less commonly discussed late effect that can significantly affect daily comfort and quality of life NCI, Late Effects of Treatment for Childhood Cancer PDQ, updated 2024).



Childhood cancer survivors face a lifetime of consequences that extend far beyond the disease itself. The treatments that save lives - chemotherapy, radiation, and surgery - can leave lasting marks on virtually every organ system, from the heart and lungs to the bones, brain, endocrine system, and reproductive organs. Secondary malignancies, neurocognitive impairment, cardiovascular disease, and fertility challenges are among the most consequential late effects, and their onset may be delayed by years or even decades after treatment ends. For those who undergo amputation, the physical, psychological, and rehabilitative demands are profound and lifelong.

What unites all of these considerations is a single, evidence-based imperative: childhood cancer survivors require not just treatment, but a sustained, multidisciplinary, and proactive approach to survivorship care - one in which exercise, psychological support, and risk-based surveillance are not optional but essential. The OncoVie® Cancer Exercise Specialist occupies a unique and critical role in this continuum, serving as a bridge between medical treatment and long-term health—helping survivors rebuild strength, restore function, reclaim identity, and ultimately live as fully as possible in the years that follow.

Immediate Postoperative Concerns

In the immediate postoperative period, the primary clinical priorities are pain management, wound healing, infection prevention, and early mobilization. Residual limb management begins immediately after surgery, with careful attention to shaping and shrinking the stump through compression wrapping or shrinker socks in preparation for eventual prosthetic fitting.

Phantom limb pain - the experience of pain, pressure, burning, or other sensations perceived as coming from the amputated limb - is one of the most challenging and clinically significant postoperative phenomena, affecting 64-85% of amputees to varying degrees, with prevalence rising to 85-97% within the first month following amputation. This phenomenon arises from maladaptive cortical reorganization following limb loss, and its management typically requires a multimodal approach incorporating pharmacological agents, mirror therapy, graded motor imagery, transcutaneous electrical nerve stimulation (TENS), and, in refractory cases, neuromodulation techniques (Falbo, Phelan, Hackman, Vogsland, and Rich, Prosthetics and Orthotics International, 2024; Roznik et al., Prosthetics and Orthotics, 2025).

Postoperative deep vein thrombosis, pulmonary embolism, and wound dehiscence are additional early complications requiring vigilant monitoring.

Prosthetic Rehabilitation

Prosthetic fitting and training represent a central pillar of amputee rehabilitation, though the process is complex, time-intensive, and highly individualized. The timing of prosthetic fitting depends on residual limb maturation, wound healing, and the patient's overall medical stability, typically beginning with a preparatory prosthesis before transitioning to a definitive device. The level of amputation - transtibial (below-knee), transfemoral (above-knee), transradial (below-elbow), or transhumeral (above-elbow) - profoundly influences the complexity of prosthetic design, the energy expenditure required for ambulation, and the functional outcomes achievable with rehabilitation (Callan et al., Pediatric Blood & Cancer, 2025).

Modern prosthetic technology has advanced dramatically, with microprocessor-controlled knees, dynamic carbon fiber feet, and myoelectric upper-limb prostheses offering increasingly sophisticated functional capabilities. However, access to advanced prosthetic technology remains deeply inequitable, with significant disparities in availability based on geography, socioeconomic status, and insurance coverage - commercially available microprocessor-controlled devices are costly and beyond the reach of most amputees globally (Toda, Chin, Oshima, Takase, and Azuma, Journal of International Medical Research, 2025).

Musculoskeletal and Physical Health Concerns

In the immediate postoperative period, the primary clinical priorities are pain management, wound healing, infection prevention, and early mobilization. Residual limb management begins immediately after surgery, with careful attention to shaping and shrinking the stump through compression wrapping or shrinker socks in preparation for eventual prosthetic fitting. Phantom limb pain - the experience of pain, pressure, burning, or other sensations perceived as coming from the amputated limb - is one of the most challenging and clinically significant postoperative phenomena, affecting up to 80% of amputees to varying degrees. This phenomenon arises from the reorganization of neural pathways in the brain and spinal cord following limb loss, and its management typically requires a multimodal approach incorporating pharmacological agents, mirror therapy, graded motor imagery, transcutaneous electrical nerve stimulation (TENS), and in refractory cases, neuromodulation techniques. Postoperative deep vein thrombosis, pulmonary embolism, and wound dehiscence are additional early complications requiring vigilant monitoring (Bhatt and Bhatt, StatPearls, 2025).

Psychological and Emotional Concerns

The psychological impact of amputation is profound and multi-faceted, encompassing grief, loss of identity, altered body image, depression, anxiety, post-traumatic stress disorder, and adjustment difficulties that `g people - fundamentally disrupts one's sense of self, physical capability, and place in the world, and the psychological adjustment process is non-linear, deeply personal, and influenced by a wide range of factors including age, pre-amputation psychological health, social support, cause of amputation, and access to mental health care. Depression is particularly prevalent in the amputee population - a systematic review and meta-analysis of 61 studies comprising 9,852 limb amputees found a pooled depression prevalence of 33.85% (95% CI 27.15-40.54%) - yet it remains significantly underdiagnosed and undertreated (Takai et al., Journal of Psychosomatic Research, 2024). Anxiety related to social re-entry, return to work, intimate relationships, and concerns about prosthetic visibility and functionality are equally common. Psychological support - including individual psychotherapy, cognitive behavioral therapy, acceptance and commitment therapy, and peer support through amputee networks -should be considered an integral and non-optional component of comprehensive rehabilitation from the earliest stages of care (Jo et al., Journal of Yeungnam Medical Science, 2021).

GLOSSARY

AIS (active isolated stretching) – lengthening of a muscle with a gentle pressure at the end range that will microscopically loosen scar tissue and allow restoration of proper muscle length.

ATM serine/threonine kinase (ATM) – is a serine/threonine protein kinase that is recruited and activated by DNA double-strand breaks. It phosphorylates several key proteins that initiate activation of the DNA damage checkpoint, leading to cell cycle arrest, DNA repair or apoptosis.

Abdominoperineal resection – surgery to remove the anus, the rectum, and part of the sigmoid colon through an incision made in the abdomen. The end of the intestine is attached to an opening in the surface of the abdomen and body waste is collected in a disposable bag outside of the body. This opening is called a colostomy. Lymph nodes may also be removed during this procedure.

Abduction – a movement in the frontal plane away from the midline of the body.

Ablation – the removal or destruction of a body part or tissue or its function. Ablation may be performed by surgery, hormones, drugs, radiofrequency, heat, or other methods.

Abnormal – a state, condition, or behavior that is unusual or different from what is considered normal. An abnormal lesion or growth in or on the body may be benign, precancerous, or premalignant, or malignant.

Absolute neutrophil count – a measure of the number of neutrophils in the blood. Neutrophils are a type of white blood cell that helps the body fight infection. An absolute neutrophil count may be used to check for infection, inflammation, leukemia, and other conditions. Cancer treatment may reduce the absolute neutrophil count.

Absolute risk – the likelihood that a person who is free of a specific type of cancer at a given age will develop that cancer over a certain period of time.

Absorption – the process of taking nutrients from the digestive system into the blood so they can be used in the body.

Acute pulmonary embolism (PE) – is a common and often fatal disease. Mortality can be reduced by prompt diagnosis and therapy. Unfortunately, the clinical presentation of PE is variable and nonspecific, making accurate diagnosis difficult.

Acquired immunodeficiency syndrome (AIDS) – a disease caused by human immunodeficiency virus (HIV). People with acquired immunodeficiency syndrome are at an increased risk for developing certain cancers and for infections that usually occur only in individuals with a weak immune system.

Acromegaly – a condition in which the pituitary gland makes too much growth hormone after normal growth of the skeleton is finished causing the bones of the hands, feet, head, and face to grow larger than normal. Acromegaly can also be caused by a pituitary gland tumor.

Actinic keratosis – a thick, scaly patch of skin that usually forms on areas exposed to the sun and may become cancer.

Active surveillance – closely follows a patient's condition but avoids treatment unless there are changes in test results. Active surveillance may avoid or delay the need for radiation or surgery. It is used to find early signs that the condition is getting worse. During active surveillance, certain exams, and tests, as well as biopsies, are done on a regular schedule.

Activities of daily living (ADL) – the tasks of everyday life; eating, dressing, getting into or out of a bed or chair, taking a bath or shower, and using the toilet. Instrumental activities of daily living are activities related to independent living and include preparing meals, managing money, shopping, doing housework, and using a telephone.

Acute – symptoms or that begin and worsen quickly; not chronic.

Acute leukemia – a rapidly progressing cancer that starts in blood-forming tissue such as the bone marrow and causes large numbers of white blood cells to be produced and enter the blood stream.

Acute myocardial infarction – heart attack occurs when blood flow to a part of your heart is blocked for a long enough time that part of the heart muscle is damaged or dies.

Adaptive immune system – is also known as the acquired immune system and is a subsystem of the overall immune system that is composed of highly specialized, systemic cells and processes that eliminate pathogens or prevent their growth.

Adduction – movement in the frontal plane back toward the midline of the body.

Adenocarcinoma – cancer that begins in cells that line certain internal organs and that have gland-like properties.

Adenoma – a tumor that is not cancer. It starts in gland-like cells of the epithelial tissue (thin layer of tissue that covers organs, glands, and other structures within the body).

Adenopathy – large or swollen lymph glands.

Adenosarcoma – a tumor that is a mixture of an adenoma (a tumor that starts in the gland-like cells of epithelial tissue) and a sarcoma (a tumor that starts in bone, cartilage, fat, muscle, blood vessels, or other connective or supportive tissue).

Adjunct therapy – another treatment used together with the primary treatment. It is used to assist the primary treatment.

Adjuvant therapy – additional cancer treatment given after the primary treatment to lower the risk that the cancer will come back. Adjuvant therapy may include chemotherapy, radiation therapy, hormone therapy, targeted therapy, or biological therapy.

Administration – the act of giving a treatment to a patient. It can also refer to the way it is given, the dose, or how often it is given.
Adoptive Immunotherapy – this may be used as a method of obtaining a long-lasting remission rather than subjecting relapsed clients to a second transplant. The patient is infused with normal white blood cells taken from the marrow donor's blood. Approximately 80% of relapsed clients went into remission following this procedure.

Adrenal gland – a small gland that makes steroid hormones, adrenaline, and noradrenaline. These hormones help control heart rate, blood pressure, and other important body functions. There are two adrenal glands, one on top of each kidney. Also called suprarenal gland.

Adult fibrosarcoma – usually affects fibrous tissue in the legs, arms, or trunk. It is most common in people between the ages of 20 and 60, but can occur in people of any age, even in infants.

Adult pineal parenchymal tumors – tumors in this region may be difficult to access surgically because they are deep within the brain. There are several types of tumors found near the pineal gland and they can either be very aggressive or very responsive to treatment.

Advanced cancer – cancer that has spread to other places in the body and usually cannot be cured or controlled with treatment.

Aerobic – reactions that need oxygen to happen or happen when oxygen is present.

Aerobic exercise – physical activity that increases the heart rate and the body's use of oxygen.

Aerobic metabolism – a chemical process in which oxygen is used to make energy from carbohydrates (sugars). Also called aerobic respiration, cell respiration, and oxidative metabolism.

Aerobic respiration – a process in which oxygen is used to make energy from carbohydrates.

Afferent (neurons) – also known as sensory neurons, they gather incoming sensory information from the environment and deliver it to the central nervous system (CNS).

Affinitor® (Everolimus) – also blocks the mTOR protein. It is taken as a pill once a day. Everolimus is used to treat advanced kidney cancers after other drugs such as sorafenib or sunitinib have been tried.

Aggressive – a tumor or disease that forms, grows, or spreads quickly. It may also describe treatment that is more severe or intense than usual.

Agonist – muscles that act as prime movers.

AIDS-related cancer – types of cancer that are more likely to occur in people who are infected with HIV. The most common types are Kaposi sarcoma and non-Hodgkin lymphoma. Other AIDS-related cancers include Hodgkin disease and cancers of the lung, mouth, cervix, and digestive system.

Alcohol ablation – ethanol (alcohol) is injected through the skin directly into a tumor to kill cancer cells. Ultrasound or a CT scan is used to guide the needle into the tumor.

Aldosterone blockers – balance electrolytes in the body and help muscle and nerve tissue to work properly.

Allergic response – a hypersensitive immune reaction to a substance that normally is harmless in most people. An allergic response may cause symptoms such as itching, inflammation, or tissue injury.

Alloantigen – a genetically determined antigen present in some but not all individuals of a species (as those of a particular blood group) and capable of inducing the production of an alloantibody by individuals which lack it.

Allogeneic – taken from different individuals of the same species or an artificial transplant.

Allogeneic bone marrow transplantation – a procedure in which a person receives stem cells from a genetically compatible donor.

Allogeneic stem cell transplantation – a procedure in which a person receives blood forming stem cells from a genetically compatible donor.

Allograft – the transplant of an organ, tissue, or cells from one individual to another individual of the same species who is a genetically compatible donor.

Allopathic medicine – a system in which healthcare professionals treat symptoms and diseases using drugs, radiation, or surgery. Also called biomedicine, conventional medicine, mainstream medicine, and Western medicine.

Alopecia – results in hair falling out in patches.

Altered reciprocal inhibition – this is the process by which a tight muscle causes decreased neural drive and, therefore, optimal recruitment of its functional antagonist is not achieved.

Alveolar soft-part sarcoma – is a rare cancer that mostly affects young adults. These tumors most commonly occur in legs.

Amputation – the removal by surgery of a limb or other body part because of injury or disease.

Analysis – a process in which anything complex is separated into simple or less complex parts.

Anaphylactic shock – a severe and sometimes life-threatening immune system reaction to an antigen that a person has been previously exposed to. The reaction may include itchy skin, edema, collapsed blood vessels, fainting, difficulty in breathing, and death.

Anaplastic – describes cancer cells that divide rapidly and have little or no resemblance to normal cells.

Anaplastic thyroid cancer – a rare and very aggressive type of thyroid cancer.

Anastomosis – is the area where the 2 ends of the digestive tract are joined together.

Anastomotic leak - after anterior resection of the rectum should be defined as a communication between the intra- and extraluminal compartments owing to a defect of the integrity of the intestinal wall at the anastomosis between the colon and rectum or the colon and anus.

Androgen – a type of hormone that promotes the development and maintenance of male sex characteristics.

Androgen ablation – treatment to suppress or block the production or action of male hormones. This can be done by removing the testicles, by taking female sex hormones, or by taking antiandrogens.

Androgen deprivation – treatment to suppress or block the production or action of male sex hormones. This can be done by removing the testicles, by taking female sex hormones, or by taking antiandrogens.

Anemia – a condition in which the number of red blood cells is below normal.

Anesthesia – loss of feeling or awareness caused by drugs or other substances. Anesthesia keeps a patient from feeling pain during surgery or other procedures. Local anesthesia is a loss of feeling in one small area of the body. Regional anesthesia is a loss of feeling in a part of the body. General anesthesia is a loss of feeling and a complete loss of awareness like a very deep sleep.

Anesthesiologist – a doctor who specializes in giving drugs or other agents that keep a patient from feeling pain during surgery or other procedures.

Aneurysm – an abnormal widening or ballooning of a portion of an artery due to weakness in the wall of the blood vessel.

Angina – is chest discomfort due to poor blood flow through the blood vessels in the heart.

Angiogenesis – the process of making new blood vessels.

A**ngiography –** a special x-ray that uses dye so that the blood vessels can be seen.

Angiosarcoma (includes hemangiosarcoma and lymphangiosarcoma) – can develop either from blood vessels (hemangiosarcomas) or from lymph vessels (lymphangiosarcomas). These tumors sometimes start in a part of the body that has been treated with radiation. Angiosarcomas are sometimes seen in the breast after radiation therapy and in limbs with lymphedema.

Anorexia – an abnormal loss of the appetite for food that may result in extreme weight loss. Anorexia can be caused by cancer, AIDS, a mental disorder, or other diseases.

Antagonist – a muscle that acts in direct opposition to a prime mover

Anterior – the opposite of posterior. Referring to a position on or near the front of the body.

Anterior pelvic tilt (lordosis) – the opposite of posterior pelvic tilt (flat back). A movement in which the pelvis rotates forward.

Antiarrythmics – help to prevent arrhythmias.

Antibacterial – a substance that kills bacteria or stops them from growing.

Antibiotic – a drug used to treat infections caused by bacteria and other microorganisms.

Antibody – a protein made by plasma cells in response to an antigen (a substance that causes the body to make a specific immune response). Each antibody can bind to only one specific antigen. The binding helps to destroy the antigen. Some antibodies destroy antigens directly. Others make it easier for white blood cells to destroy the antigen.

Anticoagulants – prevent blood clots from forming.

Antidepressant – a drug used to treat depression.

Antigen – a toxin or other foreign substance which induces an immune response in the body, especially the production of antibodies.

Antihistamine – a type of drug that blocks the action of histamines, which can cause fever, itching, sneezing, a runny nose, and watery eyes. Antihistamines are used to prevent fevers in clients receiving blood transfusions and may be used to treat allergies, coughs, and colds.

Antimetabolite – a drug that is like the natural chemicals in a normal biochemical reaction that occurs in cells, but different enough to interfere with the normal division and functions of the cells.

Antioxidant – a substance that protects cells from the damage caused by free radicals (unstable molecules made by the process of oxidation during normal metabolism). Free radicals may play a part in cancer, heart disease, stroke, and other diseases of aging. Antioxidants include beta-carotene, lycopene, vitamins A, C, and E, and other natural and manufactured substances.

Aorta – the largest artery in the body. It carries oxygen-rich blood away from the heart to vessels that reach the rest of the body.

Aortic stenosis – when the aortic valve does not open fully. This decreases blood flow from the heart.

Apheresis – a procedure in which blood is collected, part of the blood such as platelets or white blood cells is taken out, and the rest of the blood is returned to the donor.

Apoptosis – programmed cell death.

Appetite – a desire to satisfy a physical or mental need, such as for food, sex, or adventure.

Acquired (somatic) gene mutations – changes in DNA that develop throughout a person's lifetime.

Areola – the area of dark-colored skin on the breast that surrounds the nipple.

Aromatase inhibitor – are used as a type of hormone therapy for postmenopausal women who have hormone-dependent breast cancer. It is a drug that prevents the formation of estradiol, a female hormone, by interfering with an aromatase enzyme.

Arrhythmia – is a disorder of the heart rate (pulse) or heart rhythm. The heart can beat too fast (tachycardia), too slow (bradycardia), or irregularly.

Arrhythmogenic right ventricular dysplasia – is a rare type of cardiomyopathy that occurs when the muscle tissue in the right ventricle is replaced with fatty or fibrous tissue.

Arsenic – is a chemical element with symbol As and atomic number 33. Arsenic occurs in many minerals, usually in combination with sulfur and metals, but also as a pure elemental crystal. Arsenic is a metalloid. It has various allotropes, but only the gray form, which has a metallic appearance, is important to industry.

Arsenic trioxide (ATO) – is a non-chemo drug for people at higher risk of APL coming back after treatment; the targeted drug gemtuzumab ozogamicin (Mylotarg) might be added as well.

Arterial embolization – the blocking of an artery by a clot of foreign material. This can be done as treatment to block the flow of blood to a tumor.

Arterial hypertension – is a progressive disorder characterized by abnormally high blood pressure (hypertension) in the pulmonary artery, the blood vessel that carries blood from the heart to the lungs.

Arthritis – chronic inflammation of the joint. Can be osteoarthritis or rheumatoid arthritis.

Arthroplasty – a reconstructive procedure to replace a limb that uses a metallic or bone allograft. The implant, however, is an artificial joint that will not tolerate activities such as jogging, racquet sports, or heavy lifting.

Articular – of or relating to joints or to the structural components in a joint.

Asbestos – tiny fibers that are used as insulation against heat and fire in buildings. Loose asbestos fibers that are breathed into the lungs can cause lung cancer and malignant mesothelioma (cancer found in the lining of the lungs, chest, or abdomen). Asbestos that is swallowed may cause cancer of the gastrointestinal tract.

Ascites – the accumulation of fluid in the peritoneal cavity, causing abdominal swelling.

Aspiration – the removal of fluid or tissue through a needle. Also, the accidental breathing in of food or fluid into the lungs.

Asplenia – refers to the absence of normal spleen function and is associated with some serious infection risks.

Assessment – a process used to learn about a patient's/client's condition. This may include a complete medical history, medical tests, a physical exam, a mental health evaluation, etc.

Asthma – is a disorder that causes the airways of the lungs to swell and narrow, leading to wheezing, shortness of breath, chest tightness, and coughing.

Astrocytomas – are the most common form of adult brain tumor. They take hold in the star-shaped glial cells called astrocytes.

Asymmetry – lack or absence of balanced proportions between parts of a thing.

Ataxia – the loss of full control of bodily movements.

Atrioventricular (AV) block – is partial or complete interruption of impulse transmission from the atria to the ventricles. The most common cause is idiopathic fibrosis and sclerosis of the conduction system.

Atypical hyperplasia – a benign condition in which cells look abnormal under a microscope and are increased in number.

Autologous – taken from an individual's own tissues, cells, or DNA. Autologous bone marrow transplant – refers to a person's own bone marrow being used for a transplant.

Avastin® (Bevacizumab) – is considered an angiogenesis inhibitor (a medication that works to prevent cancers from making new blood vessels). It appears to prolong survival in those with advanced non-small cell lung cancer.

Axilla – the underarm or armpit.

Axillary – pertaining to the armpit area, including the lymph nodes that are located there (axillary lymph nodes).

Axillary dissection – surgery to remove lymph nodes in the armpit region. Known as an axillary lymph node dissection.

Axillary lymph node – a lymph node in the armpit region that drains lymphatic fluid from the breast and nearby areas.

Axillary web syndrome (lymphatic cording) – is a visible web of axillary skin overlying palpable cords of tissue. It occurs exclusively in conjunction with ALND.

Axitinib (Inlyta) – treatment option for kidney cancer.

B symptoms – refers to systemic symptoms of fever, night sweats, and weight loss which can be associated with both Hodgkin's lymphoma and non-Hodgkin's lymphoma. The presence or absence of B symptoms has prognostic significance and is reflected in the staging of these lymphomas.

Bacillus Calmette-Guerin (BCG) – is considered the most effective intravesical immunotherapy for treating early-stage bladder cancer.

Bacteria – a large group of single-cell microorganisms that may cause infections and disease in animals and humans.

Balance – the ability to sustain the body's center of mass over its base of support.

Barium swallow – the process of getting x-ray pictures of the esophagus or the upper GI tract (esophagus, stomach, and duodenum), following the ingestion of a liquid that contains barium. The barium coats and outlines the inner walls of the esophagus and the upper GI tract so that they can be seen on the x-ray pictures.

Basal cell carcinoma – cancer that begins in the lower part of the epidermis (the outer layer of the skin). It may appear as a small white or pearly bump that grows slowly and may crust over and bleed. Basal cell carcinomas are usually found on areas of the body exposed to the sun. They are the most common form of skin cancer and seldom metastasize to other parts of the body.

Baseline – an initial measurement that is taken to represent a beginning condition or starting point. It may be used for comparison over time to look for changes or improvements.

Bence Jones protein – a small protein made by plasma cells that are found in the urine of most people with multiple myeloma.

Benign tumor – a growth that is not cancer.

Bilateral cancer – cancer that occurs in both of a pair of organs.

Bilateral nephrectomy – surgery to remove both kidneys.

Bilateral prophylactic mastectomy – surgery to remove both breasts in order to reduce the risk of developing breast cancer. It's often the choice of a patient who tests positive for BRCA1 and BRCA2.

Bilateral salpingo-oophorectomy – surgery to remove both ovaries and both fallopian tubes.

Bile – fluid made by the liver that is stored in the gallbladder. Bile is excreted into the small intestine where it helps digest fat.

Bile duct – a tube through which bile passes in and out of the liver.

Bile duct cancers (cholangiocarcinomas) – one or two of every 10 cases of liver cancer start in the bile ducts, which are small tubes that carry bile to the gallbladder. They are treated in the same way as HCC.

Biliary – having to do with the liver, bile ducts, and/or gallbladder.

Biliary bypass surgery – this procedure is performed when an inoperable tumor is blocking the duodenum, causing bile fluid to build up in the gallbladder, or when it is blocking the common bile duct that passes through the pancreas. In the first situation, the surgeon bypasses the bile duct to the jejunum, the section of the small intestine below the duodenum. In the next situation, a catheter tube is surgically implanted in the bile duct. The fluid then drains into a small external bag. A nerve block is performed during the operation to relieve pain.

Biliary system – the organs and ducts that make and store bile and release it into the small intestine. The biliary system includes the gallbladder and bile ducts inside and outside the liver.

Biological agent – a substance that is made from a living organism or its products and is used in the prevention, diagnosis, or treatment of cancer and other diseases. Biological agents include antibodies, interleukins, and vaccines.

Biological therapy – treatment to boost or restore the ability of the immune system to fight cancer, infections, and other diseases. Agents used include monoclonal antibodies, growth factors, and vaccines.

Biopsy – the removal of cells or tissues for examination by a pathologist. There are many different types of biopsy procedures including: (1) incisional biopsy, in which only a sample of tissue is removed; (2) excisional biopsy, in which an entire lump or suspicious area is removed; and (3) needle biopsy, in which a sample of tissue or fluid is removed with a needle. When a wide needle is used, the procedure is called a core biopsy. When a thin needle is used, the procedure is called a fine-needle aspiration biopsy.

Bisphosphonate therapy – a class of drugs which are used to prevent bone loss, reduce the risk of fractures, and decrease pain.

Bladder cancer – cancer that forms in tissues of the bladder.

Bladder fibrosis – is scarring and hardening of the tissue in the bladder.

Blister – a fluid-filled sac in the outer layer of skin that can be caused by certain treatments, rubbing, heat, or diseases of the skin.

Bloating – a swelling or feeling of fullness in the abdomen that is usually the result of gas in the intestines and can be caused by many things, including overeating, lactose intolerance, and constipation. In some cases, bloating can also be a side effect of cancer or cancer treatment.

Blood – a tissue with red blood cells, white blood cells, platelets, and other substances suspended in fluid called plasma. Blood takes oxygen and nutrients to the tissues and carries away wastes.

Blood cancer – cancer that begins in blood-forming tissue, such as the bone marrow, or in the cells of the immune system. Examples of blood cancer are leukemia, lymphoma, and multiple myeloma. Also called hematologic cancer.

Blood cell count – a measure of the number of red blood cells, white blood cells, and platelets in the blood. The amount of hemoglobin and hematocrit is also measured. A blood cell count is used to help diagnose and monitor many conditions.

Blood clot – a mass of blood that forms when blood platelets, proteins, and cells stick together. When a blood clot is attached to the wall of a blood vessel, it is called a thrombus. When it moves through the bloodstream and blocks the flow of blood in another part of the body, it is called an embolus.

Blood poisoning – disease caused by the spread of bacteria and their toxins in the bloodstream.

Blood pressure – the force of circulating blood on the walls of the arteries.

Blood sugar – glucose (a type of sugar) found in the blood.

Blood test – a test done on a sample of blood to measure the amount of certain substances in the blood or to count different types of blood cells.

Blood thinner – a substance that is used to prevent and treat blood clots in blood vessels and the heart. It is also called an anticoagulant.

Blood vessel – a tube through which the blood circulates in the body. Blood vessels include a network of arteries, arterioles, capillaries, venules, and veins.

Blood-brain barrier – a network of blood vessels and tissue that is made up of closely spaced cells that help to keep harmful substances from reaching the brain. The blood-brain barrier lets some substances, such as water, oxygen, carbon dioxide, and general anesthetics, pass into the brain. This can make getting adequate concentrations of chemotherapy to the brain very difficult.

Blood-brain barrier disruption – the use of drugs to create openings between cells in the blood-brain barrier. Once the barrier is opened, anticancer drugs may be infused into an artery that goes to the brain, bypassing the blood-brain barrier.

Bone cancer – primary bone cancer is cancer that forms in cells of the bone. Secondary bone cancer is cancer that spreads to the bone from another part of the body.

Bone cement implantation syndrome (BCIS) - is poorly understood. It is an important cause of intraoperative mortality and morbidity in patients undergoing cemented hip arthroplasty and may also be seen in the postoperative period in a milder form causing hypoxia and confusion.

Bone density – a measure of the amount of minerals, primarily calcium and phosphorous, contained in a certain volume of bone.

Bone marrow – the soft, sponge-like tissue in the center of most bones. It produces white blood cells, red blood cells, and platelets.

Bone marrow ablation – a procedure to destroy bone marrow using radiation or high doses of anticancer drugs. It is done before a bone marrow or blood stem cell transplant to kill cancer cells and bone marrow cells and to create space for the healthy cells.

Bone marrow aspiration – a procedure in which a small sample of bone marrow is removed, usually from the hip bone, breastbone, or thigh bone.

Bone marrow transplantation – a procedure to replace bone marrow that has been destroyed by treatment with high doses of anticancer drugs or radiation

Bone metastasis – cancer that has spread from the original (primary) tumor to the bone.

Bone mineral density scan – an imaging test that measures bone by passing x-rays with two different energy levels through the bone. It is used to diagnose osteoporosis.

Bone scan – a technique to create images of bones on a computer screen or on film. A small amount of radioactive material is injected into a blood vessel and travels through the bloodstream; it collects in the bones and is detected by a scanner.

Bowel – the long, tube-shaped organ in the abdomen that completes the process of digestion. Is made up of two parts: the small bowel and the large bowel.

Brachytherapy – a type of radiation therapy in which radioactive material sealed in needles, seeds, wires, or catheters is placed directly into or near a tumor. It is also called seed implant radiation therapy.

Bradyarrhythmia – any disturbance of cardiac rhythm in which the heart rate is less than 60 beats/min.

Brain-derived neurotrophic factor (BDNF) – is a key molecule involved in plastic changes related to learning and memory.

Brain metastasis – cancer that has spread from the primary tumor to the brain.

Brain-stem gliomas – only represent about 5% of all adult brain tumors. They are usually made up of astrocytomas but may contain other types of cells as well.

Brain tumor – the growth of abnormal cells in the tissues of the brain. Brain tumors can be benign or malignant.

BRCA1 – a gene on chromosome 17 that normally helps to suppress cell growth. A person who inherits certain mutations in a BRCA1 gene has a higher risk of getting breast, ovarian, prostate, and other types of cancer.

BRCA2 – a gene on chromosome 13 that normally helps to suppress cell growth. A person who inherits certain mutations in a BRCA2 gene has a higher risk of getting breast, ovarian, prostate, and other types of cancer.

Breast – a glandular organ located on the chest. The breast is made up of connective tissue, fat, and breast tissue that contains the glands that can make milk.

Breast cancer – cancer that forms in tissues of the breast, usually the ducts and lobules. It can occur in both men and women: although male breast cancer is rare.

Breast carcinoma in situ – there are 3 types of breast carcinoma in situ: ductal carcinoma in situ (DCIS), lobular carcinoma in situ (LCIS), and Paget disease of the nipple. DCIS is a noninvasive condition in which abnormal cells are found in the lining of a breast duct. The abnormal cells have not spread outside the duct to other tissues in the breast. In some cases, DCIS may become invasive cancer and spread to other tissues. LCIS is a condition in which abnormal cells are found in the lobules of the breast. This condition seldom becomes invasive cancer. However, having LCIS in one breast increases the risk of developing breast cancer in either breast. Clients' with LCIS may opt for a prophylactic mastectomy. Paget disease of the nipple is a condition in which abnormal cells are found in the nipple only.

Breast density – describes the relative number of different tissues present in the breast. A dense breast has less fat than glandular and connective tissue. Mammogram films of breasts with higher density are harder to read and interpret than those of less dense breasts.

Breast duct – a thin tube in the breast that carries milk from the breast lobules to the nipple. Also called milk duct.

Breast implant – a silicone or saline-filled sac placed under or above the chest muscle to restore breast shape or facilitate reconstruction.

Breast lobe – a section of the breast that contains the lobules (the glands that make milk).

Breast lobule – a small part of a lobe in the breast.

Breast reconstruction – surgery to rebuild the breast following a mastectomy.

Breast self-exam – an exam by a woman of her breasts to check for lumps or other changes. It is recommended to do a self-exam on a monthly basis.

Breast-conserving surgery – an operation to remove the breast cancer while leaving the breast intact. Types of breast-conserving surgery include and segmental mastectomy.

Breastbone (sternum) – the long flat bone that forms the center front of the chest wall. The breastbone is attached to the collarbone and the first seven ribs.

Bronchi – the large air passages that lead from the trachea (windpipe) to the lungs.

Bronchial – having to do with the bronchi.

Bronchiectasis – is a chronic condition where the walls of the bronchi are thickened from inflammation and infection.

Bronchiolitis obliterans - also known as popcorn lung and constrictive bronchiolitis, is a disease that results in obstruction of the smallest airways of the lungs (bronchioles) due to inflammation. Symptoms include a dry cough, shortness of breath, wheezing and feeling tired.

Bronchitis – is an inflammation of the lining of your bronchial tubes.

Bronchoscope – a thin, tube-like instrument used to examine the inside of the trachea, and lungs. A bronchoscope has a light and a lens at the tip for viewing and may have a tool to remove tissue.

Bronchoscopy – a procedure that uses a bronchoscope to examine the inside of the trachea, and lungs. The bronchoscope is inserted through the nose or mouth.
Bronchoscopy may be used to detect cancer or to perform certain treatment procedures.

Cachexia – loss of body weight and muscle mass, and weakness that may occur in clients with cancer, AIDS, or other chronic diseases.

Calcification – deposits of calcium in the tissues. Calcification in the breast can be seen on a mammogram but cannot be detected by touch. Macrocalcifications are large deposits and are usually not related to cancer. Microcalcifications are specks of calcium that may be found in an area of rapidly dividing cells. Many microcalcifications clustered together may be a sign of cancer.

Cancer – a term for diseases in which abnormal cells divide without control and can invade nearby tissues. Cancer cells can also spread to other parts of the body through the blood and lymph systems.

Capsular contracture – a condition in which scar tissue around the implant or expander hardens and then contracts. This can cause deformity, pain, and abnormal firmness of the breast.

CAR T Cell therapy – rapidly emerging immunotherapy for certain people, up to age 25, whose ALL has stopped responding to other therapies.

Carcinogen – any substance that causes cancer.

Carcinogenesis – the process by which normal cells are transformed into cancer cells.

Carcinoid – a slow-growing type of tumor usually found in the gastrointestinal system (most often in the appendix), and sometimes in the lungs or other sites. Carcinoid tumors may spread to the liver or other sites in the body, and they may secrete substances such as serotonin or prostaglandins, causing carcinoid syndrome.

Carcinoid syndrome – a combination of symptoms caused by the release of serotonin and other substances from carcinoid tumors of the gastrointestinal tract. Symptoms may include flushing of the face, diarrhea, bronchial spasms, rapid pulse, and sudden drops in blood pressure.

Carcinoma – cancer that begins in the skin or in tissues that line or cover internal organs.

Carcinoma in situ – a group of abnormal cells that remain in the place where they first formed, and they have not spread to surrounding tissue.

Cardiomyopathy - is a disease of the heart muscle that makes it harder for your heart to pump blood to the rest of your body. Cardiomyopathy can lead to heart failure. The main types of cardiomyopathies include dilated, hypertrophic and restrictive cardiomyopathy.

Cardiopulmonary – the relationship between the workings of the heart and lungs.

Cardiorespiratory – function of the heart in relationship to the body's entire breathing mechanism, from the nose and throat to the lungs.

Cardiotoxicity – toxicity that affects the heart.

Cardiovascular – directs the flow of blood throughout the body.

Carotid artery – major blood vessel in the neck that supplies blood to the brain.

Castration – removal or destruction of the testicles or ovaries using radiation, surgery, or hormonal therapy.

Catheter – a flexible tube used to deliver fluids into or withdraw fluids from the body.

Cavernoma – is a cluster of abnormal blood vessels, usually found in the brain and spinal cord. They're sometimes known as cavernous angiomas, cavernous hemangiomas, or cerebral cavernous malformation (CCM).

Celiac block (chemical splanchnicectomy) – is an effective way to control pain by injecting alcohol into the tangle of nerves that serve the pancreas, thereby destroying them. The procedure is often performed at the same time as surgery to bypass an obstructive tumor in the abdomen.

Cell type – describes the kinds of cells found in normal or cancer tissue. In cancer, it is important to know the cell type to diagnose the cancer, plan treatment, and determine prognosis.

Central nervous system (CNS) – the brain and spinal cord.

Cerebrospinal fluid – the fluid that flows in and around the hollow spaces of the brain and spinal cord, and between two of the meninges (the thin layers of tissue that cover and protect the brain and spinal cord).

Cervical – relating to the neck, or to the neck of any organ or structure.

Cervical cancer – cancer that forms in tissues of the cervix. It is usually a slow-growing cancer that may not have symptoms but can be found with a regular Pap screen. Cervical cancer is almost always caused by human papillomavirus (HPV) infection. There is now a vaccine for cervical cancer.

Cervical intraepithelial neoplasia – growth of abnormal cells on the surface of the cervix.

Cervical spine – the area of the spine that contain the 7 vertebrae that make up the neck.

Chemoembolization – a procedure in which the blood supply to a tumor is blocked after anticancer drugs are given in blood vessels near the tumor. This allows a higher concentration of the drug to reach the area that it is needed most, resulting in the death of a higher number of cancer cells. It also causes fewer side effects because very little of the drug reaches other parts of the body.

Chemoimmunotherapy – chemotherapy combined with immunotherapy. Chemotherapy uses different drugs to kill or slow the growth of cancer cells; immunotherapy uses treatments to stimulate or restore the ability of the immune system to fight cancer.

Chemoprevention – the use of drugs, vitamins, or other agents to try to reduce the risk of, or delay the development or recurrence of, cancer.

Chemoradiation – treatment that combines chemotherapy with radiation therapy.

Chemotherapeutic agent – a drug used to treat cancer.

Chemotherapy – treatment with drugs that kill cancer cells.

Chest wall – the muscles, bones, and joints that make up the area of the body between the neck and the abdomen.

Cholelithiasis – is the presence of one or more calculi (GALLSTONES) in the gallbladder.

Cholestasis – any condition in which the release of bile from the liver is blocked.

Chimeric antigen receptor (CAR) T-cell therapy – immune cells (T cells) are removed from the patient's blood and altered in the lab to have specific receptors (CHIMERIC ANTIGEN RECEPTORS, or CARs) on their surface. These receptors can attach to proteins on the surface of lymphoma cells. The T cells are then multiplied in the lab and given back into the patient's blood, where they can seek out the lymphoma cells and launch an all-out immune attack against them.

Chondrosarcoma – is a rare tumor that grows in the cartilage. It can often cause swollen joints or restrict range of motion. It is often found in the pelvic bone, long bones, scapula, and base of ribs and, less frequently, in the bones of the hand, foot, nose, and base of skull. They can remain slow growing, but when they become aggressive, can metastasize to the lungs and heart. Chondrosarcoma typically affects ages 30-60.

Chordomas – are rare tumors start in the bone at the base of the skull or at the lower end of the spine. Chordomas don't start in the central nervous system, but they can injure the nearby brain or spinal cord by pressing on it. These tumors are treated with surgery, if possible, often followed by radiation therapy, but they tend to come back in the same area after treatment, causing more damage. They usually do not spread to other organs.

Choriocarcinomas – are a very rare and aggressive type of testicular cancer that occurs in adults. These cancers are likely to metastasize to distant organs of the body, including the lungs, bone, and brain. Pure choriocarcinoma does not often occur in the testicles. Typically, choriocarcinoma cells are present with other types of non-seminoma cells in a mixed germ cell tumor.

Choroid – the pigmented layer under the retina of the eye.

Choroidal melanoma – is the most common type of ocular melanoma.

Ciliary body – the ring-shaped muscle that changes the size of the pupil and the shape of the lens when the eye focuses.

Chromophobe RCC – accounts for 5-10% of kidney tumors. These are considered a less aggressive form of primary kidney cancer. Chromophobe tumors appear clear and pale like renal cell carcinoma but are larger size.

Chronic – a disease or condition that persists or progresses over a long period of time.

Chronic pain – pain that can range from mild to severe and persists or progresses over a long period of time.

Circulatory system – the system that contains the heart and the blood vessels and moves blood throughout the body to supply oxygen and nutrients and eliminate waste products. The lymphatic system is often considered part of the circulatory system.

Cirrhosis – a type of chronic, progressive liver disease in which liver cells are replaced by scar tissue. It is often seen because of long-term alcohol abuse.

Classical seminoma – more than 95% of seminomas are typical. These usually occur in men when they are between 25 and 45.
Claudication - pain caused by too little blood flow, usually during exercise.

Clavicle (collarbone) – one of a pair of bones at the base of the front of the neck. The clavicles connect the breastbone to the shoulder blades.

Clear cell sarcoma – is a rare cancer that often develops in tendons of the arms or legs. Under the microscope, it has some features of malignant melanoma, a type of cancer that develops from pigment-producing skin cells. How cancers with these features start in parts of the body other than the skin is not known.

Colectomy – an operation to remove all or part of the colon. When only part of the colon is removed, it is called a partial colectomy.

Collecting duct – a type of kidney cancer that makes up less than 1% of all cases. This is a very rare and aggressive type of tumor that is more common in younger adults and doesn't respond to conventional therapies for renal cortical tumors.

Colo-anal anastomosis – the colon is connected to the anus following a proctectomy (surgical removal of the rectum).

Colon – the longest part of the large intestine (which is connected to the small intestine at one end and the anus at the other). The colon removes water and some nutrients and electrolytes from partially digested food. The remaining material, solid waste, moves through the colon to the rectum and leaves the body through the anus.

Colon cancer – cancer that forms in the tissues of the colon. Most colon cancers are adenocarcinomas (cancers that begin in cells that make and release mucus and other fluids).

Colonoscopy – examination of the inside of the colon through the rectum, using a colonoscope. A colonoscope is a thin instrument with a light and a lens at the tip for viewing. It may also have a tool to remove tissue to be checked under a microscope for signs of disease.

Colorectal – having to do with the colon or the rectum.

Colorectal cancer – cancer that develops in the colon and/or the rectum.

Colostomy – an opening into the colon from the outside of the body. A colostomy provides a new path for waste material to leave the body after part of the colon has been removed.

Colposcope – a lighted magnifying instrument used to examine the vagina and cervix.

Colposcopy – examination of the vagina and cervix using a colposcope.

Common bile duct – a tube that is part of the biliary duct system and carries bile from the liver and the gallbladder through the pancreas and into the duodenum (the upper part of the small intestine). It is formed where the ducts from the liver and gallbladder are joined.

Complementary and alternative medicine – forms of treatment, that may include dietary supplements, megadose vitamins, herbal preparations, special teas, acupuncture, massage therapy, magnet therapy, spiritual healing, and meditation, that are used in addition to or instead of standard treatments. These practices generally are not considered standard medical approaches. Standard treatments go through an in-depth research process to prove they are safe and effective, but less is known about most types of alternative medicine practices.

Complete (total) hysterectomy – surgery to remove the entire uterus, including the cervix .

Compression garment – a tight-fitting, elastic garment, such as a sleeve or stocking. Compression garments are used in the treatment of lymphedema and used to improve blood flow.

Congestive heart failure – is a chronic progressive condition that affects the pumping power of your heart muscles. While often referred to simply as "heart failure," CHF specifically refers to the stage in which fluid builds up around the heart and causes it to pump inefficiently.

Conization – surgery to remove a cone-shaped piece of tissue from the cervix and cervical canal.

Connective tissue – supporting tissue that surrounds other tissues and organs.

Conservative surgical excision – surgery to remove the cancer and a margin of normal tissue less than 2 centimeters.

Constipation – a condition in which stool becomes hard, dry, and difficult to pass, and bowel movements don't happen very often. Painful bowel movements, feeling bloated, uncomfortable, and sluggish are among the other side-effects.

Continent diversion – another type of urostomy is the continent diversion. Here, the pouch created from the piece of intestine has a valve created. The valve allows the urine to be stored in the pouch and emptied several times each day by placing a drainage tube (catheter) into the hole. Some clients prefer this because there is no bag on the outside.

Contracture – a permanent tightening of the muscles, tendons, skin, and nearby tissues that causes the joints to shorten and become very stiff. This may prevent normal movement of a joint or other body part. Contractures may be caused by injury, scarring, and nerve damage, or by not using the muscles (i.e., frozen shoulder). It may also occur at some point in time after a stem cell transplant that caused chronic graft-versus-host disease. It is also one of the side-effects following breast reconstruction with implants.

Contraindication – a symptom or medical condition that makes a particular treatment or procedure inadvisable because a person is likely to have a bad reaction. For example, having high blood pressure is a contraindication for performing isometric exercises.

Contralateral – having to do with the opposite side of the body.

Conventional (clear cell) – a type of renal cortical kidney cancer which accounts for 6065% of cases.

Conventional medicine – a system in which medical doctors and other healthcare professionals treat symptoms and diseases using drugs, radiation, or surgery.

Cordectomy – an operation on the vocal cords or on the spinal cord.

Core – the center of the body and the beginning point of movement. The lumbo-pelvic-hip complex.

Core biopsy – the removal of a tissue sample with a wide needle for examination under a microscope.

Core needle biopsy – the removal of a tissue sample with a wide needle for examination under a microscope.

Core stability – neuromuscular efficiency of the lumbo-pelvic-hip complex.

Core strength – the ability of the lumbo-pelvic-hip complex to control and individual's changing center of gravity.

Corticot**ropin releasing factor (CRF) –** is a major regulator of the hypothalamic pituitary adrenal (HPA) axis response. CRF is a stress-related neuropeptide whose dysregulation has been associated with depression.

Coronal (Frontal) plane – this plane bisects the body into its front and back halves. Joint motion in this plane occurs around an anterior/posterior axis and includes abduction and adduction of the limbs, lateral flexion of the spine, and eversion and inversion of the foot.

Corticosteroids – reduce inflammation.

Cosmesis - is the preservation, restoration, or bestowing of bodily beauty. In the medical context, it usually refers to the surgical correction of a disfiguring defect, or the cosmetic improvements made by a surgeon following incisions.

Cranial nerve palsy – is a type of muscle malfunction involving at least one of the cranial nerves. Cranial nerve palsies are usually very easy to identify because they involve the muscles of the face, and people's faces change because of the palsy. A patient may find it difficult to smile, to control eye movements, and to engage in other facial expressions.

Craniopharyngioma – is a benign tumor that occurs most often in children and adolescents than in adults. It develops near the optic nerve and the pituitary gland. It may bring on visual impairment and hormonal imbalances. It may also affect the hypothalamus, the part of the brain that regulates temperature, hunger, and thirst.

Craniospinal radiation – if tests find that a brain tumor has spread along the covering of the spinal cord (meninges), or into the surrounding cerebrospinal fluid, then radiation may be given to the whole brain and spinal cord.

Craniotomy – an operation in which an opening is made in the skull. A plate of bone is removed, and the skin is pulled back to expose the brains surface.

Cruciferous vegetable – a member of the family of vegetables that includes broccoli, Brussels sprouts, cabbage, cauliflower, collard greens, kale, and turnips. These vegetables contain substances that may protect against cancer.

Cryoablation – a procedure in which tissue is frozen to destroy abnormal cells. Liquid nitrogen or liquid carbon dioxide is used to freeze the tissue.

Cryotherapy – any method that uses cold temperature to treat disease.

CT scan – a series of detailed pictures of areas inside the body taken from different angles. The pictures are created by a computer linked to an x-ray machine.

Cure – a treatment to restore health.

Curettage – removal of tissue with a curette (a spoon-shaped instrument with a sharp edge).

Curette – a spoon-shaped instrument with a sharp edge.

Cushing's syndrome – results from high levels of the hormone cortisol in the body. The rise in hormone levels could be due to body's increased production of cortisol or overuse of corticosteroids. Notable symptoms include hump between the shoulders, round face, and purple stretch marks on the skin. Treatment includes reducing steroid usage, surgery, radiation therapy and medications.

Cyanosis – bluish discoloration, especially of the skin and mucous membranes, due to excessive concentration of deoxyhemoglobin in the blood caused by deoxygenation.

Cylophosphamide – also known as cytophosphane, is a medication used as chemotherapy and to suppress the immune system.

Cyclosporine – is an immunosuppressant that produces some tendency to develop high blood pressure, kidney and liver problems, tremors or shaking, headache or body pain, diarrhea, constipation, vomiting, numbness, and the growth of body hair.

Cytokine – a substance that is made by cells of the immune system. Some cytokines can boost the immune response and others can suppress it.

Cytokine release syndrome – happens when your immune system responds to infection or immunotherapy drugs more aggressively than it should. CRS symptoms include fever, nausea, fatigue and body aches. Prompt treatment is essential, as symptoms can worsen quickly.

Cytopenia – a condition in which there is a lower-than-normal number of blood cells.

D&C (dilation and curettage) – a procedure to remove tissue from the cervical canal or the inner lining of the uterus.

DCIS (ductal carcinoma in situ) – a noninvasive condition in which abnormal cells are found in the lining of a breast duct. The abnormal cells have not spread outside the duct to other tissues in the breast.

Dacron cuff – a sheath of Dacron surrounding an atrial or venous catheter to prevent accidental displacement.

Debulking – surgical removal of as much of a tumor as possible. Debulking may increase the chance that chemotherapy or radiation therapy will kill all the tumor cells. It may also be done to relieve symptoms or help the patient live longer.

Deep vein thrombosis (DVT) – occurs when a blood clot (thrombus) forms in one or more of the deep veins in your body, usually in your legs. Deep vein thrombosis can cause leg pain or swelling, but also can occur with no symptoms. It can be very serious because blood clots in your veins can break loose, travel through your bloodstream and lodge in your lungs, blocking blood flow (pulmonary embolism).

Degenerative disease **–** a disease in which the function or structure of the affected tissues or organs changes for the worse over time.
Dehydration – a condition caused by the loss of too much water from the body. Severe diarrhea or vomiting can cause dehydration.

Dendritic cells (DCs) – are antigen-presenting cells (also known as accessory cells) of the immune system. Their main function is to process antigen material and present it on the cell surface to the T cells of the immune system. They act as messengers between the innate and the adaptive immune systems.

Depression – a mental condition marked by ongoing feelings of sadness, despair, loss of energy, and difficulty dealing with normal daily life. Depression affects 15-25% of cancer clients.

Dermabrasion – removal of the top layer of skin using a rotating wheel or small particles to rub away.

Desmoplastic small round cell tumor – is a rare sarcoma of adolescents and young adults, found most often in the abdomen.

Diabetes – usually refers to diabetes mellitus (Type I) in which there is also a high level of glucose in the blood because the body does not make enough insulin or use it the way it should. There is also Type II (adult-onset diabetes) which can usually be managed with diet and exercise.

Diagnostic test – a type of test used to help diagnose a disease or condition.

Diagnostic trial – a research study that evaluates methods of detecting disease.

Dialysis – the process of filtering the blood when the kidneys are not able to cleanse it.

Diaphragm – the thin muscle below the lungs and heart that separates the chest from the abdomen.

Diarrhea – frequent and watery bowel movements.

DIEP flap – a muscle conserving type of breast reconstruction in which blood vessels (deep inferior epigastric perforators), as well as ski, fat, and tissue are removed from the lower abdomen and used for reconstruction. This procedure does not compromise abdominal and core strength because the rectus muscles are left in place.

Diet – the things that a person or animal eats and drinks or the act of restricting caloric consumption.

Dietitian (nutritionist) – a healthcare professional with training in nutrition who can help with dietary choices for health and weight loss purposes.

Differentiation – when used to describe cancer, describes how much or how little tumor tissue looks like the healthy tissue it came from. Well-differentiated cancer cells look like normal cells and tend to grow and spread more slowly than poorly differentiated cells. This is used for tumor grading and diagnostic purposes.

Digestive system – the system is made up of the series of organs (salivary glands, mouth, esophagus, stomach, liver, pancreas, gallbladder, small and large intestines, and rectum) and works together to make food absorbable in the body.

Digestive tract – the series of organs (mouth, esophagus, stomach, small and large intestines, and rectum and anus) through which food and liquids pass, nutrients are absorbed, and waste is eliminated.

Dilatation and curettage (D&C) – a procedure to remove tissue from the cervical canal or the inner lining of the uterus. The cervix is made larger by dilating it a sharp spoonshaped instrument called a curette is inserted into the uterus to remove tissue.

Dilated cardiomyopathy – a condition that develops when the ventricles enlarge and weaken. Over time, this can cause the heart to lose its ability to pump blood effectively.

Diplopia – double vision.

Disorder – a disturbance of normal functioning of the mind or body. Can also refer to the lack of order.

Disorientation – loss of one's sense of direction, position, or relationship with one's surroundings.

Diuretics – remove excess sodium from the body and reduce the amount of fluid in the blood.

Dysplasia – abnormal cell growth.

Disseminate – to scatter or distribute over a large area or range. To spread throughout an organ of the body.

Distal pancreatectomy – the removal of the body and tail of the pancreas.

Distant cancer (distant metastasis) – refers to cancer that has spread (metastasized) from the primary tumor to distant organs or lymph nodes.

Donor – a person who gives blood, cells, tissue, semen, eggs, or an organ for use in another person, such as in a blood transfusion or an organ transplant. It could also be someone who is philanthropic and donates something to a cause.

Dorsal – the opposite of ventral. Refers to a position on or towards the back of the body.

Dose – quantity of medicine taken, or radiation given, at a particular time.

Ductal carcinoma – the most common type of breast cancer. It is also known as DCIS and it is 97% curable. In situ means contained. It has not spread beyond the lining of the breast duct. It is a noninvasive condition in which abnormal cells are found in the lining of a breast duct.

Dumping syndrome – occurs when food, especially sugar, moves too fast from the stomach to the duodenum - the first part of the small intestine - in the upper gastrointestinal (GI) tract. This condition is also called rapid gastric emptying. With most, or all the stomach missing, the food spills into the intestine too rapidly. In late dumping syndrome the small intestine is forced to absorb larger amounts of food than normal, driving up the concentration of sugar in the circulation. The pancreas produces excess insulin to regulate the blood glucose level. Clients may feel weak or tired several hours after eating from a drop in blood sugar. They may also have a headache, sweating, anxiety, and/or tremors. Early dumping syndrome can take place several minutes after eating. Blood pressure increases, but blood flow to the intestine decreases, Symptoms include an irregular or rapid heartbeat, dizziness, shortness of breath, flushed skin, vomiting, abdominal cramps, and diarrhea. The smaller the remaining stomach, the worse the symptoms. The symptoms usually subside within 3-12 months, but in some clients the condition may become chronic. Clients can control their symptoms by eating frequent, smaller meals, low in carbohydrates. Fluids should be consumed between meals rather than accompanying them.

Duodenum – the first part of the small intestine between the stomach and the middle part of the small intestine (jejunum). After foods mix with stomach acid, they move into the duodenum, where they mix with bile from the gallbladder and digestive juices from the pancreas. Absorption of vitamins, minerals, and other nutrients begins in the duodenum.

Dura matter (Dura) – the outermost of the three layers of the meninges surrounding the brain and spinal cord.

Dysarthria - difficult or unclear articulation of speech that is otherwise linguistically normal.

Dysesthesias - comes from the Greek word "dys," meaning "Not-normal," and "aesthesis," which means "sensation" (abnormal sensation). It is defined as an unpleasant, abnormal sense of touch. It often presents as pain but may also present as an inappropriate, but not discomforting, sensation.

Dysgraphia – a neurological disorder that is characterized by impaired handwriting.

Dysphagia – is the medical term for the symptom of difficulty in swallowing.

Dysplasia – abnormal development or growth of tissues, organs, or cells. Although cells make look abnormal under a microscope, they are not cancer.

Dyspnea – difficult, painful breathing or shortness of breath. In 85% of cases it is due to either asthma, pneumonia, cardiac ischemia, interstitial lung disease, congestive heart failure, chronic obstructive pulmonary disease, or psychogenic causes.

Dysuria – is a symptom of pain, discomfort, or burning when urinating.

Early menopause – a condition in which the ovaries stop working and menstrual periods stop before age 40. The usual onset for natural menopause is 51. A woman is said to be in menopause when she hasn't had a period for 12 months in a row. Symptoms of menopause include hot flashes, mood swings, night sweats, vaginal dryness, trouble concentrating, decrease sexual desire, weight gain, osteoporosis, and infertility. Induced menopause, such as occurs when the ovaries are damaged by radiation, chemotherapy, or other medications; or as occurs when the ovaries are surgically removed (by bilateral oophorectomy

Early-stage breast cancer – breast cancer that has not spread beyond the breast or to the nearby axillary lymph nodes. This includes ductal carcinoma in situ and stage I, stage IIA, stage IIB, and stage IIIA breast cancer.

Early-stage cancer – a term used to describe cancer that is early in its growth and may not have spread to other parts of the body. This may vary amongst cancer types.

Edema – abnormal pooling of fluid in tissues or the accumulation of excess interstitial fluids. It is not the same as lymphedema in which lymph collects in the soft tissues because of damage to the lymphatic system.

Efferent neurons – neurons that transmit nerve impulses from the brain and/or spinal cord to the muscles and glands. Also known as motor neurons.

Efficacy – the capacity to produce an effect. In medicine, the ability of an intervention (treatment, surgery, medical device, etc.) to produce the desired change.

EGFR – a genetic mutation that is regularly tested for in lung cancer clients is a gene called EGFR, or epidermal growth factor receptor (this helps the cells divide). It is mutated in about 10% of clients with non-small cell lung cancer and in nearly 50% of lung cancers arising in those who have never smoked.

Electrodessication (electrosurgery) – destroys tissue by a using a high-frequency electric current applied with a needle-shaped electrode.

Electrofulguration – a procedure where a high-energy laser beam is used to destroy tissue.

Electrolarynx – a battery-operated device which is handheld and placed under the mandible producing a vibration to allow speech. It is used to help a person speak after a laryngectomy.

Electrolyte – are minerals in your blood and other body fluids that carry an electric charge. The primary ions of electrolytes are sodium, potassium, calcium, magnesium, and chloride. Sodium is the main electrolyte found in extracellular fluid and is involved in fluid balance and blood pressure control. Muscle contraction is dependent upon the presence of calcium, sodium, and potassium. Without sufficient levels of these key electrolytes, muscle weakness or severe muscle contractions may occur

Embolization – is a non-surgical minimally invasive procedure that blocks an artery with a clot or foreign material. The purpose of embolization is to prevent blood flow to an area of the body, which can potentially shrink a tumor.

Embryonal carcinomas – a type of non-seminoma that's partially present in about 40% of testicular tumors, but pure embryonal carcinomas occur only 3% to 4% of the time.
When seen under a microscope, these tumors can look like tissues of very early embryos. These tumors tend to grow rapidly and metastasize outside the testicle.

EML4-ALK – clients whose tumors do not have mutations in either EGFR or KRAS may have another abnormality called EML4-ALK. Clients will be tested for certain cell proteins and those with these proteins in their tumors may be less likely to benefit from traditional chemotherapy given after initial treatment (adjuvant).

Endocarditis – inflammation of the inside lining of the heart chambers and heart valves (endocardium).

Endocrine system – a system of glands, each of which secretes different types of hormones that are released directly into the blood stream. The endocrine system controls metabolism, growth and development, sexual development, sleep, hunger, tissue function, and mood.

Endocrinologists – specially trained physicians who diagnose diseases related to the glands.

Endoluminal laser therapy – the tumor is reduced with a laser attached to an endoscope that is inserted through an incision in the abdomen.

Endoluminal stent placement – a thin, flexible tube (stent) is placed between the stomach and small intestine or the stomach and the esophagus to create a clear passageway for food.

Endometrial – having to do with the endometrium (the membrane lining the uterus).

Endometrial biopsy – a doctor takes a sample of tissue from the endometrium for examination. It is looked at under a microscope for the presence of abnormal cells. This is done by inserting a thin tube through the cervix into the uterus, and gently scraping (while simultaneously suctioning) to remove the sample.

Endometrial cancer – cancer that starts in the endometrium.

Endometrial hyperplasia – an overgrowth of the endometrial cells that result in a thickening of the lining of the uterus. It is usually not cancer but can lead to it.

Endoprostheses – is used to replace joints that have been removed by surgery, like the knee, hip or shoulder joints. This allows the joints to move and bend. An endoprosthesis is usually made of metal and plastic. The life span of these prostheses is limited to an average of 15 years 15,75.

Endoscope – a device with a light attached to it, a lens for viewing, and possibly a tool to remove tissue as well.

Endoscopic mucosal resection – the cancer is removed through an endoscope that's passed down the throat to the stomach. It is only done for cancers at a very early stage in which the risk spread to the lymph nodes is very unlikely.

Endoscopy – a procedure that lets a doctor look inside the body using an endoscope to examine the inside of the body.

Enophthalmos – is a functional deformity in which the eye sinks down into the cheek.

Enucleation – a laparoscopic surgical procedure to remove a small pancreatic tumor without removing any other tissue.

Ependymomas – occur in the ependymal cells found in the lining of the brain's hollow cavities and the central canal of the spinal cord. Eighty-five percent of these tumors are benign, but the malignant form of these tumors has a greater likelihood of spreading up and down the spine via the spinal fluid.

Epidermis – is composed of the outermost layer of the skin.

Epidural – an injection into the dura mater (epidural space) that is between the wall of the spinal canal and the covering of the spinal cord.

Epidural spinal cord compression – is metastasis of cancer into the spine or epidural space that causes secondary compression of the spinal cord.

Epigenetics – is the study, in the field of genetics, of cellular and physiological phenotypic trait variations that are caused by external or environmental factors that switch genes on and off and affect how cells read genes instead of being caused by changes in the DNA sequence.

Epiglottis – the flap of cartilage that sits at the base of the tongue and covers the trachea (windpipe) during swallowing so that food does not enter the lungs.

Epithelial – refers to the cells that line the cavities and surfaces of the body. They also form many glands.

Epithelioid sarcoma – most often develops in tissues under the skin of the hands, forearms, feet, or lower legs. Adolescents and young adults are often affected.

Erectile dysfunction (impotence) – the inability to have or maintain an erection of the penis sexual intercourse. Also called impotence.

Erection – a physiological phenomenon in which the penis swells with blood, causing it to become firm, enlarged, and engorged.
Erythrocyte (red blood cell) – the most common type of blood cells in the body. They carry oxygen to all parts of the body.

Esophageal – having to do with the esophagus, the muscular membranous tube for the passage of food from the pharynx (throat) to the stomach.

Esophageal cancer – cancer that forms in tissues lining the esophagus.

Esophageal stent – a tiny tube placed at a point of narrowing or blockage in the esophagus, to keep it open so the patient can swallow soft food and liquids.

Esophageal stricture – describes a narrowing or tightening of the esophagus. It typically occurs when stomach acid and other irritants damage the lining of the esophagus over time. This leads to inflammation (esophagitis) and scar tissue, which causes the esophagus to narrow.

Esophagectomy – surgery to remove all or part of the esophagus.

Esophagoscopy – endoscopic examination of the esophagus using an esophagoscope (a thin, tube-like instrument with a light and a lens for viewing) inserted through the mouth. Esophagoscopy alone is uncommon. It is generally performed as part of a more complex upper endoscopic procedure in which the esophagus, stomach, and portions of the small intestine are explored endoscopically.

Estrogen – a generic term for estrus-producing compounds (the female sex hormones), including estradiol, estriol, and estrone. The estrogens are formed in the ovaries, adrenal cortex, testis, and fetoplacental unit. They help develop and maintain female sex characteristics and the growth of long bones. Estrogens can also be made in the laboratory and may be used as a type of birth control, to treat symptoms of menopause and menstrual disorders, osteoporosis, and to improve breast and prostate cancer.

Estrogen blocker (aromatase inhibitors) – are sometimes referred to as anti-estrogens. Estrogen blockers lower estrogen levels in the body and prevent testosterone, which both men and women have, from converting into estrogen

Estrogen receptor – are a group of proteins found in cells and they are receptors that are activated by the hormone estrogen. In women who are found to be "estrogen receptor positive," the overwhelming concern is that they may cause the cells to proliferate.

Estrogen receptor negative – breast cancer cells without a receptor to which estrogens can attach; this is associated with a poorer prognosis as they usually don't respond to antiestrogen therapy.

Estrogen receptor positive – breast cancer cells with a receptor to which estrogens can attach; these cancer cells may grow in the presence of estrogen and may stop growing or die when treated with estrogen blockers.

Estrogen receptor test – a laboratory test to find out if cancer cells have estrogen receptors.

Estrogen replacement therapy – medications containing female hormones to replace the ones the body no longer makes after menopause.

Evoked potential electrophysiological mapping – during surgery, small electrodes are used to stimulate nerves and measure their electrical responses, or evoked potential. By establishing the function of specific nerves in each patient, the surgeon can identify the critical areas of the brain to avoid.

Ewing's sarcoma – is a tumor of the bone which affects children and young adults. It differs from osteosarcoma in that it tends to be found in bones such as ribs rather than the long bones of the arm and leg. It is uncommon before age 5 and after age 30. It may involve any part of the bony skeleton and may extend into the soft tissue around the bones. Fever, chills and weakness, intermittent pain, and swelling are initial symptoms. When the tumor is found outside the bones, it is known as "soft tissue" or extra-osseous Ewing's sarcoma. For many years Ewing's sarcoma was considered fatal, but with present treatment methods it is highly treatable and, in many cases, curable. The most curable cases are those found in the lower jaw, skull, face, scapula, vertebra, or clavicle, and those below the elbow or knee. Ewing's sarcoma typically affects the same age group as osteosarcoma; 10-25 years of age.

Excision – removal by cutting. In surgery, the complete removal of an organ, tissue, bone or tumor from a body

Excisional biopsy – a surgical procedure in which the entire abnormal area is removed as well as an additional layer of tissue. The tissue is sent to pathology and examined under a microscope.

Exenteration – surgical removal of all the contents of a body cavity.

Exocrine pancreas cell – a cell in the pancreas that produces enzymes which are secreted into the small intestine. These enzymes help digest food as it passes through the gastrointestinal tract.

Extended resection – a reconstructive procedure after part of chest wall, left atrium, and diaphragm are removed. May require a muscle flap for structural stability. It may be from the serratus anterior, pectoralis major, latissimus dorsi or rectus abdominis. Muscle imbalances will need to be addressed depending on where the flap was taken from.

Extension – the opposite of flexion. A straightening movement in which the relative joint angle between two adjacent segments increases.

Externally rotated – pointing outward.

External radiation therapy – is a method for delivering a beam, or several beams, of high-energy x-rays to a patient's tumor/tumor site. These high energy x-rays deposit a lethal dose of radiation to the area of the tumor to destroy the cancer cells while sparing the surrounding normal tissues. No radioactive sources are placed inside the patient's body.

Extremity – the furthest point or limit of something. In anatomy, a limb of the body; such as the arm or leg.

FK-506 – is an immunosuppressant whose side effects include infection, heart and lung damage, headaches, diarrhea, increased tension, nausea, blurred vision, diabetes, itching, liver and kidney dysfunction, loss of appetite, insomnia, confusion, weakness, depression, cramps, neuropathy, seizures, and tremors.

Fallopian tube – two very fine tubes in a women's body that allow eggs to pass from an ovary to the uterus.

False-negative test result – a test result that appears negative when it is not.

False-positive test result – a test result that appears positive when it is not.

Family medical history – a record of illnesses and medical conditions affecting your family. It may show a pattern of certain diseases amongst family members.

Fanconi syndrome – is a disease of the proximal renal tubules of the kidney in which glucose, amino acids, uric acid, phosphate and bicarbonate are passed into the urine, instead of being reabsorbed. Fanconi syndrome affects the proximal tubule, which is the first part of the tubule to process fluid after it is filtered through the glomerulus.

Fascia – a structure of connective tissue that surrounds muscles, groups of muscles, blood vessels, and nerves, binding some structures together, while permitting others to slide smoothly over each other.

Fat necrosis – is a lump that forms in the breast due to fat cells that have either been damaged or degenerated. It is caused by trauma to the breast. Many times, the lump will form with a bruising or redness around it. It is common for clients who have recently undergone east surgery or radiation to develop breast necrosis.

Fatigue – a condition that is marked by extreme tiredness and the inability to focus, function, and perform activities of daily living due to lack of energy. Fatigue may be acute or chronic. It is reported by 76% of cancer clients.

Fertility – the natural capability to produce offspring.

Fertility preservation – an effort to help cancer clients retain their fertility.

Fibrolamellar HCC – is a rare subtype that often has a higher chance for successful treatment than other types of liver cancer.

Fibromyxoid sarcoma, low-grade – is a slow growing cancer that most often develops as a painless growth in the trunk or arms and legs (particularly the thigh). It is more common in young to middle aged adults. It is also sometimes called an Evans' tumor.

Fibrosarcoma – this is a very rare form of bone cancer which may occur at any age but is rare in children. Fibrosarcoma may develop in persons who have had radiation or at the site of a past bone fracture. It is also felt that Paget's disease (for unknown reasons, parts of the skeleton become overactive and dismantle simultaneously rebuild themselves at an abnormally fast rate) may be a predisposing factor in the development of fibrosarcoma.

Fine-needle aspiration biopsy – a diagnostic procedure in which tissue or fluid is removed with a thin needle for examination under a microscope.

***First-line (induction) therapy* –** is usually the standard initial treatment used to reduce or manage cancer. It is followed by other treatments including radiation therapy, chemotherapy, and hormonal therapy.

Fistula – is an abnormal connection between an organ, vessel, or intestine and another structure.

Five-year survival rate – a term that is used in medicine for estimating the prognosis of a disease. It refers to the percentage of people who are alive, five years after their initial diagnosis.

Flexibility – the ability to have optimum range of motion (ROM) as well as neuromuscular control throughout a specific ROM to prevent injury and enhance performance.

Flexion – the opposite of extension. The relative angle between two adjacent segments decreases.

Fluoroscopy – is an imaging technique that uses X-rays to obtain real-time moving images of the interior of an object.

Follicular thyroid cancer – accounts for 50% of thyroid cancers and are most common in women over 50 years old. It grows slowly and is highly treatable.

Force production – the force generated by a muscle action.

Fulguration – the destruction of tissue, usually malignant tumors, by means of a high-frequency electric current applied with a needlelike electrode.

Functional image-guided surgery – this procedure is carried out prior to brain surgery, during a special MRI scan. The patient is asked to perform certain repetitive activities. The parts of the brain that are responsible for those functions will demonstrate heightened activity, which the scan will convert to an image. The neurosurgeon will have a map that will direct him to the mass and around sensitive areas.

Fusion (arthrodesis) – a reconstructive procedure to replace a limb that may result in a stiff joint but permits activities such as running and jumping.

Gallium scan – a small amount of radioactive material, gallium, is injected into a vein. It travels through the bloodstream and into the body's tissues, primarily the bones, liver, intestine, and areas of tissue where inflammation or a buildup of white blood cells is present. It often takes a few days to build up in these areas, so a scan is usually done at 2 days and again at 3 days after the tracer is injected. Areas where there is noticeable build up show up as bright or "hot" spots in the pictures. The problem areas may be caused by infection, certain inflammatory diseases, or a tumor.

Gamma Knife therapy (radiosurgery) – directs highly focused beams of ionizing radiation with high extreme precision to the tumor site. It is a relatively recent technique used to destroy intracranial and extracranial tumors and other lesions that are otherwise inaccessible for open surgery.

Gangliomas – contain both neurons and glial cells. These tumors are very uncommon in adults. They are typically slow growing (grade II) tumors and can usually be cured by surgery alone or surgery combined with radiation therapy.

Gardner syndrome (familial colorectal polyposis) – is a subtype of Familial Adenomatous Polyposis (FAP). Gardner syndrome is an autosomal dominant form of polyposis characterized by the presence of multiple polyps in the colon together with tumors outside the colon.

Gastrectomy – an operation to remove all or part of the stomach.

Gastric – having to do with the stomach.

Gastric (stomach) cancer – cancer that forms in tissues lining the stomach.

Gastric Bypass – if the tumor is blocking the flow of food from the stomach, the stomach may be sewn directly to the small intestine so the patient can continue to eat normally.

Gastric feeding tube (gastrostomy tube) – is a medical device used to provide nutrition to clients who cannot obtain nutrition by swallowing. The state of being fed by a feeding tube is called gavage, enteral feeding or tube feeding. Placement may be temporary for the treatment of acute conditions or lifelong in the case of chronic disabilities.

Gastric pull-up – replaces the throat and the entire esophagus by taking the "J" shaped part of the stomach and attaching it to the pharynx.

Gastroduodenostomy – connecting what remains of the stomach to the duodenum.

Gastrojejunostomy – connecting what remains of the stomach to the jejunum.

Gastroesophageal junction – the place where the esophagus is connected to the stomach.

Gastrointestinal – refers to the stomach and intestines and sometimes includes everything from the mouth to the anus.

Gastrointestinal stromal tumor (GIST) – This is a type of sarcoma that develops in the digestive tract. It is covered in Gastrointestinal Stromal Tumor (GIST).

Gene – a molecular unit of heredity passed from parent to offspring. A gene is any section along the DNA that has instructions encoded that allow a cell to produce a specific product – usually, a protein, such as an enzyme – that triggers one precise action. There are between 50,000 and 100,000 genes, and every single gene is made up of thousands, even hundreds of thousands, of chemical bases.

Gene expression – the process by which a gene gets turned on in a cell to make RNA and proteins. Gene expression may be measured by looking at the RNA, or the protein made from the RNA, or what the protein does in a cell.

Gene expression profile – is the measurement of the activity of thousands of genes at once, to create a picture of cellular function. These profiles can, for example, distinguish between cells that are actively dividing, or show how the cells react to a particular treatment.

Genetic marker of susceptibility – a specific change in a person's DNA that makes the person more likely to develop certain diseases such as cancer.

Genetic predisposition – an inherited increase in the risk of developing a disease. Also called genetic susceptibility.

Genitourinary – is a word that refers to the urinary and genital organs.

Genomic sequencing – enables the high-speed analysis of multiple genes simultaneously, including all of those in a person's genome.

Germ cell tumors – more than 90% of cancers of the testicle develop in germ cells (these are the cells that produce sperm). There are 2 main types of germ cell tumors: seminomas and non-seminomas.

Gerota's fascia – a fibrous envelope of tissue that surrounds the kidney.

Gingival hypertrophy – increase in the size or gums.

Glaucoma – is a group of diseases that damage the eye's optic nerve and can result in vision loss and blindness.

Glioma – about 3 out of 10 brain cell tumors are gliomas. They are a cancer of the brain that begins in glial cells (cells that surround and support nerve cells).

Glomerular injury – an injury relating to a cluster of nerve endings, spores, or small blood vessels, especially around the end of a kidney tubule.

Glossectomy – surgical removal of all the tongue.

Gliottis – the middle part of the larynx; the area where the vocal cords are located.

Glucagon – a hormone produced by the pancreas that increases the level of glucose (sugar) in the blood.

Glucose – a type of sugar; the chief source of energy for living organisms.

Glycemia – glucose (sugar) found in the blood. Also called blood sugar.

Glycemic index – a measure of the increase in the level of blood glucose caused by eating a specific carbohydrate. Foods with a high glycemic index release glucose quickly and cause a rapid rise in blood sugar. Foods with a low glycemic index release sugar slowly into the blood.

Goniometer – an instrument used for measuring angles.

Grading – a system for classifying cancer cells in terms of how abnormal they appear when examined under a microscope. The objective of a grading system is to provide information about the probable growth rate of the tumor and its tendency to spread. The systems used to grade tumors vary with each type of cancer. Grading plays a role in treatment decisions.

Graft – healthy skin, bone, or other tissue taken from one part of the body and used to replace diseased or injured tissue removed from another part of the body.

Graft-versus-host disease (GVHD) – is a common complication following an allogeneic tissue transplant. It is commonly associated with stem cell or bone marrow transplant but may also apply to other forms of tissue graft. White blood cells in the graft recognize the host as "foreign". The transplanted immune cells then attack the host's own body cells. GVHD can also occur after a blood transfusion if the blood products used have not been irradiated.

Graft-versus-tumor effect – appears after allogeneic hematopoietic stem cell transplantation. The graft contains donor T cells that can be beneficial for the recipient by eliminating residual malignant cells. GvT might develop after recognizing tumor-specific or recipient-specific alloantigens.

Groin – the crease or hollow where the inner part of each thigh meets with the trunk, together with the adjacent region and often including the external genitals.

Gut-brain axis – is the bi-directional communication that takes place between the central nervous system and gut microbiota.

Gynecologic – having to do with the female reproductive organs.

Gynecologic cancer – cancer of the female reproductive organs. This may include any of the following: the cervix, endometrium, fallopian tubes, ovaries, uterus, and/or vagina.

HLRCC – is a relatively rare, inherited known form of kidney cancer that is difficult to diagnose before surgery in clients without a known family history of the disease. Genetic testing is available for individuals suspected of having the syndrome.

Hallucination – the perception of visual, auditory, or tactile experiences without an external stimulus. The person has a compelling sense of their reality. Hallucinations can be caused by nervous system disease, certain drugs, or mental disorders.

Halsted radical mastectomy – surgery for breast cancer in which the breast, pectoralis major and minor, and all the lymph nodes under the arm are removed. It is rarely, if ever, used anymore in the U.S. Doctors consider radical mastectomy only when the tumor has spread to the chest muscles.

Hand-foot syndrome – also called Palmar-Plantar Erythrodysesthesia, is a side effect which can occur with several types of chemotherapy or biologic therapy drugs used to treat cancer. It is marked by pain, swelling, numbness, tingling, or redness of the hands or feet.

Heart failure – is a condition in which the heart cannot pump enough blood to the rest of the body

Hemangiosarcoma – originates in the blood vessels and is found in the arms, legs, and trunk.

Hematocrit – the percentage by volume of red blood cells in each sample of blood after it has been spun in a centrifuge. Results are used to check for conditions such as anemia, dehydration, malnutrition, and leukemia.

Hematomegaly – abnormal enlargement of the liver.

Hematopoiesis – new blood cell formation

Hematuria – is the presence of blood in a person's urine.

Hemiparesis – is partial weakness on one side of the body.

Hemodynamic compromise – "blood flow compromise", which is anything that may prevent proper blood flow such as a hemorrhage, plaque atherosclerosis, etc.

Hemoglobin – a protein in red blood cells that carries oxygen from the respiratory organs to tissues and organs in the body and carries carbon dioxide back to the lungs. Results are used to check for conditions such as anemia, dehydration, and malnutrition.

Hemorrhage – the escape of blood from the blood vessels. A hemorrhage may be internal or external, and usually involves excessive bleeding in a short period of time.

Hemorrhagic cystitis – is an inflammation of the bladder defined by lower urinary tract symptoms that include dysuria, hematuria, and hemorrhage. The disease can occur as a complication of cyclophosphamide, ifosfamide and radiation therapy.

Hepatectomy – surgery to remove all the liver.

Hepatic – referring to the liver.

Hepatic fibrosis – is overly exuberant wound healing in which excessive connective tissue builds up in the liver. The extracellular matrix is overproduced, degraded deficiently, or both. The trigger is chronic injury, especially if there is an inflammatory component.

Hepatic veno-occlusive disease (VOD) – is a serious problem in which blood flow inside the liver is blocked. It only happens in people with allogeneic transplants, and mainly in those who received the drugs busulfan or melphalan as part of conditioning. It usually happens within 3 weeks of conditioning. VOD is more common in older people who had liver problems prior to the transplant, and in those with acute GVHD. It starts with jaundice, dark urine, tenderness below the right ribs, and rapid weight gain (mostly abdominal bloating).

Hepatoblastoma – is very rare type of liver cancer most often is found in children.

Hepatocellular carcinoma (HCC) – make up most primary liver cancers. They begin in hepatocyte cells. Sometimes they begin as a single tumor; other times they start in multiple spots in the liver. The latter is more common in people with liver damage, such as cirrhosis.

Hepatomegaly – abnormal enlargement of the liver.

Hepatitis – a disease of the liver causing inflammation. It is accompanied by liver cell damage and death. It is caused most frequently by viral infection, but also certain drugs, chemicals, or poisons. Symptoms include an enlarged liver, fever, nausea, vomiting, jaundice, aching muscles, abdominal pain, and dark urine.

HER1 – the protein found on the surface of some cells and to which epidermal growth factor binds, causing the cells to divide. It is found in excessively high levels on the surface of many types of cancer cells. These cells may divide rapidly in the presence of epidermal growth factor.

HER2 positive – describes cancer cells that have too much of a protein called HER2 on their surface. When it is made in larger than normal amounts by cancer cells, the cells may grow more quickly and be more likely to metastasize to other parts of the body. Cancers that are HER2 positive may include breast, bladder, pancreatic, ovarian, and stomach cancers.

HER2/neu – a protein involved in normal cell growth that may be found on some types of cancer cells. Cancer cells removed from the body may be tested for the presence of HER2/neu to help decide the best treatment plan.

Herceptin – a type of monoclonal antibody used to treat breast cancer that is HER2positive. Herceptin binds to HER2 on the surface of HER2-positive cancer cells and may kill them.

Hereditary – genetically transmitted from parent to offspring.
Hernia – the protrusion of an organ or the fascia of an organ through the wall of the cavity that holds it in place. Most hernias occur in the abdomen.

High blood pressure (hypertension) – a blood pressure of 140/90 or higher. Uncontrolled high blood pressure can harm the arteries and cause an increased risk of stroke, heart attack, kidney failure, and blindness.

High blood sugar (hyperglycemia) – higher than normal amount of glucose in the blood. High blood sugar can be a sign of diabetes or other conditions.

High grade (poorly differentiated) – a term used to describe cells that look abnormal under a microscope. These cells are typically fast-growing, have the tendency to metastasize, and are extremely aggressive.

High-dose chemotherapy – involves the administration of extremely high, potentially toxic doses of chemotherapy, to eradicate cancer cells. It is usually followed by bone marrow or stem cell transplantation to rebuild the bone marrow.

High-dose radiation – an amount of radiation that is greater than that given in typical radiation therapy. High-dose radiation is directed precisely at the tumor to avoid damaging the healthy surrounding tissue.

Hirsutism – results in excessive amounts of dark, course hair growth on women where men typically grow hair - face, chest and back.

Hodgkin lymphoma (Hodgkin disease) – a cancer originating from the white blood cells that is marked by the presence of a type of cell called the Reed-Sternberg cell. Hodgkin's lymphoma is characterized by the orderly spread of disease from one lymph node group to another.

Homeopathic medicine (Homeopathy) – an alternative medical system that was developed 200 years ago in Germany. Homeopathy is based on the idea that "like cures like." That is, if a substance causes a symptom in a healthy person, giving the person a very small amount of the same substance may cure the illness. In theory, a homeopathic dose enhances the body's normal healing and self-regulatory processes.

Homeostasis – is derived from the Greek, homeo or "same", and stasis or "stable" and means remaining stable or remaining the same. It is a state of balance among all the body systems needed for the body to survive and function correctly.

Horizontal (Transverse) Plane – this plane bisects the body into top and bottom halves. Joint motion in this plane occurs around a longitudinal or vertical axis and includes internal and external rotation of the limbs, right and left rotation for the head and trunk, and radioulnar pronation and supination. When referring to transverse plane motions of the foot, we use the terms abduction and adduction.

Hormonal therapy – treatment that adds, blocks, or removes hormones. For certain conditions (such as diabetes, thyroid disease, or menopause), hormones are given to adjust low hormone levels. To slow or stop the growth of certain cancers (such as prostate and breast cancer), synthetic hormones or other drugs may be given to block or destroy the body's natural hormones.

Hormone – a chemical released by a cell or gland in one part of the body that sends out messages that affect other cells in the body.
Hormone receptor – a molecule that can bind to a specific hormone.
Hormone receptor test – a test that will show whether or not an amount of certain proteins (hormone receptors) will fuel the growth of the tumor.

Hormone replacement therapy – hormones (estrogen, progesterone, or both) given to women after menopause to replace the hormones no longer produced by the ovaries.

HPV (human papillomavirus) – is the most common sexually transmitted virus in the U.S. There are more than 40 HPV types that can infect the genital areas of males and females. These HPV types can also infect the mouth and throat. It can cause abnormal tissue growth (warts) and other changes to cells. Infection for a long time with certain types of HPV can cause cervical cancer. HPV may also play a role in some other types of cancer, such as anal, vaginal, vulvar, penile, oropharyngeal, and squamous cell skin cancers.

Human microbiome – includes bacteria, archaea, fungi, protists and viruses. Though micro-animals can also live on the human body, they are typically excluded from this definition. The human microbiome refers specifically to the collective genomes of resident microorganisms.

Hydrocephalus – a serious condition that can result from the tumor impeding the normal flow of cerebrospinal fluid, causing it to build up and the brain to swell.

Hydrocortisone – a steroid hormone used to relieve the symptoms of certain hormone shortages and to suppress an immune response.

Hydronephrosis - is a condition that typically occurs when a kidney swells due to urine failing to properly drain from the kidney to the bladder. This swelling most commonly affects only one kidney, but it can involve both kidneys.

Hypercalcemia – higher than normal levels of calcium in the blood.

Hyperfractionated radiation therapy – radiation treatment in which the total dose of radiation is divided into small doses and treatments are given more than once a day.

Hyperphagia - is a medical term meaning excessive hunger and abnormally large intake of solids by mouth.

Hyperplasia – an abnormal increase in the number of normal cells in an organ or tissue.

Hypersensitivity – an exaggerated response by the immune system to a drug or other substance.

Hypertension (high blood pressure) – a blood pressure of 140/90 or higher.

Hyperthermia – abnormally high body temperature. This may be caused as part of treatment, by an infection, or by exposure to heat.
Hyperthyroidism - too little thyroid hormone. Symptoms include weight loss, palpitations, tachycardia, heat intolerance, muscular weakness, and hyperphagia.

Hyperthyroidism – too much thyroid hormone. It may cause weight loss, chest pain, rapid heart rate, irregular heartbeat, cramps, diarrhea, a feeling of being hot, sweats, and bone loss or osteoporosis.

Hypertrophic cardiomyopathy (HCM) – is a condition in which the heart muscle becomes thick. Often, only one part of the heart is thicker than the other parts. The thickening can make it harder for blood to leave the heart, forcing the heart to work harder to pump blood.

Hypertrophy – enhancement of skeletal muscle fibers in response to overcoming force from high volumes of tension.

Hyperuricemia – is when you have too much uric acid in your blood. This condition can lead to health problems such as gout and kidney stones.

Hypoglycemia – abnormally low blood sugar.

Hypomobility – restricted motion.

Hypopharyngeal cancer – cancer that forms in tissues of the hypopharynx (the bottom part of the throat).

Hypopharynx – the bottom part of the throat.

Hypophosphatemic rickets – is a disorder characterized by hypophosphatemia, defective intestinal absorption of calcium, and rickets or osteomalacia unresponsive to vitamin D. It is usually hereditary. Symptoms are bone pain, fractures, and growth abnormalities.

Hypothalamus – is the part of the brain that regulates temperature, hunger, and thirst.

Hypothyroidism – too little thyroid hormone. Symptoms include weight gain, constipation, dry skin, and sensitivity to the cold.

Hysterectomy – surgery to remove the uterus and, sometimes, the cervix. When the uterus and the cervix are removed, it is called a total hysterectomy. When only the uterus is removed, it is called a partial hysterectomy.

Ibuprofen – is a nonsteroidal anti-inflammatory drug (NSAID) used for relief of symptoms of arthritis, fever, as pain reliever, especially where there is an inflammatory component, and dysmenorrhea.

Ileostomy – is a surgical opening constructed by bringing the end or loop of small intestine (the ileum) out onto the surface of the skin. Intestinal waste passes out of the ileostomy and is collected in an external pouch.

Ilizarov apparatus – is a type of external fixation used in orthopedic surgery to lengthen or reshape limb bones; as a limb-sparing technique to treat complex and/or open bone fractures; and in cases of infected non-unions of bones that are not amenable with other techniques.

Image guided ablation – small needles are passed through the skin and x-rays are used to guide them into the cancer. These needles can then freeze (cryoablation) or boil (radiofrequency ablation) the cancer, eliminating the tumor. The body is then able to remove the dead tissue, leaving scar tissue behind in its place.

Image-guided radiation therapy – a procedure that uses a computer to create an image of the tumor to help guide the radiation beam during radiation therapy. The images are made using CT, ultrasound, X-ray, or other imaging techniques. Compared to external beam radiation therapy, it is more accurate and causes less damage to the surrounding healthy tissue.

Imagery (guided imagery) – a form of meditation in which a person focuses on positive images in their mind. It can help them relax, reduce stress, and provide a sense of wellbeing.

Immune checkpoint inhibitors - newer drugs, such as pembrolizumab (Keytruda) and nivolumab (Opdivo), that work by blocking checkpoints, which can boost the immune response against cancer cells.

Immune function – the state in which the body recognizes foreign materials and can neutralize them before they can do any harm.

Immune response – a response of the immune system to a foreign substance, including antibody production, cell-mediated immunity, and immunological tolerance.

Immune system – the complex system of cellular and molecular components that defend the body against infections and other diseases.

Immunity – the condition of being immune; protected against an infectious disease.

Immunization – a technique used to cause an immune response resulting in resistance to a specific disease.

Immunocompromised – having a weakened immune system caused by certain diseases or treatments.

Immunodeficiency – the body's ability to fight infections and other diseases is impaired.

Immunodeficiency syndrome – a syndrome associated with the body's inability to produce an immune response and an increased susceptibility to infection.

Immunosuppression – suppression of the body's immune response with drugs administered in preparation for bone marrow or other organ transplantation, to prevent rejection of the donor tissue. It may also result from AIDS, lymphoma, or from anticancer drugs.

Immunotherapy (biologic therapy) – a form of treatment that uses biologic agents to enhance or stimulate normal immune function. They may also be used to lessen certain side effects caused by some cancer treatments. Agents used in immunotherapy include monoclonal antibodies, growth factors, and vaccines.

Impairment – an abnormality or loss of a physical or mental ability because of injury or disease.

Implant – material inserted or grafted into an organ or structure of the body.

Impotence (erectile dysfunction) – the inability to achieve or maintain an erection of the penis adequate for sexual intercourse.

IMRT – a format for delivering high-dose radiation therapy using computer-generated images to show the exact location, shape, and size of the tumor, minimizing damage to surrounding healthy tissue.

Incisional biopsy – removal and examination of a lump or suspicious area. The tissue is then examined under a microscope to look for signs of disease and establish a precise prognosis.

Incontinence – inability to control excretory functions.

Indolent cancer – one that grows extremely slowly; sometimes taking 2-4 years to double in size.

Induction therapy (first-line therapy) – the first therapeutic measure used to treat a disease. It may be followed by other treatments, such as chemotherapy, radiation therapy, and hormone therapy to eradicate any remaining signs of the disease.

Infection – invasion and multiplication of microorganisms in the body. They can occur in any part of the body and can spread throughout the body. These bacteria, viruses, yeast, or fungi can cause a fever and other problems, depending on where the infection occurs. Under normal circumstances, the body's natural defense system is strong and can often fight the germs that lead to infection. Some cancer treatments cause immunocompromization, thereby weakening the body's natural defense system.

Inferior – the opposite of superior. A position below a specific reference point.

Inferior vena cava – the largest vein in the body. It returns deoxygenated blood to the heart from parts of the body below the diaphragm.

Infertility – the inability to produce children.

Infiltrating (invasive) breast cancer – cancer that has spread from its point of origin in the breast into the surrounding, healthy tissue. Infiltrating breast cancer can spread to other parts of the body through the blood and lymphatic systems.

Infiltrating (invasive) cancer – cancer that has spread beyond its point of origin and is growing into the surrounding, healthy tissues.

Infiltrating ductal carcinoma – the most common type of invasive breast cancer. It starts in the cells that line the milk ducts in the breast, grows outside the ducts, and often spreads to the lymph nodes.

Inflammation – a protective tissue response to injury or destruction of tissues, which serves to destroy, dilute, or wall off both the injurious agent and the injured tissues. The classical signs of acute inflammation are pain, heat, redness, swelling, and loss of function.

Inflammatory breast cancer – is very rare and materializes in the lymph vessels in the skin of the breast. It resembles an infection; the skin becomes thick, raised, and red. Instead of a single lump, it usually involved the entire breast. It is a very fast-growing disease and usually more prone to metastasis.

Infusion – the introduction of a substance, including drugs, into a vein.

Ingestion – the taking of food, drugs, etc., into the body by mouth.

Inguinal orchiectomy – an operation in which the testicle is removed through an incision in the groin.

Inherited gene mutation – is one that is transmitted through genes that have been passed from parents to their offspring.

Inlyta® (Axitinib) – also inhibits several tyrosine kinases, including some that are involved in the formation of new blood vessels. It is taken as a pill twice a day.

Insertion – the part of a muscle that is attached to the part to be moved.

Insulin – a hormone made by the islet cells of the pancreas. It is the major fuel-regulating hormone that is secreted into the blood in response to a rise in concentration of blood glucose or amino acids. Insulin promotes the storage of glucose and the uptake of amino acids, increases protein and lipid synthesis, and inhibits lipolysis and gluconeogenesis.

Intensity – the level of demand that a given activity requires.

Intensity-modulated radiation therapy – is a type of 3-D radiation therapy that targets tumors with greater precision than conventional radiation therapy. Using highly sophisticated computer software and 3-D images from CT scans, the radiation oncologist can develop an individualized treatment plan that delivers high doses of radiation to cancerous tissue while sparing surrounding organs and reducing the risk of injury to healthy tissues.

Intercalary allograft reconstruction – a reconstructive procedure to replace a limb, in which transplants of bone, tendon, ligaments, and connective tissue are used. Often a cast or brace must be worn for six to twelve months until the allograft is healed to the host bone.

Internally rotated – the opposite of externally rotated. Pointing inward/toward the midline of the body.

Interstitial chemotherapy – after a craniotomy is done to remove as much of the tumor as possible, dissolvable wafers containing chemotherapy drugs are implanted directly on or next to the part of the tumor that could not be removed by surgery. Over the course of several weeks, it slowly delivers one thousand times the normal dose of anti-cancer drugs to the affected area of the brain.

Interstitial fluid – fluid found in the spaces around cells. It comes from substances that leak out of blood capillaries and helps bring oxygen and nutrients to cells well as remove waste products from them. As new interstitial fluid is produces, it replaces the older fluid. It then drains towards the lymph vessels and becomes lymph.

Interstitial Pneumonitis – often categorized as both an interstitial lung disease and a form of acute respiratory distress syndrome (ARDS) but it is distinguished from the chronic forms of interstitial pneumonia such as idiopathic pulmonary fibrosis.

Intervention – any measure whose purpose is to improve health or alter the course of disease.

Intestine – also called the bowels and divided into large and small intestine, they extend from the stomach to the anus, where waste products exit the body.

Intraepithelial – within the layer of cells that form the surface or lining of an organ.

Intraoperative radiation – is external beam radiation given during an operation.

Intrathecal chemotherapy – treatment in which anticancer drugs are injected into the cerebrospinal, bypassing the blood-brain barrier, where traditional chemotherapy can't reach.

Intravenous (IV) – within or administered into a vein. It usually refers to a way of giving a drug or fluids through a needle or tube inserted into a vein.

Intravesical therapy – one or more drugs (immunotherapy or chemotherapy may be used) are instilled directly into the bladder through a catheter tube rather than being given by mouth or into a vein. The tube is clamped for a period of time so that the drug remains in contact with the bladder lining.

Invasive (infiltrating) cancer – cancer that has spread beyond its point of origin and is growing into surrounding, healthy tissues.

Iris – the pigmented cells surrounding the pupil.

Irradiation (radiation therapy) – the use of high-energy radiation to kill cancer cells and shrink tumors. It may come from a machine outside the body, or it may come from radioactive material placed in the body near cancer cells.

Ischemia – is a restriction in blood supply to tissues, causing a shortage of oxygen and glucose needed to keep tissue alive. Ischemia is generally caused by problems with blood vessels, with resultant damage to or dysfunction of tissue.

Islet cell (islet of Langerhans cell) – a pancreatic cell that produces insulin and glucagon which are secreted into the bloodstream. These hormones help control blood sugar levels.

Islet cell carcinoma – a rare cancer that forms in the islet cells in the pancreas.

Isolated limb perfusion – procedure that sends chemotherapy directly to an arm or leg in which the cancer has formed. Blood flow is restricted and anticancer drugs are injected directly into the blood of the limb, sending a higher dose of drugs to the tumor.

Isolation – state of being isolated or separated from others. Isolation is sometimes used to stop the spread of disease.

Isometric – when a muscle exerts force equal to the amount being placed on it.

Isthmus – a narrow part inside the body that connects two larger structures.

Isthmusectomy – surgical removal of the isthmus, the part that connects the two wing-shaped lobes.

Jaundice – yellowish pigmentation of the skin and whites of the eyes. Jaundice is often seen in liver disease such as hepatitis or liver cancer. It may also indicate an obstruction of the biliary tract, for example by gallstones or pancreatic cancer.

Jejunostomy – the creation of a permanent opening between the jejunum and the surface of the abdominal wall. It allows a feeding tube to be put into the small intestine.

Jevtana® (Cabazitaxel) – a recently approved chemotherapy drug for the treatment of metastatic prostate cancers that have progressed in clients taking docetaxel. Cabazitaxel inhibits the growth of cancer cells.

Joint – the place where two or more bones are connected.

Kaposi's sarcoma (KS) – is cancer that is found in the tissues under the skin or mucous membranes. It causes red-brown or purple patches on the skin, most often on the legs. It spreads to other organs in the body such as the lungs, liver, or intestinal tract. In the 1980's many cases were discovered in people with AIDS. In these cases, lesions may be found in the mouth, nose, lymph nodes, GI tract, lungs, liver, and spleen. KS usually spreads more quickly in clients with AIDS. It may produce significant deterioration in the affected organ. About 30% of AIDS clients develop KS.

Keratitus – is an inflammation of the cornea (the clear, dome-shaped tissue on the front of the eye) that covers the pupil and iris.

Ketones – build up when the body needs to break down fats and fatty acids to use as fuel. This is most likely to occur when the body does not get enough sugar or carbohydrates. Ketones are also made by the body when there is not enough insulin.

Kidney – one of a pair of organs in the abdomen. The kidneys are essential in the urinary system and serve homeostatic functions such as the regulation of electrolytes, maintenance of acid–base balance, and regulation of blood pressure. They serve the body as a natural filter of the blood and remove wastes which are diverted to the urinary bladder. In producing urine, the kidneys excrete wastes such as urea and ammonium, and they are also responsible for the reabsorption of water, glucose, and amino acids.

Kidney cancer – cancer that forms in tissues of the kidneys.

Kidney (renal) failure – a medical condition in which the kidneys fail to adequately remove waste and toxins from the blood or keep body chemicals in balance. Acute kidney failure usually occurs when the blood supply to the kidneys is suddenly interrupted or when the kidneys become overloaded with toxins. Causes of acute failure include accidents, injuries, or complications from surgeries in which the kidneys are deprived of normal blood flow for extended periods of time. Heart-bypass surgery is an example of one such procedure. Chronic kidney failure has numerous causes. The most common is diabetes mellitus. The second most common is long-standing, uncontrolled hypertension, or high blood pressure. Polycystic kidney disease is another well-known cause of chronic kidney disease. Most people afflicted with polycystic kidney disease have a family history of the disease. Overuse of common drugs such as aspirin, ibuprofen, and acetaminophen can also cause chronic kidney damage. A person in end-stage-renal-disease (ESRD) needs or a kidney transplant.

Kinetic chain – the interrelation of the nervous, muscular, and skeletal systems.

KRAS – a genetic mutation that is regularly tested for, and is found to be mutated, in about 25% of clients with non-small cell lung cancer.

Kyphoplasty – is a procedure to inject special cement into a damaged vertebra to stop pain caused by a spinal fracture and stabilize the bone.

Kyphosis – exaggerated outward curvature of the thoracic region of the spine.

Lacriminal duct – tear duct.

Lactic acid – is mainly produced in muscle cells and red blood cells.
It forms when the body breaks down carbohydrates to use for energy during times of low oxygen levels. Your body's oxygen level might drop during intense exercise or if you have an infection or disease.

Lateral – the opposite of medial. Referring to a position that is relatively further away from the midline of the body, toward the outside of the body.

Lateral flexion – the bending of any aspect of the spine from side to side.

Laparoscopic (minimally invasive) surgery – is a modern surgical technique in which operations in the abdomen are performed through small incisions as opposed to the larger, open surgery incisions. Laparoscopic surgery includes operations within the abdominal or pelvic cavities. There are several advantages to the patient with laparoscopic surgery versus an open procedure. These include reduced pain and shorter recovery time.

Laparotomy – a surgical incision made in the wall of the abdomen.

Large intestine – is the portion of the digestive system most responsible for the absorption of water from the indigestible residue of food. The small intestine passes material into the large intestine at the cecum. Material passes through the ascending, transverse, descending and sigmoid portions of the colon, and finally into the rectum. From the rectum, the waste is expelled from the body.

Laryngeal cancer – cancer that forms in tissues of the larynx.

Laryngectomee – a person whose larynx (voice box) has been removed.

Laryngectomy – an operation to remove all or part of the larynx (voice box).

Laryngitis – inflammation of the larynx.

Laryngoscope – a tubular endoscope that is inserted into the larynx through the mouth and used for observing the interior of the larynx.

Laryngoscopy – is a medical procedure that is used to obtain a view of the vocal folds and the glottis.

Larynx – the part of the respiratory tract between the pharynx and the trachea, having walls of cartilage and muscle and containing the vocal cords enveloped in folds of mucous membrane.

Laser – a device that is used to help diagnose and treat disease by making virtually bloodless cuts with narrow beams of intense light that may be used to cut or destroy tissue.

Layer syndrome – is the combination of LCS and UCS where clients display impairment with motor skills and have a poorer prognosis because of the longer duration of their impairment. You are more likely to see this in the elderly.

LEEP (loop electrosurgical procedure) – a technique that uses a thin, low-voltage electrified wire loop to cut out abnormal tissue.

Left main coronary artery stenosis – the left main coronary artery (an artery that arises from the aorta above the left cusp of the aortic valve and feeds blood to the left side of the heart) becomes tapered and backed up with fat or cholesterol.

Left ventricular non-compaction – occurs when the lower left chamber of the heart, which helps the heart pump blood, does not develop correctly. Instead of the muscle being smooth and firm, the cardiac muscle in the left ventricle is thick and appears spongy. The abnormal cardiac muscle is weak and has an impaired ability to pump blood because it either cannot completely contract or it cannot completely relax.

Leiomyosarcoma – develops in the smooth muscles of the uterus and back part of abdominal cavity. It is very rare.

Leptomeningeal metastasis – when cancer spreads to the tissues that cover the brain and spinal cord.

Lesion – an abnormality in the tissue that is usually caused by disease or trauma.

Lethargy – the quality or state of being drowsy and dull, listless, unenergetic, or listless and lazy. It can be caused by many things, including illness, injury, or drugs.

Leukapheresis – is a procedure in which white blood cells are separated from a sample of blood. It is a specific type of apheresis - the more general term for separating out one constituent of blood and returning the remainder to the circulation.

Leukemia – progressive malignant disease that starts in blood-forming tissue such as the bone marrow and causing proliferation of blood cells that enter the bloodstream.

Leukocyte (white blood cell) – a type of immune cell made in the bone marrow and found in the blood and lymphatic tissue. Leukocytes help the body fight infections and other diseases.

Leukoencephalopathy – is all the brain white matter diseases, whether their molecular cause is known or not.

Leukopenia – a condition in which there is a lower-than-normal number of white blood cells in the blood.

Leukoplakia – white patches in the mouth that won't rub off.

Leydig cell tumors – these are usually benign tumors that develop from the Leydig cells in the testicle. Leydig cell tumors develop in adults about 75% of the time and in children about 25%. They often produce androgens but sometimes produce estrogens. Most Leydig cell tumors are contained within the testicle and are cured with surgery.

Libido – sexual desire.

Ligament – the primary connective tissue that connects bone-to-bone to provide stability and limit joint range of motion.

Limb-sparing surgery – administering high-dose radiation as the first step of treatment may shrink an otherwise inoperable soft-tissue sarcoma to a resectable size. The tumor is removed along with a margin of healthy tissue. The removed segment is replaced with a bone graft or metal prosthetic bone. The margin of tissue that has been removed is then replaced with healthy tissue taken from another part of the body. Additional irradiation is given postoperatively.

Lipolysis – the splitting up or decomposition of body fat.

Liposarcoma (includes dedifferentiated, myxoid, and pleomorphic liposarcomas) – are malignant tumors of fat tissue. They can develop anywhere in the body, but they most often develop in the thigh, behind the knee, and inside the back of the abdomen. They occur mostly in adults between 50 and 65 years old.

Liver – a large dark-red gland located in the upper abdomen on the right side, just beneath the diaphragm. The liver stores and filters blood, secretes bile, and converts sugars into glycogen.

Liver cancer – primary liver cancer is cancer that forms in the tissues of the liver. Secondary liver cancer is cancer that metastasizes to the liver from another part of the body.

Load – the amount of weight recommended for an exercise set.

Lobe – a portion of an organ, such as the liver, lung, breast, thyroid, or brain.

Lobectomy – surgery to remove a whole lobe or section of an organ. A bilobectomy is the removal of two of the lobes.

Lobular carcinoma – cancer that begins in the lobules of the breast. Lobular carcinoma in situ (LCIS) isn't really cancer but suggests a high probability of getting it and probably in both breasts. When cancer has spread from the lobules to surrounding tissues, it is invasive lobular carcinoma.

Lobule – a small lobe or a subdivision of a lobe.

Local anesthesia – the injection or application of anesthetic drugs to induce a temporary loss of feeling in one small area of the body. The patient remains awake but has no feeling around the body treated with the anesthetic for an hour or so.

Local cancer – an invasive cancer contained in the organ where the cancer began.

Local therapy – treatment that affects the cancerous cells in the tumor and the area surrounding it.

Local transanal resection (transanal excision) – is done with instruments inserted through the anus, without making an opening in the skin of the abdomen. This operation cuts through all layers of the rectum to remove cancer as well as some surrounding normal rectal tissue, and then closes the hole in the rectal wall. This procedure can be used to remove some T1 N0 M0 stage I rectal cancers that are relatively small and not too far from the anus.

Localization – the process of restricting the site of a lesion or disease to a limited area.

Lordosis – "arching" of the low back.

Low anterior resection – some stage I rectal cancers and most stage II or III cancers in the upper third of the rectum (close to where it connects with the colon) can be removed by low anterior resection. The part of the rectum containing the tumor is removed without affecting the anus. The colon is then attached to the remaining part of the rectum so that after the surgery bowels may be moved in the usual way. The surgeon makes an incision in the abdomen. Then the surgeon removes the cancer and a margin of normal tissue on either side of the cancer, along with nearby lymph nodes and fatty and fibrous tissue around the rectum. The colon is then reattached to the rectum that is remaining so that a permanent colostomy is not necessary.

Lower-crossed syndrome – manifests when the tightness in the thoracolumbar extensors on the dorsal side crosses with the tightness of the iliopsoas and rectus femoris.

Lower extremity – the lower half of the body that includes the pelvic area, legs, ankles, and feet.

Lumbar spine – the portion of the spine (small of the back) that is located between the chest (thorax) and pelvis.

Lumbar puncture (spinal tap) – a procedure in which a thin needle is put into the lower part of the spinal column to collect cerebrospinal fluid or to give drugs.

Lumbo-pelvic-hip complex – the anatomical structures of the lumbar, thoracic, and cervical spine as well as the pelvic girdle and hip joint.

Lumpectomy – the cancerous breast tissue, with a rim of normal tissue around it, is removed. Whether or not a woman can undergo a lumpectomy is determined by the size of her tumor, the size of her breast, the number of sites of cancer within the breast, and whether the patient can undergo subsequent radiation treatments, among other factors. Clients who choose lumpectomy will likely be advised to have radiation therapy to the breast area after surgery.

Lung – one of a pair of saclike organs of respiration in the chest. They supply the body with oxygen and remove carbon dioxide from the body. It is common for the right lung, which is divided into three lobes, to be slightly larger than the left, which has two lobes.

Lung biopsy – the removal of a small piece of lung tissue to be checked for cancer by a pathologist. The tissue may be removed using a bronchoscope, by fine needle aspiration, by video-guided surgery, or by open surgery. In open surgery, an incision is made between the ribs and a sample of lung tissue is removed for biopsy.

Lung cancer – cancer that forms in tissues of the lung. There are two main types: small cell lung cancer and non-small cell lung cancer. They are diagnosed based on the cells' appearance under a microscope.

Luteinizing hormone – is a hormone produced by gonadotroph cells in the anterior pituitary gland. In females, it triggers the release of eggs (ovulation) and the development of the corpus luteum. In males, it stimulates the production of testosterone.

Luteinizing hormone-releasing hormone – a hormone that acts on the pituitary to stimulate the production of luteinizing hormone; which then stimulates the production of sex hormones in men and women.

Lymph – is the fluid that circulates throughout the lymphatic system. It is formed when the interstitial fluid (the fluid which lies in the interstices of all body tissues) is collected through lymph capillaries. As the blood and the surrounding cells add and remove substances from the interstitial fluid, its composition changes constantly and it eventually changes into lymph fluid. It is then transported through lymph vessels to lymph nodes before emptying ultimately into the right or the left subclavian vein, where it mixes back with blood.

Lymphangiosarcoma – usually develops in the lymph vessels of the arms.

Lymph node (gland) – an oval-shaped organ of the immune system that is surrounded by a capsule of connective tissue. Lymph nodes act as filters or traps for foreign particles and are important in the proper functioning of the immune system. Lymph nodes also have clinical significance. They become inflamed or enlarged in various conditions, which may range from trivial, such as a throat infection, to life-threatening such as cancers. In the latter, the condition of lymph nodes is so significant that it is used for cancer staging, which decides the treatment to be employed, and for determining the prognosis.

Lymph node dissection (lymphadenectomy) – a surgical procedure in which the lymph nodes are removed, and a sample of tissue is checked under a microscope for signs of cancer. In a sentinel node biopsy, a single lymph node is removed. In a regional lymph node dissection, some of the lymph nodes in the tumor area are removed. In a radical node dissection, most or all the lymph nodes in the tumor area are removed. Removing one or many lymph nodes puts the patient at risk for lymphedema in that area of the body. The risk increases as a greater number of lymph nodes are removed and/or if radiation is part of their treatment.

Lymph node drainage – the flow of lymphatic fluid from an area of tissue into a specific lymph node.

Lymph node mapping (sentinel lymph node mapping) – is a procedure that uses dyes and radioactive substances to identify the first node or nodes that receive lymphatic fluid from a cancerous tumor.

Lymph vessel – are thin walled, valved structures, that carry lymphatic fluid and white blood cells through the lymphatic system.

Lymphatic elephantiasis – stage three lymphedema. At this stage it is irreversible. The limb is usually hard and fibrotic. It almost always occurs in the legs, or in long-term, untreated lymphedema.

Lymphatic system – is a network of organs, lymph nodes, lymph ducts, and lymph vessels that produce and transport lymph from tissues to the bloodstream. The lymph system is a major component of the body's immune system. It includes the bone marrow, spleen, thymus, lymph nodes, and lymphatic vessels.

Lymphedema – a painful and disfiguring condition that can be caused by the removal of, or damage to the lymphatic system, in which extra lymph fluid builds up in tissues and causes potentially irreversible swelling.

Lymphoblast – an immature cell which typically will differentiate to form a mature lymphocyte. Normally lymphoblasts are found in the bone marrow, but in acute lymphoblastic leukemia (ALL), lymphoblasts proliferate uncontrollably and are found in large numbers in the peripheral blood.

Lymphoblastic – referring to lymphoblasts.

Lymphoblastic lymphoma – is a rare and very fast-growing type of non-Hodgkin lymphoma, a result of abnormal adaptive immune cells, typically T-cells, which are found in the lymph nodes and thymus gland.

Lymphocyte – a type of white blood cell (they make up 20-40% of all white blood cells) that is made in the bone marrow and is found in the blood and in lymph tissue. Lymphocytes can be divided into large lymphocytes and small lymphocytes. Large granular lymphocytes include natural killer cells (NK cells). Small lymphocytes consist of B lymphocytes and T lymphocytes. B lymphocytes make antibodies, and T lymphocytes help kill tumor cells and help control immune responses.

Lymphoma – is a cancer of the lymphocytes, cells that form part of the immune system. There are two types of lymphoma: Hodgkin lymphoma (HL, also called Hodgkin's disease) and non-Hodgkin lymphoma (NHL). Both HL and NHL can occur in the same places and have similar symptoms. There are five subtypes of HL. NHL may derive from either abnormal B or T cells and has 30 subtypes that are distinguished by unique genetic markers. While lymphomas are often confined to lymph nodes and other lymphatic tissue, they can spread to other types of tissue almost anywhere in the body. Lymphoma development outside of lymphatic tissue is called extra-nodal disease.

Lymphoma vaccines – vaccines that are designed to help treat, not prevent, lymphomas. The goal is to create an immune reaction against lymphoma cells in patients who have very early disease or in patients whose disease is in remission. So far, they seem to have very limited side effects, but are only available in clinical trials.

Lymphovascular or perineural invasion – sometimes tumor cells can invade the blood vessels, or the lymph or nerve channels within breast tissue.

Lytic lesion – destruction of an area of bone due to a disease such as cancer. Lytic lesions appear as gaping black holes in x-rays and are common in multiple myeloma.

MTCP-1 – is a tumor suppressor gene that may be involved in leukemogenesis.

Macrophages – can locate and 'eat' particles, such as bacteria, viruses, fungi, and parasites. Macrophages are born from white blood cells called monocytes, which are produced by stem cells in our bone marrow.

Maculopathy – is any pathological condition of the macula, an area at the center of the retina that is associated with highly sensitive, accurate vision.

Male breast cancer – cancer that forms in tissues of the breast in men. It is very rare and usually affects older men. Because men typically do not perform self-examinations, by the time the cancer is found, it may be at a more advanced stage.

Malignancy (cancer) – a term for cancerous cells that can spread to other parts of the body through the blood and lymphatic systems.

Malignant – cancerous.

Malignant giant cell tumor – begins in connective tissue of bone marrow. It may weaken the knees or vertebra and cause bone fractures. Malignant giant cell tumors typically affect ages 40-55.
Malignant mesenchymoma – is a rare type of sarcoma that shows features of fibrosarcoma and features of at least 2 other types of sarcoma.

Malignant peripheral nerve sheath tumors (includes neurofibrosarcomas, neurogenic sarcomas, and malignant schwannomas) – include neurofibrosarcomas, malignant schwannomas, and neurogenic sarcomas. These are sarcomas that develop from the cells that surround a nerve.
Malocclusion - imperfect positioning of the teeth when the jaws are closed.

Malnutrition – a condition that occurs when your body is not getting enough key nutrients, such as vitamins and minerals that are needed for optimum health. Malnutrition may occur when there is a lack of nutrients in the diet or when the body cannot absorb nutrients from food. Cancer and cancer treatment may cause malnutrition. If untreated, malnutrition can lead to mental or physical disability, illness, and possibly death.

Mammary gland – milk-producing glandular organs in females that are in the chest.

Mammogram – a low energy x-ray of the breast used as a screening and diagnostic tool for abnormalities of the breast.

Mammography – the process of performing a mammogram.

Mandibulectomy – removes all or part of the jawbone (mandible).
Mantle field – mantle-shaped radiotherapy field that covers the neck, mid-chest, and lymph nodes in the armpit.

Margin – the edge or border of the tissue removed in cancer surgery. When no cancer cells are found at the edge of the tissue, it is called a "clean," or "clear" margin; and suggests that all the cancer has been removed.

Marginal mandibulectomy – a piece of jawbone is removed, but the bone is not cut all the way through.

Mast cells - are very similar to basophil granulocytes (a class of white blood cells) in blood. Both are granulated cells that contain histamine and heparin, an anticoagulant. Basophils leave the bone marrow already mature, whereas the mast cell circulates in an immature form, only maturing once in a tissue site.

Mastectomy – surgery to remove part, or all, of the breast. There are several different types of mastectomy procedures that differ in the amount of tissue and lymph nodes removed, as well as potentially debilitating side-effects.

Mastitis – an infection in the tissue of the breast. It is most often seen in nursing mothers.

Medial – the opposite of lateral. Refers to a position closer to the midline of the body.

Median (Sagittal) Plane – this plane bisects the body into the right and left sides. Joint motion in this plane occurs around a frontal axis and includes flexion and extension.

Mediastinoscopy – two or three incisions are made in the chest and an endoscope is placed inside to assess the lymph nodes and to take biopsies if necessary.

Medical castration – the use of drugs to suppress the function of the ovaries or testicles.

Meditation – is a practice in which an individual trains the mind and/or induces a mode of consciousness to realize some benefit and to minimize distracting or stressful thoughts or feelings. The term "meditation" can refer to the state itself, as well as to practices or techniques employed to cultivate the state. Meditation may help relax the body and mind and improve overall health and well-being. It may be used to help with symptoms related to the diagnosis and treatment of disease to help relieve stress, pain, anxiety, and depression.

Medullary breast carcinoma – a rare subtype of invasive ductal carcinoma, accounting for only 5% of all breast cancers. Medullary breast carcinoma can occur at any age, but it usually affects women in their late 40s and early 50s. Medullary carcinoma is more common in women who have a BRCA1 mutation. Medullary breast carcinoma doesn't grow quickly and usually doesn't spread outside the breast to the lymph nodes. For this reason, it's typically easier to treat than other types of breast cancer.

Medullary thyroid cancer – cancer that develops in the C cells of the thyroid and makes up 3-4% of all thyroid cancers. Tumors usually present as a mass in the neck. The C cells make a hormone (calcitonin) that helps maintain a healthy level of calcium in the blood. Approximately 25% of cases are hereditary. Family members can be screened for calcitonin elevation and/or for the RET proto-oncogene.

Medulloblastomas - develop from neuroectodermal cells (early forms of nerve cells) in the cerebellum. They are fast-growing (grade IV) tumors and often spread throughout the CSF pathways, but they can be treated by surgery, radiation therapy, and chemotherapy. Medulloblastomas occur much more often in children than in adults. They are part of a class of tumors called EMBRYONAL TUMORS that can also start in other parts of the central nervous system.

Melanocyte – melanin-producing cells located in the bottom layer of the skin's epidermis, the middle layer of the eye, the inner ear, meninges, bones, and heart.

Melanoma – the most dangerous form of skin cancer that begins in melanocytes. It is the leading cause of death for skin disease. It may begin in a mole, but can also begin in other pigmented tissues, such as in the eye or in the intestines. Often the first sign of melanoma is a change in the size, shape, color or feel of a mole.

Meningiomas – comprise about one in five brain tumors. They materialize in the meningeal membrane that covers the brain and spinal cord. Ninety-five percent of these tumors are benign. Once they are removed, they rarely recur.

Menstruation – the monthly shedding of the uterine lining (endometrium). Most menstrual cycles last from 3-5 days, begin at puberty, and last until menopause (usually 50). Menstruation occurs about every 28 days when a woman is not pregnant, however, cycles can range anywhere from 21 to 35 days in adults and from 21 to 45 days in young teens.

Metabolic – relating to metabolism (the physical and chemical changes that occur in cells to allow growth and maintain body functions).

Metabolite – any substance produced by metabolism.

Metastasis – the transmission of cancer cells from one part of the body to another by way of blood vessels or the lymphatic system.

Metastasize – to spread from one part of the body to another.

Metastatic – having to do with metastasis.

Microbiome – a complex ecosystem of thousands of different microorganisms that call our bodies home and is associated with obesity, inflammatory bowel disease, multiple sclerosis, diabetes, allergies, asthmas, autism, and cancer.

Mitosis – is a process of cell duplication, in which one cell divides into two genetically identical daughter cells.

Mitotic inhibitors (plant alkaloids) – drugs derived from natural plant sources that inhibit cell division or mitosis.

Mixed gliomas – these brain tumors contain two or more types of glial cells. The oligo cell is more promising as far as a better outcome goes because it is highly sensitive to chemotherapy. The most malignant element will determine the course of therapy.

Modality – a method of application of a therapeutic agent or regimen.

Modified radical mastectomy – is the surgical removal of the breast, the nipple, many of the axillary lymph nodes, and the lining over the chest muscle. This procedure has replaced the radical mastectomy as the most common surgery for breast cancer. The nipple and areola may be reconstructed later. The new nipple won't have any sensation, and there will most likely be significant numbness in the remaining skin of the breast.

Mohs micrographic surgery – a surgical procedure in which individual layers of tissue are removed and examined one at a time under a microscope to look for signs of cancer. This is done until all cancerous tissue has been removed.

Monoclonal antibody – protein substances which is produced in the laboratory that can bind to substances in the body, including tumor cells. They are made by identical immune cells that are all clones of a unique parent cell and bind only to cancer cell-specific antigens that induce an immunological response against the target cancer cell.

Monoclonal gammopathy of unknown significance (MGUS) – is characterized by the presence of an abnormal protein in the blood that is produced by plasma cells. MGUS can be referred to as a benign condition as there is only a small risk that MGUS can develop into myeloma or a related blood disorder.

Moyamoya disease – is a rare, progressive blood vessel (vascular) disorder in which the carotid artery in the skull becomes blocked or narrowed, reducing blood flow to your brain.

Mucositis – is a condition in which the cells that line the mouth and intestinal tract are destroyed by the high-dose chemotherapy with or without radiation therapy. Symptoms include mouth pain and ulcers, abdominal pain, diarrhea, and infection.

Multiple exostoses – (sometimes called multiple osteochondromas) syndrome is an inherited condition that causes many bumps on a person's bones. These bumps are made mostly of cartilage. They can be painful and deform and/or fracture bones. This disorder is caused by a mutation in any one of the 3 genes EXT1, EXT2, or EXT3. Patients with this condition have an increased risk of chondrosarcoma. An enchondroma is a benign cartilage tumor that grows into the bone. People who get many of these tumors have a condition called multiple enchondromatosis. They have an increased risk of developing chondrosarcomas.

Multiple myeloma – cancer of the plasma cells (white blood cells that produce antibodies).

Muscle balance – the establishment of normal length-tension relationships that help to ensure proper length and strength of each muscle around a joint.

Muscle imbalance – the opposite of muscle balance. The alteration of muscle length surrounding a joint.

Muscle wasting – the wasting or loss of muscle tissue caused by disease or lack of use.

Musculoskeletal – having to do with muscles, nerves, tendons, ligaments, bones, joints, and cartilage.

Myeloablative chemotherapy – high-dose chemotherapy that kills cells in the bone marrow, including cancer cells. It lowers the number of normal blood-forming cells in the bone marrow and can cause severe side effects. Myeloablative chemotherapy is usually followed by a bone marrow or stem cell transplant to rebuild the bone marrow.

Myelodysplastic syndrome – a group of diverse bone marrow disorders in which the bone marrow does not produce enough healthy blood cells. MDS is often referred to as a "bone marrow failure disorder".

Myeloproliferative neoplasms – are blood cancers that occur when the body makes too many white or red blood cells, or platelets. This overproduction of blood cells in the bone marrow can create problems for blood flow and lead to various symptoms.

Myocarditis – inflammation of the heart muscle.
Myxofibrosarcoma, low-grade – are most often found in the arms and legs of elderly patients. They are most common in or just under the skin and there might be more than one tumor nodule.

Narcotic – a drug (such as opium or morphine) that in moderate doses dulls the senses, relieves pain, and induces profound sleep but in excessive doses causes stupor, coma, or convulsions.

Nasal – having to do with the nose.

Nasopharyngeal cancer – is the most common cancer originating in the nasopharynx, the uppermost region of the pharynx (throat), behind the nose where the nasal passages and auditory tubes join the remainder of the upper respiratory tract.

Nasopharynx – the uppermost region of the pharynx (throat), behind the nose where the nasal passages and auditory tubes join the remainder of the upper respiratory tract.

Natural killer (NK) cells – are a type of lymphocyte that control several types of tumors and microbial infections by limiting their spread and subsequent tissue damage.

Near-total thyroidectomy – surgery to remove the lobe containing the tumor, the isthmus, and most of the opposite lobe. This procedure is also known as a subtotal thyroidectomy.

Neck dissection (cervical neck dissection) – surgery to remove lymph nodes and other tissues in the neck.

Necrosis – tissue death.

Neobladder – a newer method of bladder reconstruction that routes the urine back into the urethra, restoring urination.

Neoplasm – an abnormal mass of tissue that results when cells divide more than they should or do not die when they should. Neoplasms may be benign (not cancer), or malignant (cancer). Also called tumor.

Nephrectomy – surgery to remove all or part of a kidney. In a partial nephrectomy, part of a kidney is removed. In a simple nephrectomy, an entire kidney is removed. In a radical nephrectomy, an entire kidney, the adrenal gland and nearby lymph nodes, and other surrounding tissue is removed. In a bilateral nephrectomy, both kidneys are removed.

Nerve – an enclosed cable-like bundle of axons in the peripheral nervous system. They convey impulses of sensation, motion, etc., between the brain or spinal cord and other parts of the body. The messages are sent by chemical and electrical changes in the cells that make up the nerves.

Nerve block – injection of an anesthetic into or around a nerve, or into the spine, to block pain.

Nerve-sparing radical prostatectomy – a modified form of a radical retropubic prostatectomy to preserve sexual potency and urinary continence.

Nerve-sparing surgery – type of surgery that attempts to save the nerves near the tissues being removed.

Nervous system – the organ system which, along with the endocrine system, correlates the adjustments and reactions of a person to their internal and external environment, comprising the central and peripheral nervous systems.

Neuroplastcity – the ability of the brain to form and reorganize synaptic connections, especially in response to learning or experience or following injury.

Neuroendoscopy – a neurosurgeon works through a small opening in the skull using a thin tube with a powerful lens and high-resolution video camera to see into the skull and brain. Advantages of this minimally invasive neurosurgical procedure include a small incision site, an enhanced ability to perform microsurgical procedures, and potentially less trauma to healthy tissue.

Neurofibromatosis type I - is a genetic disorder that causes tumors to form on nerve tissue. These tumors can develop anywhere in your nervous system, including your brain, spinal cord, and nerves. Neurofibromatosis is usually diagnosed in childhood or early adulthood.

Neurofibrosarcoma – develops in the peripheral nerves of the arms, legs, and trunk.

Neuron – the functional unit of the nervous system.

Neurogenesis – the growth and development of nervous tissue.

Neurotransmitters – chemical messengers that cross the neuromuscular junction to trigger appropriate receptor sites.

Neuropathy (peripheral neuropathy) – is damage to nerves of the peripheral nervous system, which may be caused either by diseases of or trauma to the nerve or the side effects of systemic illness. Common symptoms associated with damage to the motor nerve are muscle weakness, cramps, and spasms. Loss of balance and coordination may also occur. Damage to the sensory nerve can produce tingling, numbness, and a burning pain.

Neurotoxicity – occurs when the exposure to toxic substances (neurotoxins) cause damage to nervous tissue. Symptoms may appear immediately after exposure or be delayed. They may include limb weakness or numbness, loss of memory, vision, and/or intellect, uncontrollable obsessive and/or compulsive behaviors, delusions, headache, cognitive and behavioral problems, and sexual dysfunction. Individuals with certain disorders may be especially vulnerable to neurotoxins.

Neurotoxin – a substance that is toxic to nerve tissue.

Neurotransmitters – are the chemicals which allow the transmission of signals from one neuron to the next across synapses. They are also found at the axon endings of motor neurons, where they stimulate the muscle fibers.

Neutropenia – is an abnormally low count of neutrophils, white blood cells that help your immune system fight off infections, particularly of bacteria and fungi. You have several types of white blood cells, and between 45 and 70 percent of all white blood cells are neutrophils.

Neutrophils – are a type of white blood cell (WBC or granulocyte) that protect us from infections, among other functions. They make up approximately 40 percent to 60 percent of the white blood cells in our bodies and are the first cells to arrive on the scene when we experience a bacterial infection.

Nexavar® (Sorafenib) – has been shown to slow the progression of the cancer in some clients with advanced kidney disease. It acts by blocking both angiogenesis and growth stimulating molecules in the cancer cell. Sorafenib does this by blocking several important cellular enzymes called tyrosine kinases that are important for cell growth and survival. It is taken as a pill.

Nipple – the small raised, projection in the center of the breast through which milk can flow.

Nipple discharge – the release of fluid, other than milk, coming from the nipple.

Nipple-sparing mastectomy – in this procedure the nipple and areola are left in place while the breast tissue under them is removed. Women who have a small early-stage cancer near the outer part of the breast, with no signs of cancer in the skin or near the nipple, are better candidates for nipple-sparing surgery. Cancers that are larger or nearby may mean that cancer cells are hidden in the nipple. Some doctors give the nipple tissue a dose of radiation during or after surgery to try and reduce the risk of the cancer coming back.

Nocturia – is a condition in which you wake up during the night because you must urinate. Causes include high fluid intake, sleep disorders, and bladder obstruction. Treatment includes certain activities, such as restricting fluids.

Node-negative – cancer that is contained at its site of origin and has not spread to the lymph nodes.

Node-positive – cancer that has spread beyond its site of origin to the lymph nodes.

Nodule – a growth or lump that may be malignant (cancer) or benign (not cancer).

Non-Hodgkin lymphoma (NHL) – a type of cancer of the immune system. NHL involves white blood cells (known as lymphocytes). Under normal conditions, these cells help defend your body from disease. In people with NHL, too many abnormal white blood cells build up in the blood, bone marrow, spleen, and/or lymph nodes. There are more than 30 types of NHL. They are divided into 2 main categories: indolent NHL and aggressive NHL. These correspond to how fast the tumors are growing. Most NHL occurs in white blood cells called B-cells.

Non-seminomas – testicular cancers that usually occur in men between their late teens and early 30s. Most tumors are mixed with at least two different types, but this does not change treatment. All non-seminoma germ cell cancers are treated the same way. There are four main types of non-seminoma tumors.

Non-small cell lung cancer (NSCLC) – is the most common type of lung cancer. It usually grows and spreads more slowly than cancer. There are three common forms of NSCLC: adenocarcinomas are often found in an outer area of the lung, squamous cell carcinomas are usually found in the center of the lung next to an air tube (bronchus), large cell carcinomas can occur in any part of the lung. They tend to grow and spread faster than the other two types.

Non-invasive – cancer that has not spread outside the point of origin.

Non-malignant (benign) – not cancerous.

Non-melanoma skin cancer – there are two main types of nonmelanoma skin cancer: most nonmelanoma cancers are basal cell carcinoma. It can damage deeper tissues, such as muscles and bones, but almost never spreads to other parts of the body. Squamous cell carcinoma is less common. It often starts in skin that has been injured or diseased. It sometimes spreads to other parts of the body.

Non-metastatic – cancer that has not spread from the primary site (point of cancer origin) to other places in the body.

Non-opioid – acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDS) such as aspirin and ibuprofen.

Non-prescription – a medicine that can be bought without a prescription (over-the counter).

Noonan syndrome – is a genetic disorder that prevents normal development in various parts of the body. A person can be affected by Noonan syndrome in a wide variety of ways. These include unusual facial characteristics, short stature, heart defects, other physical problems and possible developmental delays.

Normal range – is a set of values that are used to interpret a patient's test results. It is based on the results that are seen in 95% of the healthy population. Norms may vary with gender, age, sex, and race.

Nutritional counseling – is an ongoing process in which a health professional, usually a registered dietitian, works with an individual to assess his or her usual dietary intake and identify areas where change is needed. The nutrition counselor provides information, educational materials, support, and follow-up to help the individual make and maintain the needed dietary changes.

Nutritionist (dietician) – are experts in food and nutrition. They advise people on what to eat to lead a healthy lifestyle or achieve a specific health-related goal.

Obese – is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems.

Observation – watching a patient's condition (watch and wait), but not administering treatment unless symptoms appear or change.

Obstruction – a condition of being clogged or blocked; something that obstructs.

Obstructive lung disease - is a category of respiratory disease characterized by airway obstruction.

Occlusion – the blockage or closing of a blood vessel or hollow organ.

Occlusive Cerebral vasculopathy (central nervous system vasculopathy) – inflammation of the blood vessel wall involving the brain and occasionally the spinal cord.

Ocular melanoma – is the most common primary cancer of the eye in adults.

Oligodendrogliomas – these brain tumors form in oligodendrocytes, another type of glial cell that transmits nerve impulses. These cells grow so slowly that they may not be detected for years.

Omentectomy – surgery to remove part or all the omentum.

Omentum – is a large fatty structure which hangs off the middle of the colon and drapes over the intestines inside the abdomen.

Ommaya reservoir – a device placed under the scalp and used to deliver anticancer drugs to the cerebrospinal fluid.

Oncocytoma – a type of renal cortical kidney cancer that accounts for 5-10% of kidney tumors. They have almost no risk of spreading or causing death.

Oncogene – is a gene that has the potential to cause cancer. In tumor cells, they are often mutated or expressed at high levels. Most normal cells undergo a programmed form of death (apoptosis). Activated oncogenes can cause those cells that ought to die to survive and proliferate instead.

Oncologist – a doctor who specializes in treating cancer.

Oncology – the study of cancer.

Oncology nurse – a nurse whose specialty is taking care of people with cancer.

Oncotype DX breast cancer assay – is a diagnostic test that quantifies the likelihood of disease recurrence in women with early-stage hormone estrogen receptor (ER) positive only breast cancer (prognostic significance) and assesses the likely benefit from certain types of chemotherapy (sparing those who will not benefit from chemotherapy from undergoing unnecessary treatment).

Oophorectomy – surgery to remove one or both ovaries.

Open colectomy – an operation to remove all or part of the colon through a lengthy incision in the abdomen wall. Partial and complete colectomies can also be done laparoscopically.

Open prostatectomy – an operation to remove part, or all of the prostate through a lengthy incision in the lower abdomen (retropubic) or perineum – the area between the anus and scrotum (perineal).

Operable – able to treat by surgical operation.

Opiate – a narcotic drug containing or derived from opium used to treat pain or cause sleep. Examples of opiates are codeine, heroin, and morphine.

Opioid – is a psychoactive chemical that works by binding to opioid receptors, which are found principally in the central and peripheral nervous system and the gastrointestinal tract. The receptors in these organ systems mediate both the beneficial effects and the side effects of opioids.

Optic chiasm neuropathy – damage to the the X-shaped structure formed by the crossing of the optic nerves in the brain.

Oral cancer – cancer of the mouth.

Oral cavity – the part of the mouth behind the teeth and gums that is bounded above by the hard and soft palates and below by the tongue and the mucous membrane connecting it with the inner part of the mandible.

Oral cavity cancer – cancer that forms in the oral cavity.

Orbital hypoplasia – is a congenital disorder characterized by underdevelopment of the optic nerves.

Orchiectomy (castration) – surgery to remove one or both testicles.
Origin – the more fixed, central attachment of a muscle.

Oropharyngeal cancer – is a disease which malignant cells form in the tissue of oropharynx. Oropharynx is a middle part of the throat which includes the base of the tongue, the tonsils, the soft palate, and the walls of the pharynx. Oropharyngeal cancers can be divided into two types, HPV-positive, which are related to human papillomavirus infection, and HPV-negative cancers, which are usually linked to alcohol or tobacco use.

Oropharynx – the middle part of the throat which includes the base of the tongue, the tonsils, the soft palate, and the walls of the pharynx.

Orthopnea - is shortness of breath (dyspnea) that occurs when lying flat, causing the person to have to sleep propped up in bed or sitting in a chair.

Osteoarthritis – is the most common joint disorder, which is due to aging and wear and tear on a joint.

Osteoblasts – are mononucleate cells that are responsible for bone formation.

Osteoclasts – large multinuclear cells associated with absorption and removal of bone.

Osteonecrosis – is a disease resulting from the temporary or permanent loss of blood supply to the bones. Without blood, the bone tissue dies, and ultimately the bone may collapse. It most commonly affects the ends (epiphysis) of the femur, the bone extending from the knee joint to the hip joint. Other common sites include the upper arm bone, knees, shoulders, and ankles. The disease may affect just one bone, more than one bone at the same time, or more than one bone at different times. Osteonecrosis of the jaw (ONJ) is a rare condition that has been linked to the use of bisphosphonate medications.

Osteopenia – is a condition where bone mineral density is lower than normal. It is considered by many doctors to be a precursor to osteoporosis.

Osteoporosis – is a disease of bones that leads to an increased risk of fracture. In osteoporosis, the bone mineral density (BMD) is reduced, bone microarchitecture deteriorates, and the amount and variety of proteins in bone are altered.

Osteoradionecrosis – is bone death due to radiation.

Osteosarcoma – is the most common type of bone cancer. It originates in the newly forming tissue of the bone and develops in the long bones of the arms and legs. It contains immature bone cells that destroy and replace normal tissue, weakening the bone. It is usually found in the area of the knee joint; however, it can occur in the arm or back, or less commonly, in any other bone. The main danger is that has a high tendency to spread to distant areas of the body, particularly the lungs. Osteosarcoma typically affects ages 10-25.

Ostomy – refers to the surgically created opening (stoma) in the body for the discharge of body wastes.

Otolaryngology – the practice of surgical management and treatment of patients with diseases and disorders of the ear, nose, throat (ENT), and related structures of the head and neck.

Ototoxicity – refers to drug or chemical-related damage to the inner ear, resulting in damage to the organs responsible for hearing and balance. Such damage can lead to temporary or permanent hearing loss, and/or loss of balance.

Ovarian – having to do with the ovaries (a pair of female reproductive glands in which eggs are formed).

Ovarian ablation (suppression) – has been used for more than a century in the treatment of breast cancer. Methods of irreversible ovarian ablation include surgical oophorectomy and ovarian irradiation.

Ovarian cancer – cancer that forms in the ovaries.

PARP (poly-ADP-ribose polymerase) Inhibitors – a new class of drugs currently being studied for ovarian cancer. PARP enzymes inside a cell typically repair damage to the cell's DNA. The goal is that by stopping PARP activity in cancer cells, they will prevent the cellular repair and cause apoptosis (programmed cell death).

PNF stretching (proprioceptive neuromuscular facilitation) – a shortening contraction of the opposing muscle to place the target muscle on stretch, this is followed by an isometric contraction of the target muscle.

Pain threshold – the point at which pain begins to be felt.

Palate – the roof of the mouth.

Pallor – an unhealthy pale appearance.

Palliative care – is an area of healthcare that focuses on relieving and preventing the suffering of clients, without curing the disease.
Pallor - an unhealthy pale appearance.

Pancreas – is a gland located behind the stomach. It releases the hormones, insulin, and glucagon, as well as digestive enzymes that help you digest and absorb food.

Pancreatectomy – surgery to remove all or part of the pancreas.

Pancreatic – having to do with the pancreas.

Pancreatic (exocrine) cancer – a disease in which cancer cells are found in the tissues of the pancreas.

Pancreatitis – inflammation of the pancreas.

Pancreatoduodenectomy (Whipple procedure) – a type of surgery used to treat pancreatic cancer. This operation is performed to treat cancerous tumors on the head of the pancreas, or those involving the common bile duct, and the duodenum.

Panniculectomy – a "tummy tuck" to remove excess skin and underlying fat in the abdominal area.

Pap smear (test) – is a screening test used to detect potentially pre-cancerous and cancerous cells in the endocervical canal of the female reproductive system.

Papillary, or chromophil kidney cancer – a type of renal cortical kidney cancer that makes up 10-15% of cases. Papillary carcinomas can develop as individual or multiple tumors, appearing either in the same kidney or in both kidneys. There are two types of papillary cancers, Type 1 and Type 2. Type 1 is more common and usually grow slowly. Type 2 is more aggressive. Papillary carcinomas have been associated with genetically inherited syndromes, including hereditary papillary renal cell carcinoma (HPRCC) and hereditary leiomyomatosis and renal cell carcinoma (HLRCC).

Papillary thyroid cancer – accounts for 75% to 85% of all thyroid cancer cases. It occurs more frequently in women and presents in the 30-40-year age group. It is also the predominant cancer type in children with thyroid cancer, and in clients with thyroid cancer who have had previous radiation to the head and neck.

Papillopathy – unilateral or bilateral optic disc swelling in which the patient has either type 1 or type 2 diabetes mellitus.

Paralysis – complete or partial loss of muscle function for one or more muscles.

Parathyroid gland – are small endocrine glands in the neck that produce parathyroid hormone. Parathyroid glands control the amount of calcium in the blood and within the bones.

Paresethia – sensations of tickling, tingling, burning, pricking, or numbness of a person's skin with no apparent long-term physical effect. It is more generally known as the feeling of "pins and needles" or of a limb "falling asleep". The manifestation of paresthesia may be transient or chronic.

Partial (segmental) cystectomy – is a bladder-preserving treatment that involves surgical removal of the bladder tumor and surrounding bladder wall

Partial (subtotal) hysterectomy – surgery to remove the uterus, but not the cervix.

Partial laryngectomy – is the surgical removal of a portion of the larynx, or the voice box.

Partial (segmental) mastectomy – surgical removal of the cancer, a wedge of normal tissue around it, and the lining over the chest muscle below the tumor. Usually, some axillary lymph nodes are removed. In almost all cases there will be a course of radiation therapy following the surgery.

Partial nephrectomy – removes only the diseased part of the kidney while sparing the healthy, functioning kidney tissue.

Partial oophorectomy – surgery to remove one or both ovaries.

Partial remission – may be defined as 50% or greater reduction of tumor growth as may be found on physical examination, radiologic study, or by biomarker levels from a blood or urine test.

Partial-thickness mandibular resection (marginal mandibulectomy) – may be all that is needed if the jaw-bone looks normal on x-ray, and there is no evidence the cancer has spread into the jaw-bone. In this procedure a piece of jaw-bone is removed, but the bone is not cut all the way through.

Passive range of motion (ROM) – the opposite of active ROM. The amount of movement obtained by the examiner without the assistance of the client/patient.

Pathology report – is a document that contains the diagnosis determined by examining cells and tissues under a microscope. This plays an important role in cancer diagnosis and screening.

Pelvic exenteration – is the most extensive pelvic surgery. It is used most often when cancer of the cervix has come back in the pelvis after surgery or radiation therapy. In this surgery, the uterus, cervix, ovaries, fallopian tubes, vagina, bladder, urethra, and rectum are removed. Two ostomies are created, one for urine and one for stool. The vagina is usually rebuilt.

Pelvic inflammatory disease (PID) – refers to infection of the uterus, fallopian tubes, and other reproductive organs. It is a serious complication of some sexually transmitted diseases (STDs), especially chlamydia and gonorrhea. PID can damage the fallopian tubes and tissues in and near the uterus and ovaries.

Pelvic lymphadenectomy – surgery to remove lymph nodes in the pelvis to determine if there are cancer cells present.

Pelvic wall – the muscles and ligaments that line the part of the body between the hips.

Pericarditis – inflammation of the membranous sac enclosing the heart.

Perimenopausal – is technically defined as the time from which menses start to become irregular and FSH levels have increased, until the time when it is known that periods have ceased completely.

Perineal colostomy – an opening made surgically to allow the colon to exit the body through the perineum. A new path for waste material to leave the body is provided after part of the colon has been removed.

Perineal prostatectomy – surgery to remove the prostate through an incision made between the scrotum and the anus (perineum).

Perineum – the area of the body between the anus and the vulva in females, and between the anus and the scrotum in males.

Perineural – occurring about or around nervous tissue or nerves.

Periodontal disease – are infections of the structures around the teeth, which include the gums, periodontal ligament, and alveolar bone.

Peripheral blood stem cell transplant – is a method of replacing blood-forming stem cells destroyed by cancer treatment. PBSCT is now a much more common procedure than its bone marrow harvest equivalent; this is in-part due to the ease and less invasive nature of the procedure.

Peripheral neuropathy – is a result of nerve damage and often causes numbness and pain in the hands and feet. The pain of peripheral neuropathy is usually described as tingling, numbness, or burning. It can result from problems such as traumatic injuries, chemotherapy, infections, metabolic problems, and exposure to toxins. One of the most common causes is diabetes. In many cases, peripheral neuropathy symptoms improve with time – especially if the condition is caused by an underlying condition that can be treated.

Peritoneal – relating to or affecting the peritoneum (the tissue that lines the abdominal wall and pelvic cavity).

PET scan (positron emission tomography) – is an imaging test that uses a radioactive substance called a tracer to look for disease in the body.

Petechiae – are tiny, circular, non-raised patches that appear on the skin or in a mucous or serous membrane. They occur as the result of bleeding under the skin.

Phantom limb pain – is pain that is felt in the area where a limb has been amputated.

Pharmacokinetics – the study of the movement of drugs in the body, including the processes of absorption, distribution, localization in tissues, biotransformation, and excretion.

Pharynx (throat) – is the part of the throat that is right below the mouth and nasal cavity, and above the esophagus and larynx. The human pharynx is conventionally divided into three sections: the nasopharynx the oropharynx, and the laryngopharynx. The pharynx is part of the digestive system and the respiratory system; it is also important in vocalization.

Photodynamic therapy – is a treatment that uses special drugs, called photosensitizing agents, along with light to kill cancer cells.

Photosensitizing agent – an agent used in photodynamic therapy which, when absorbed by cells and exposed to light, is activated, killing cancer cells. PDT may also work by destroying the blood vessels that feed the cancer cells and by alerting the immune system to attack the cancer. It can only treat areas where light can reach. This means it is mainly used to treat problems on or just under the skin, or in the lining of internal organs.

Pineal region tumors – occur in or around the pineal gland, a small organ located in the center of the brain. The pineal gland produces melatonin, a hormone that plays an important role in the sleep-wake cycle. They can be slow growing (pineocytoma) or fast growing (pineoblastoma). Since the pineal region is very difficult to reach, it requires a high level of surgical expertise to remove these tumors.
Pineoblastoma - is a rare, aggressive type of cancer that begins in the cells of the brain's pineal gland.

Pineocytoma – is one of several different types of tumors that arisearound the pineal gland, requiring different therapies. The exact diagnosis is critical for choosing the correct therapy. Pineal tumors typically present with hydrocephalus, a buildup of fluid pressure within the brain.

Pitting edema – in stage/ one lymphedema, when the skin is pressed the pressure will leave a pit that takes some time to fill back in.

Pituitary gland – a pea-sized gland located at the base of the skull between the optic nerves. The pituitary gland secretes hormones.The pituitary is sometimes referred to as the “master gland” as it controls hormone functions such as our temperature, thyroid activity, growth during childhood, urine production, testosterone production in males and ovulation and estrogen production in females. In effect the gland functions as our thermostat that controls all other glands that are responsible for hormone secretion.

Pituitary tumors – develop from the pituitary gland and are usually benign. They are divided by size into macroadenomas (greater than 1 cm in size) and microadenomas (less than 1 cm in size). Arising from the pituitary gland, these tumors can over-produce a variety of hormones that cause symptoms such as fatigue, menstrual irregularities, and weight gain or loss, among many others. Most pituitary tumors, however, do not produce hormones. These tumors, which are common among 30-50-year-olds.

Plane of motion – refers to the plane in which exercise is performed.

Plasmapheresis – plasma is removed from blood cells by a cell separator. The separator spins blood at a rapid speed to separate blood cells from the plasma, or it passes the blood through a membrane with pores so tiny that only plasma can fit through. Cells are put back in the body while the plasma is disposed of and replaced with other liquids such as a saline and albumin combination, fresh frozen plasma, or a plasma substitute. In a method like kidney dialysis treatment, this procedure removes autoantibodies, contained in the plasma, from the blood.

Plastic surgery – is a medical specialty concerned with the correction or restoration of form and function.

Platelet (thrombocyte) – a small colorless disk-shaped cell fragment without a nucleus, found in large numbers in blood and involved in clotting.

Pleura – is a serous membrane which folds back onto itself to form a two-layered membranous pleural sac. The outer pleura is attached to the chest wall but is separated from it by the endothoracic fascia. The inner pleura covers the lungs and adjoining structures, including blood vessels, bronchi, and nerves.

Pleural cavity – is the potential space between the two pleura (visceral and parietal) of the lungs.

Pleural effusion – is a buildup of fluid between the layers of tissue that line the lungs and chest cavity.

Pneumonectomy – a surgical procedure to remove a lung.

Pneumonia – is a lung infection affecting primarily the microscopic air sacs known as alveoli. It is usually caused by infection with viruses or bacteria and less commonly other microorganisms, certain drugs and other conditions such as autoimmune diseases. Symptoms include cough, fever, chest pain, and difficulty breathing.

Pneumonitis (pulmonitis) – inflammation of the lung tissue.

Pneumothorax – collapse of a lung; a collection of air in th space of the lungs that puts pressure on the lung so that it cannot expand as much as it normally does when a breath is taken.

Polypectomy – removal of polyps in the colon to look for signs of cancer.

Positive axillary lymph node – when cancer has spread to a lymph node in the area of the armpit (axilla).

Posterior – the opposite of anterior. Has to do with a structure found toward the back of the body.

Posterior pelvic tilt – the opposite of an anterior pelvic tilt (lordosis). A movement in which the pelvis rotates backward; typically associated with a flat back.

Postmenopausal – the time of a woman's life following menopause.

Postoperative – after surgery.

Postural deviation – muscle imbalance/poor posture. Misalignment of the kinetic chain that can lead to joint deterioration and injury.

Posture – position of the body for alignment of the kinetic chain.

Potassium – is a very important mineral for the proper function of all cells, tissues, and organs in the human body. It is also an electrolyte, a substance that conducts electricity in the body, along with sodium, chloride, calcium, and magnesium. Potassium is crucial to heart function and plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function.

Premature atrial contractions – a type of irregular heartbeat which starts in the upper two chambers of the heart. They are not as serious as premature ventricular contractions. An individual with this condition may report feeling that his or her heart "stops" after a symptom. They are also called heart palpitations.

Premature ventricular contractions – a type of irregular heartbeat which starts in the lower chambers of the heart.

Proctectomy – a surgical procedure to remove the rectum.

Progesterone – is a female hormone important for the regulation of ovulation and menstruation.

Progesterone receptor (PR) – is a protein found in cells, activated by the hormone progesterone that is a useful prognostic indicator of breast cancers that are likely to respond to anti-estrogen receptor (ER) therapies.

Progesterone receptor negative (PR-) – describes cancer cells that do not need progesterone to grow. Therefore, they do not respond when treated with hormones that block progesterone from binding.

Progesterone receptor positive – describes cells that have a protein to which the hormone progesterone will bind. Cancer cells that are progesterone receptor positive need progesterone to grow and will usually stop growing when treated with hormones that block progesterone from binding. Also called PR+.

Progesterone receptor test – a lab test to find out if cancer cells have progesterone receptors (proteins to which the hormone progesterone will bind). If the cells have progesterone receptors, they may need progesterone to grow, and this can affect how the cancer is treated.

Progestin – a natural or synthetic progestational substance that mimics some or all the actions of progesterone.

Prognosis – the likely course of a disease or ailment; the likelihood of recovery or recurrence from a disease.

Programmed cell death (apoptosis) – a genetically directed process of cell self-destruction that is marked by the fragmentation of nuclear DNA, is activated either by the presence of a stimulus or removal of a suppressing agent or stimulus and is a normal physiological process eliminating DNA-damaged, superfluous, or unwanted cells.

Progression – movement or development of a disease toward a more advanced state.

Proliferating – increasing rapidly in numbers.

Prolymphocytes – is a white blood cell with a certain state of cellular differentiation in lymphocytopoiesis (generation of lymphocytes).

Pronation – the opposite of supination. A rotational movement of the forearm at the radioulnar joint, or of the foot at the subtalar and talocalcaneonavicular joints.

Prone – the opposite of supine. Laying on one's stomach.

Prophylactic – acting to defend against or prevent something, especially disease; protective.

Prophylactic cranial irradiation – radiation therapy to the head to minimize the risk that cancer will spread to the brain.

Prophylactic mastectomy – surgery to reduce the risk of developing breast cancer by removing one or both breasts before disease develops. Recommended for women with LCIS.

Prophylactic oophorectomy – surgery to reduce the risk of ovarian cancer by removing the ovaries before the disease develops.

Proprioception – a form of sensory (afferent) information that uses mechanoreceptors to provide information about static and dynamic positions, movements, and sensations related to muscle force and movement.

Prostate – a gland surrounding the bladder neck and urethra in the male; it contributes a secretion to the semen.

Prostate cancer – cancer that forms in tissues of the prostate; usually occurs in older men.

Prostatectomy – surgery to remove part, or all, of the prostate and some of the surrounding tissue. Nearby lymph nodes may also be removed. It may be done through a retropubic incision made in the wall of the lower abdomen, or an incision in the perineum (the area between the anus and the scrotum).

Prosthesis – an artificial device to replace a missing body part.

Protease inhibitor – are a class of drugs used to treat or prevent infection by viruses, including HIV and Hepatitis C.

Protein – of a group of complex organic macromolecules that contain carbon, hydrogen, oxygen, nitrogen, and usually sulfur and are composed of one or more chains of amino acids.

Protein synthesis – the process in which cells build proteins.

Prothrombin – a protein present in blood plasma which is converted into active thrombin during coagulation.

Proton – a stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron.

Proton beam radiation therapy – a type of radiation therapy that uses streams of protons to kill tumor cells, minimizing damage to the surrounding healthy tissue.

Proto-oncogenes – is a normal gene which, when altered by mutation, becomes an oncogene that can contribute to cancer. Proto-oncogenes may have many different functions in the cell. Some proto-oncogenes provide signals that lead to cell division. Other proto-oncogenes regulate programmed cell death (apoptosis).

Provenge® (Sipuleucel-T) – is made by harvesting a patient's immune cells, engineering them to fight prostate cancer cells, and reinfusing them into the patient. It has been shown to extend survival in men with metastatic prostate cancer.

Proximal – the opposite of distal. Referring to a position closer to the midline of the body than another part.

Proximal colon – the first and middle parts of the colon that includes the cecum (a pouch that connects the small intestine to the colon), the ascending colon, and the transverse colon.

Proximal subtotal gastrectomy – the upper stomach as well as the lower esophagus is removed then the gullet is sewed to the stomach.

PSA (prostate-specific antigen) – is a protein made by the prostate cells, found in the blood, and used to help detect prostate cancer.

Pulmonary – having to do with the lungs.

Pulmonary edema – abnormal buildup of fluid in the air sacs of the lungs. It is often cause by congestive heart failure, but it can be caused by high blood pressure, pneumonia, certain toxins, and medicines, or living at a high altitude as well. Symptoms include coughing up blood, shortness of breath, and difficulty exercising.

Pulmonary hypertension – is abnormally high blood pressure in the arteries of the lungs. It makes the right side of the heart work harder than normal.

Pulmonary infarction – (usually hemorrhagic) is most commonly caused by pulmonary embolism (PE) in combination with chronic left heart failure. It occurs in the minority (10-15%) of clients with PE.

Punch biopsy – a technique that involves the use of a circular blade that is rotated down through the epidermis and dermis, and into the subcutaneous fat, yielding a 3- to 4-mm cylindrical core of tissue sample which is then examined under a microscope.

Q-angle – is formed in the frontal plane by two-line segments: from tibial tubercle to the middle of the patella. It has been linked to increased knee pain, ACL injuries and patellofemoral pain syndrome in women.

Quality of life – all aspects of emotional, physical, and social satisfaction with life.

Radiation brachytherapy (internal radiotherapy) – is a procedure that involves placing radioactive material inside the body. It allows doctors to deliver higher doses of radiation to specific areas of the body, compared with external beam radiation that projects radiation from a machine outside of your body. Brachytherapy may cause fewer side effects than does external beam radiation, and the overall treatment time is usually shorter with brachytherapy.

Radiation oncologist – is a physician who specializes in the treatment of cancer clients, using radiation therapy as the main modality of treatment.

Radiation sickness – serious illness caused by exposure to a large dose of ionizing of radiation over a short period of time. The onset and type of symptoms depends on the radiation exposure. Relatively smaller doses result in gastrointestinal effects such as nausea and vomiting and symptoms related to falling blood counts such as infection and bleeding. Relatively larger doses can result in neurological effects and rapid death. Treatment of acute radiation syndrome is generally supportive with blood transfusions and antibiotics.

Radical cystectomy – surgical removal of the entire bladder, nearby lymph nodes (lymphadenectomy), part of the urethra, and nearby organs that may contain cancer cells. In men, the prostate, the seminal vesicles, and part of the vas deferens are also removed. In women, the cervix, the uterus, the ovaries, the fallopian tubes, and part of the vagina are also removed.

Radical hysterectomy – surgical removal of the uterus, cervix, and part of the vagina. The ovaries, fallopian tubes, and nearby lymph nodes are also removed.

Radical excision – takes out the entire area containing cancer with margins extending approximately 5 centimeters on all sides.

Radical inguinal orchiectomy – removes the testicle (or testicles) containing the cancer. An incision is made in the groin, and the testicle is moved through the opening.

Radical lymph node dissection – a surgical procedure to remove most or all of the lymph nodes in the area around the cancerous tumor.

Radical mastectomy – surgical removal of the breast, the pectoralis major and minor, all the axillary lymph nodes, and some additional fat and skin.

Radical neck dissection – during the surgery to remove the voice box, all the lymph nodes in the neck are removed. Additionally, the internal jugular vein, the spinal accessory nerve, and the sternocleidomastoid muscle are removed. If any one of these structures can be spared, the procedure is referred to as a modified radical neck dissection.

Radical nephrectomy – surgical removal of an entire kidney, nearby adrenal gland and lymph nodes, and other surrounding tissue.

Radical perineal prostatectomy – surgical removal of all of the prostate through an incision between the scrotum and the anus (perineum). It is typically performed to remove early prostate cancer. Radical perineal prostatectomy is less commonly used than another surgery such as the open radical retropubic prostatectomy or the robot assisted laparoscopic radical retropubic prostatectomy. Lymph nodes can be sampled through the same incision, although this procedure is not commonplace in the U.S. at this time. When the cancer is small and confined to the prostate, radical perineal prostatectomy achieves the same rate of cure as the retropubic approach, but less blood is lost and recovery is faster.

Radical retropubic prostatectomy – surgical removal of all the prostate and nearby lymph nodes through an incision in the wall of the abdomen.

Radical trachelectomy – surgical removal of the cervix, parametrium (tissue immediately next to the cervix) and the upper two centimeters of the vagina but does not remove the uterus. The uterus then is connected to the remaining portion of the upper vagina. Radical trachelectomy is like a radical hysterectomy, but it leaves a woman's uterus (womb) intact. After the procedure, many women can conceive and deliver full-term babies.

Radioactive iodine – uses large doses of a form of iodine that's radioactive. Radioactive iodine treatment is often used after thyroidectomy to destroy any remaining healthy thyroid tissue, as well as microscopic areas of thyroid cancer that weren't removed during surgery. Radioactive iodine treatment may also be used to treat thyroid cancer that recurs after treatment or that spreads to other areas of the body. Radioactive iodine treatment comes as a capsule or liquid that you swallow. The radioactive iodine is taken up primarily by thyroid cells and thyroid cancer cells, so there's a low risk of harming other cells in your body.

Range of motion (ROM) – the range that a bodily segment moves during a particular exercise.

Recipient – one who receives blood, tissue, or an organ from a donor.

Rectal – of, relating to, or situated near the rectum.

Rectal cancer – cancer that forms in the tissues of the rectum.

Rectal reconstruction – surgery to rebuild the rectum, following its removal, using a section of the colon.

Recurrent cancer – is defined as the return of cancer after treatment and after a period during which the cancer cannot be detected.

Red blood cell (erythrocyte) – are the most common type of blood cell and the principal means of delivering oxygen (O2) to the body tissues via the blood flow through the circulatory system.

Reed-Sternberg cell – a giant binucleated cell that appears in people with Hodgkin disease.

Regional – an area of the body immediately surrounding the tumor.

Regional lymph node – a lymph node that drains lymph from the area immediately surrounding the tumor.

Regional lymph node dissection – removal of some of the lymph nodes in the area immediately surrounding the tumor.

Registered dietitian – is an expert in food and nutrition. They advise people on what to eat to lead a healthy lifestyle or achieve a specific health-related goal.

Rehabilitation – to restore to good health and function, following an injury or disease, through therapy and education.

Relapse – a recurrence of a past medical condition.

Remission – is a period where you are deemed to have no detectable, or very little detectable cancer in your body.

Renal cell carcinoma – is the most common type of kidney cancer in adults. It begins in the renal tubules and occurs most often in men ages 50 – 70.

Renal cortical tumors – cancer that arises in the main part of the kidney that contains the renal tubules.

Renal failure – is a medical condition in which the kidneys fail to adequately filter toxins and waste products from the blood. The two forms are acute (acute kidney injury) and chronic (chronic kidney disease); a number of other diseases or health problems may cause either form of renal failure to occur.

Renal lithiasis – kidney stones.

Renal tubular acidosis – is a medical condition that involves an accumulation of acid in the body due to a failure of the kidneys to appropriately acidify the urine.

Reproductive system – is a system of organs which work together for the purpose of reproduction. The organs involved in producing offspring. In women, this system includes the ovaries, the fallopian tubes, the uterus, the cervix, and the vagina. In men, it includes the prostate, the testes, and the penis.

Resectable – able to be removed by surgery.

Resected – removed by surgery.

Resection – removal of all or part of an organ, tissue, or structure.

Resorption – a process in which a substance is lost by being destroyed and then absorbed by the body.

Respirator (ventilator) – a machine that is used to help a patient breathe.

Respiratory failure – is inadequate gas exchange by the respiratory system, with the result that levels of arterial oxygen, carbon dioxide or both cannot be maintained within their normal ranges.

Respiratory gating – without respiratory gating, doctors often deliver radiation to the entire area that a tumor moves through as the patient breathes, ensuring that the tumor gets proper dosing, but also delivering radiation to areas with healthy tissue. Respiratory gating software eliminates the need to apply radiation with such broad strokes, instead focusing radiation on the tumor, and sparing more healthy tissue. This is particularly useful for tumors near the lungs, where radiation-induced scarring can impair future breathing.

Respiratory therapist – is a health care professional that specializes in the promotion of optimum cardiopulmonary function and health.

Respiratory therapy – is the health care discipline that specializes in the promotion of optimum cardiopulmonary function and health.

Restrictive cardiomyopathy – is a rare form of heart muscle disease that is characterized by restrictive filling of the ventricles. In this disease the contractile function (squeeze) of the heart and wall thicknesses are usually normal, but the relaxation or filling phase of the heart is very abnormal.

Restrictive lung disease – refers to a group of lung diseases that prevent the lungs from fully expanding with air.

Retroperitoneal – is the anatomical space in the abdominal cavity behind the peritoneum.

Retroperitoneal lymph node dissection – surgical removal of the retroperitoneal lymph nodes behind the abdomen.

Retropubic prostatectomy – surgery to remove part, or all, of the prostate and some of the tissue around it through an incision in the wall of the abdomen. Nearby lymph nodes may also be removed.

Rhabdomyosarcoma – is usually found in the thigh, shoulder, and upper arm. It may be large when found. It tends to spread to the lymph nodes. Rhabdomyosarcoma usually affects people in their 40's and 50's.

Rheumatoid arthritis (RA) – is a long-term disease that leads to inflammation of the joints and surrounding tissues.

Rhinorrhea – is a condition where the nasal cavity is filled with a significant amount of mucus fluid. The condition, commonly known as a runny nose, occurs relatively frequently.

Rickets – is a disorder caused by a lack of vitamin D, calcium, or phosphate. It leads to softening and weakening of the bones. Symptoms: Bone pain or tenderness in the arms, legs, pelvis, and spine.

Room air desaturation – below 70% puts clients at risk for dysrhythmia, hemodynamic decompensation, hypoxic brain injury, and death.

Rothmund-Thomson syndrome – is a rare condition that affects many parts of the body, especially the skin, eyes, bones, and teeth. Signs and symptoms can include a characteristic facial rash (poikiloderma); sparse hair, eyelashes, and/or eyebrows; short stature; skeletal (bone) and dental abnormalities; cataracts; premature aging; and an increased risk for cancer, especially osteosarcoma.

Sacrum – is a shield-shaped bony structure that is located at the base of the lumbar vertebrae and that is connected to the pelvis.

Salpingo-oophorectomy – surgical removal of the fallopian tubes and ovaries.

Sarcoma – cancer of the bone, cartilage, fat, muscle, blood vessels, or connective tissue. Both children and adults can develop a sarcoma. It can start in any part of the body, such as the bone or soft tissue. About 60% begin in an arm or leg, 30% start in the trunk or abdomen, and 10% are in the head or neck. Sarcoma is rare in adults, accounting for about 1% of all adult cancers. However, sarcoma in general represents about 15% of all cancers in children.

Scapula (shoulder blade) – either of two large, flat, triangular bones forming the back part of the shoulder.

Scar tissue – is thick, dense tissue that appears after injuries.

Scleral icterus – jaundice in the white part of the eye.

Scleroderma – is a group of rare diseases that involve the hardening and tightening of the skin and connective. In some people, scleroderma affects only the skin.

Scoliosis – an abnormal curvature of the spine. Scoliosis may be present at birth but may also occur at some point in time after radiation therapy to the backbone.

Scrotum – the external sac that contains the testicles and is located behind the penis.

Second primary cancer – is a new primary cancer developing in a person with a history of cancer in a new site or tissue and after the initial cancer.

Second-line therapy – treatment that is given when initial treatment s either unsuccessful or stops working altogether.

Second-look surgery – is performed after a procedure or course of treatment to determine if the patient is free of disease.

Secondary cancer – can refer either to a second primary cancer, or to cancer that has spread from one part of the body to another (metastatic cancer).

Secondhand smoke (passive smoking) – is smoke that comes from the burning of a tobacco product and smoke that is exhaled by smokers. Secondhand smoke is a serious health hazard causing close to 50,000 deaths per year. It can cause or exacerbate a wide range of adverse health effects, including lung cancer, respiratory infections, and asthma.

Secrete – to produce or discharge.

Sedation – is the act of calming by administration of a sedative. A sedative is a medication that commonly induces the nervous system to calm.

Segmental (partial) cystectomy – surgery to remove part of the bladder.

Segmental mandibulectomy – if the x-ray shows the tumor has grown into the jaw-bone, a whole portion of the mandible will need to be removed. The removed piece of the jaw can then be replaced with a piece of bone from another part of the body, such as the fibula, hip bone, or the shoulder blade. Depending on the situation, sometimes a metal plate or a piece of bone from a donor may be used instead.

Segmental (partial) mastectomy – surgery to remove the cancerous portion of the breast, a wedge of normal tissue around it, and the lining over the chest muscles below the cancer. Sometimes lymph nodes under the arm may also be removed. It is a type of breast-conserving surgery.

Segmental resection – a surgical procedure to remove all or part of a gland.

Sentinel lymph node – is the first lymph node reached by cancer cells metastasizing from a tumor.

Sentinel lymph node biopsy – using a blue dye and a special radioactive substance that can be traced using imaging techniques, doctors can identify during surgery the first lymph node (the sentinel node) to which cancer cells would travel.

SERM (selective estrogen receptor modulator) – block the effects of estrogen in the breast tissue. SERMs work by occupying the estrogen receptors in breast cells. If a SERM is in the estrogen receptor, there is no room for estrogen, and it can't attach to the cell. If estrogen isn't attached to a breast cell, the cell doesn't receive estrogen's signals to grow and multiply. Tamoxifen and raloxifene are SERMs.

Sertoli cell tumors – these tumors develop from normal Sertoli cells, which support and nourish the sperm-producing germ cells. Like the Leydig cell tumors, they are usually benign.

Sharp mesorectal incision – a procedure for cancers that have grown through the wall of the rectum or involve the lymph nodes which may require more extensive surgery. This approach allows the delicate removal of all cancerous tissue in and around the rectum, but carefully avoids severing the nerves that are involved in sexual and urinary function and allows most clients to avoid a permanent colostomy.

Shave biopsy – a procedure in which a skin abnormality and a thin layer of surrounding skin are removed with a small blade for examination under a microscope. Stitches are not needed with this procedure.

Short-term side effect – a problem that is caused by treatment of a disease or illness. It is typically acute rather than chronic. Short-term side effects of cancer treatment include nausea, vomiting, diarrhea, hair loss, fatigue, weight loss, weight gain, sleeplessness, and mouth sores.

Shoulder blade (scapula) – one of a pair of triangular bones at the back of the shoulder. It is the bone that connects the upper arm with the collarbone.

Shunt – a passage that is made to allow blood, food, or air to move from one part of the body to another.

Side-effect – a problem that is caused by treatment of a disease or illness. Side effects may be short-term (acute), or long-term (chronic).

Sigmoid colon – is the "S" shaped part of the large intestine that is closest to the rectum and anus.

Simple (total) mastectomy – surgery to remove the entire breast and surrounding tissue. Some of the lymph nodes under the arm may also be removed.

Simple nephrectomy – surgery to remove one kidney.

Sinus – is a cavity within a bone or other tissue. Most commonly found in the bones of the face and connecting with the nasal cavities.

Sinusoidal Obstruction Syndrome – previously known as veno-occlusive disease (VOD), is a distinctive and potentially fatal form of hepatic injury that occurs predominantly, if not only, after drug or toxin exposure.

Sinus tachycardia – a resting heart rate greater than 100 beats per minute in an average adult – originates from the sinoatrial node (the heart's electrical pacemaker).

Skeletal – having to do with the bones of the body (skeleton).

***Skeletal metastases* –** spread of cancer to the bones.

Skeleton – an internal or external framework of bone, cartilage, or other rigid material supporting or containing the body of an animal or plant. It is made up of about 206 bones.

Skin cancer – is named after the type of skin cell from which it arises. Basal cell cancer originates from the lowest layer of the epidermis and is the most common but least dangerous skin cancer. Squamous cell cancer originates from the middle layer and is less common but more likely to spread and, if untreated, become fatal. Melanoma, which originates in the pigment-producing cells (melanocytes), is the least common, but most aggressive, most likely to spread and, if untreated, become fatal.

Skin graft – is a patch of skin that is removed by surgery from one area of the body and transplanted, or attached, to another area.

Skin-sparing mastectomy – is performed to facilitate immediate breast reconstruction. Skin-sparing mastectomy incisions are smaller than those required for a modified radical or simple mastectomy. Most of the breast tissue is removed, but most of the breast skin is saved to hold and shape the reconstructed breast. In a skin-sparing mastectomy, the incision is made around the areola. Sometimes it is necessary to make another incision extending down or to the side to remove as much breast tissue as possible.

Skip metastasis – a tumor or nodule located in the same bone as the main tumor, but not in continuity with the tumor.

Sleeve pneumonectomy – surgical removal of the entire lung as well as lower trachea. The airway must be reconstructed following this procedure.

Sleeve resection – may be used to treat some cancers in large airways in the lungs. A surgeon may be able to do this operation instead of a pneumonectomy to preserve more lung function.

Small bowel resection – surgical removal of the cancer part of the intestine.

Small cell lung cancer – the fastest growing type of lung cancer that forms in tissues of the lung and can spread to other parts of the body. It spreads more quickly than non-small cell lung cancer.

Small intestine – is the part of the gastrointestinal tract following the stomach and followed by the large intestine and is where much of the digestion and absorption of food takes place.

Small intestine cancer – cancer that forms in tissues of the small intestine.

Soft palate – soft tissue constituting the back of the roof of the mouth.

Soft tissue – refers to tissues that connect, support, or surround other structures and organs of the body, not being bone. Soft tissue includes tendons, ligaments, fascia, skin, fibrous tissues, fat, and synovial membranes (which are connective tissue), and muscles, nerves, and blood vessels (which are not connective tissue).

S**oft tissue sarcoma –** are cancerous tumors that originate in the soft tissues of the body.

Solid tumor – an abnormal mass of tissue that usually does not contain cysts or liquid areas.

Sonogram – a diagnostic medical image created using ultrasound echo (sonographic) equipment.

Spacial frame technique (Taylor special frame) – is a versatile multiplanar external fixator that combines ease of application with computer accuracy to effectively reduce fractures and correct all aspects of deformity in reconstructive orthopoedic surgery.

Spasm – a sudden, involuntary contraction of a muscle or group of muscles.

Spasticity – is a velocity-dependent increase in muscle tone and uncontrolled, repetitive, involuntary contractions of skeletal muscles. It presents as upper motor neuron symptoms in patients with central nervous system pathology such as stroke, spinal cord injury, brain injury, or multiple sclerosis.

Speculum – an instrument for opening or distending a body orifice or cavity to permit visual inspection

Spermatocytic seminoma – this rare type of seminoma tends to occur in older men. The average age of men diagnosed with spermatocytic seminoma is about 65. Spermatocytic tumors tend to grow more slowly and are less likely to spread to other parts of the body than classical seminomas.

Sphincter – a ring like muscle that normally maintains constriction of a body passage or orifice and that relaxes as required by normal physiological functioning.

Spinal block – is a safe and effective alternative to general anesthesia when the surgical site is located on the lower extremities.

Spinal (vertebral) column – a series of articulated vertebrae, separated by intervertebral disks and held together by muscles and tendons, that extends from the cranium to the coccyx or the end of the tail, encasing the spinal cord and forming the supporting axis of the body; the spine.

Spinal cord – the long, cordlike part of the central nervous system that is enclosed within the vertebral column (spine) and descends from the base of the brain, with which it is continuous. The spinal cord branches to form the nerves that convey motor and sensory impulses to and from the tissues of the body.

Spinal cord compression – develops when the spinal cord is compressed by bone fragments from a vertebral fracture, a tumor, abscess, ruptured intervertebral disc, or another lesion. It is regarded as a medical emergency independent of its cause and requires swift diagnosis and treatment to prevent long-term disability due to irreversible spinal cord injury.

Spinal tap (lumbar puncture) – is a procedure to collect and look at the cerebrospinal fluid surrounding the brain and spinal cord. During a lumbar puncture, a needle is carefully inserted into the spinal canal low in the back. Samples of CSF are collected and studied for color, blood cell counts, protein, glucose, and other substances. Some of the sample may be put into a special culture cup to see if any infection, such as bacteria or fungi, grows. The pressure of the CSF also is measured during the procedure.

Spleen – a large, highly vascular lymphoid organ, lying in the human body to the left of the stomach below the diaphragm, serving to store blood, disintegrate old blood cells, filter foreign substances from the blood, and produce lymphocytes. Removal of the spleen may make a patient more prone to infection.

Splenectomy – a surgical procedure to remove the spleen.

Splenomegaly – abnormal enlargement of the spleen.

Squamous cell carcinoma – is a cancer of a kind of epithelial cell, the squamous cell. These cells are the main part of the epidermis of the skin, and this cancer is one of the major forms of skin cancer. However, squamous cells also occur in the lining of the digestive tract, lungs, and other areas of the body, and SCC occurs as a form of cancer in diverse tissues, including the lips, mouth, esophagus, urinary bladder, prostate, lung, vagina, and cervix, among others. Despite sharing the name squamous cell carcinoma, the SCCs of different body sites can show tremendous differences in their presenting symptoms, natural history, prognosis, and response to treatment.

Stabilizers – are muscles that support or stabilize the body while the prime movers and the synergists perform the movement patterns.

Stage – how much cancer there is in the body and where it is located.

Staging – describes the extent or severity of an individual's cancer based on the extent of the original (primary) tumor and the extent of spread in the body. Knowing the stage of the disease helps the doctor plan a treatment and determine a prognosis.

Staging system – a system that is used to describe the extent of cancer in the body.

Stamina – strength of physical constitution, ability to endure physical activity, stress, or disease over time.

Static Posture – any posture that is held for a long time.

Static stretching – is used to stretch muscles while the body is at rest. It is composed of various techniques that gradually lengthen a muscle to an elongated position (to the point of discomfort) and hold that position for 30 seconds to two minutes.

Stem cell – cell found in most, if not all, multi-cellular organisms. It is characterized by the ability to renew itself through mitotic cell division and differentiating into a diverse range of specialized cell types.

Stem cell mobilization – G-CSF is a hormone that stimulates the bone marrow to grow very rapidly; when this occurs, stem cells move out into the blood stream in large numbers. The stem cells can be collected and stored for use at a later time. They may be used later to replace the bone marrow during a stem cell transplant.

Stem cell transplant – a procedure for replacing immature, blood-forming cells in the bone marrow that have been destroyed by drugs, radiation, or disease. Stem cells are collected and then injected into the patient. The stem cells stimulate the production of healthy blood cells. Cells may be taken directly from the patient (autologous), from a donor who is genetically compatible (allogeneic), or from an identical twin (syngeneic).

Stent – is a mesh 'tube' inserted into a natural passage/conduit in the body to prevent or counteract a disease-induced, localized flow constriction. The term may also refer to a tube used to temporarily hold such a natural conduit open to allow access for surgery.

Stereotactic biopsy – is a biopsy procedure that uses a computer and imaging performed in at least two planes to localize a target lesion in three-dimensional space and guide the removal of tissue for examination by a pathologist under a microscope.

Stereotactic external-beam radiation therapy – uses focused radiation beams targeting a well-defined tumor, relying on detailed imaging, computerized three-dimensional treatment planning and precise treatment set-up to deliver the radiation dose with extreme accuracy.

Stereotactic radiosurgery – a type of external radiation therapy that uses special equipment to position the patient and precisely deliver radiation to a tumor. The total dose of radiation is divided into several smaller doses given over several days.

Stereotactic radiation therapy – is used to treat brain tumors and other brain disorders. It is also being studied in the treatment of other types of cancer, such as lung cancer.

Sterile – a term referring to any process that eliminates or kills all forms of life from an item or field. May also be the condition of a person being unable to bear children, especially through natural means.

Sternum (breastbone) – a plate of bone forming the middle of the anterior wall of the thorax and articulating with the clavicles and the cartilages of the first seven ribs. It consists of three parts, the manubrium, the body, and the xiphoid process.

Sternotomy – the doctor may split the sternum through its midline in order to see both sides of chest to locate undetected cancer. In some cases, the doctor will also remove a small portion of the lung.

Steroid – any of numerous naturally occurring or synthetic fat-soluble organic compounds having as a basis, 17 carbon atoms arranged in four rings and including the sterols and bile acids, adrenocortical and sex hormones, certain natural drugs such as digitalis compounds, and the precursors of certain vitamins.

Steroidogenesis – is the multistep process for biosynthesis of steroid hormones from cholesterol.

Stoma – any opening in the body. For example, a mouth, a nose, and an anus are natural stomata. Any hollow organ can be manipulated into an artificial stoma as necessary. This includes the esophagus, stomach, duodenum, ileum, colon, pleural cavity, ureters, urinary bladder, and renal pelvis.

Stomach – the food reservoir and first major site of digestion; located just under the diaphragm and divided into a body and a pylorus. It receives partially processed food and drink funneled from the mouth through the esophagus and gradually feeds liquefied food (chyme) into the small intestine. The stomach lies in the epigastric and left hypogastric regions bounded by the anterior abdominal wall and the diaphragm between the liver and the spleen.

Stomach (gastric) cancer – cancer that forms in tissues lining the stomach.

Stomatitis – is inflammation of the mouth and lips.

Strength – bodily or muscular power.

Stroke – occurs when blood flow is interrupted to part of the brain. Without blood to supply oxygen and nutrients and to remove waste products, brain cells quickly begin to die. Depending on the region of the brain affected, a stroke may cause paralysis, speech impairment, loss of memory and reasoning ability, coma, or death.

Stromal tumors – tumors can also develop in the supportive and hormone-producing tissues, or stroma, of the testicles. These tumors are known as gonadal stromal tumors. They make up less than 5% of adult testicular tumors but up to 20% of childhood testicular tumors. The two main types are Leydig cell tumors and Sertoli cell tumors.
Subclavian artery - the left subclavian artery supplies blood to the left arm and the right subclavian artery supplies blood to the right arm, with some branches supplying the head and thorax.

Subcutaneous – situated or lying underneath the skin.

Subcutaneous emphysema – is when gas or air is in the layer under the skin

Subcutaneous mastectomy – is a type of skin-sparing mastectomy which removes tissue through an incision under the breast, leaving the skin, areola, and nipple intact. Some women who have prophylactic mastectomies prefer a subcutaneous procedure because it retains their nipples and offers very good cosmetic results. By working through the incision under the breast, the new breast is reconstructed without visible scars. Because a subcutaneous mastectomy leaves more tissue behind, working through the incision under the breast makes it impossible to remove as much tissue as a simple or modified radical mastectomy. This procedure is considered appropriate only as a prophylactic measure.

Subcutaneous port – is a tube surgically placed into a blood vessel and attached to a disk placed under the skin. It is used for the administration of intravenous fluids and drugs; it can also be used to obtain blood samples.

Subjective improvement – an improvement that is reported by the patient but cannot be measured against a norm.

Subtotal (partial) hysterectomy – is a procedure in which a woman's uterus is removed but the cervix is left in place.

Subtotal nodal irradiation – radiation to both the mantle and abdominal field.

Sutent® (Sunitinib) – blocks several tyrosine kinases, but not the same ones as sorafenib. This drug is a pill that has been shown to shrink or slow the progression of kidney cancer in many cases. It attacks both blood vessel growth and other targets that stimulate cancer cell growth.

Superficial – lying on, not penetrating below, or affecting only the surface.

Superior – the opposite of inferior. A position about a specific reference point.

Superior vena cava – is a large diameter, yet short, vein that carries deoxygenated blood from the upper half of the body to the hearts' right atrium.

Supination – the opposite of pronation. The rotation of the forearm and hand so that the palm faces forward or upward; also: a corresponding movement of the foot and leg in which the foot rolls outward with an elevated arch.

Supine – the opposite of prone. Lying on one's back.

Supraclavicular lymph node – a lymph node found superior to the clavicle.

Supraglottic (horizontal partial) laryngectomy – is a surgical technique designed with the goal of complete elimination of cancer arising from the epiglottis, aryepiglottic folds, and false vocal cords while minimizing morbidity and maintaining the three primary functions of the larynx—airway protection, respiration, and phonation.

Supraglottis – the area of the pharynx above the glottis as far as the epiglottis.

Supraventricular arrhythmias – early extra beats that originate in the upper chamber of the heart.

Survival rate – is a part of survival analysis, indicating the percentage of people in a study or treatment group who are alive for a given period after diagnosis. Survival rates are important for prognosis.

Sympathetic nervous system – the part of the nervous system that is continuously active to maintain stability, temperature, and pH of the body. Primarily, this nervous system counteracts parasympathetic nervous system. This system also helps in controlling the internal organs of the body such as eyes, heart, lungs, blood vessels, sweat glands, digestive system, kidney, and penis. Dilation of pupils, rate and force of contraction, dilation of bronchioles, constriction of blood vessels, activation of sweat secretion, inhibition of peristalsis, promotion of renin secretion, and promotion of ejaculation in men are all aided by this nervous system. increases heart rate, blood pressure, breathing rate, and pupil size. It also causes blood vessels to narrow and decreases digestive juices.

Symptom – subjective evidence of disease or physical disturbance; something that indicates the presence of a bodily disorder.

Syncope – fainting or passing out.

Synergistic – producing synergy; two drugs combining to give the user the same type of experience while building off each other.

Synergists – are muscles that assist prime movers during functional movement patterns.

Synergistic dominance – this is the process in which a synergist compensates for a prime mover to maintain force production.

Synovial fluid – a clear fluid secreted by membranes in joint cavities, tendon sheaths, and bursae, and functioning as a lubricant.

Synovial sarcoma – is a malignant tumor of the tissue around joints. The most common locations are the hip, knee, ankle, and shoulder. This tumor is more common in children and young adults, but it can occur in older people.

Synthetic – not of natural origin.

Systemic chemotherapy – uses anticancer drugs, either injected into a vein or given by mouth, that travel through the blood to cells all over the body.

Systemic disease – is a disease that affects a number of organs and tissues or affects the body as a whole.

Systemic radiation therapy – **radioactive material is injected or ingested and** travels throughout the body and is absorbed by cancer cells.

Systemic therapy – any treatment that uses substances that will travel through the bloodstream, seeking out and affecting cells throughout the body.

T-cell – a lymphocyte of a type produced or processed by the thymus gland and actively participating in the immune response.

T-cell depleting monoclonal antibody – depletion of graft T cells is an effective way of reducing the incidence of acute and chronic GVHD.

Tachycardia – rapidly beating heart; usually defined as greater than 100 beats per minute.

Tachyarrhythmia's – abnormal heart rhythms with a ventricular rate of 100 or more beats per minute. Signs and symptoms related to the tachyarrhythmia may include shock, hypotension, heart failure, shortness of breath, chest pain, acute myocardial infarction, palpitations, and/or decreased level of consciousness.

Tagraxofusp-erzs (ElzonrisTM) – targeted therapy for Blastic Plasmacytoid Dendritic Cell Neoplasm and First CD123-Targeted Therapy

Takotsubo cardiomyopathy – also known as Takotsubo syndrome, is a temporary condition where your heart muscle becomes suddenly weakened or 'stunned'. The left ventricle, one of the heart's chambers, changes shape and enlarges.

Tamoxifen® – attaches to the hormone receptor in the cancer cell, blocking estrogen from attaching to the receptor. Since hormone-receptor positive cells need estrogen to grow, tamoxifen can slow or stop the growth of cancer cells. Unlike aromatase inhibitors, tamoxifen can be used to treat breast cancer in both premenopausal and postmenopausal women.

Tarceva® (Erlotinib) – works by not allowing EGFR (epidermal growth factor receptor this helps the cells divide and is mutated in about 10% of clients with non-small cell lung cancer and in nearly 50% of lung cancers arising in those who have never smoked). While potentially effective in many kinds of clients, it has been shown to be more likely
to work for those who have never smoked or in younger women.

Targeted therapy – is a type of treatment that blocks the growth of cancer cells by interfering with specific targeted molecules needed for carcinogenesis and tumor growth, rather than by simply interfering with all rapidly dividing cells. Radiotherapy is not considered a 'targeted therapy' despite it being often aimed at the tumors. Targeted therapy may have fewer side effects than other types of cancer treatments.

Taxotere® (Docetaxel) – damages the structure of prostate cancer cells, is considered the standard of care in chemotherapy for men with prostate cancer that is resistant to hormone therapy.

Telangiectasias (spider veins) – are small, dilated blood vessels near the surface of the skin or mucous membranes, measuring between
0.5 and 1 millimeter in diameter. These dilated blood vessels can develop anywhere on the body but are commonly seen on the face around the nose, cheeks, and chin.

Tendon – is a tough band of fibrous connective tissue that usually connects muscle to bone and is capable of withstanding tension.

Teratomas – are germ cell tumors with areas that look like each of the 3 layers of a developing embryo (the endoderm, mesoderm, and ectoderm) when seen under a microscope. The 3 main types of these tumors are the mature teratoma, immature teratoma, and teratoma with malignant transformation. Mature teratomas are tumors formed by cells like cells of adult tissues. They are generally benign and can usually be cured with surgery. Immature teratomas are less well-developed cancers with cells that look like those of an early embryo. Unlike mature teratomas, this type is more likely to grow and to metastasize outside of the testicle. Teratoma with malignant transformation is a very rare cancer. These cancers have some areas that look like mature teratomas but have other areas where the cells have become a type of cancer that develops outside of the testicle, in tissues such as muscles, glands of the lungs or intestines, or the brain.

Terminal disease – a disease that cannot be cured or adequately treated and that is reasonably expected to result in the death of the patient within a short period of time.

Testicle (testes) – either of the two oval organs that produce sperm in men and other male mammals, enclosed in the scrotum behind the penis.

Testicular cancer – cancer originating in the tissue of one or both testicles. Testicular cancer is most common in men aged 15-34.

Testosterone – is a steroid hormone from the androgen group. It plays a key role in the development of male reproductive tissues such as the testis and prostate as well as promoting secondary sexual characteristics such as increased muscle, bone mass, and the growth of body hair. In addition, testosterone is essential for health and well-being as well as the prevention of osteoporosis.

Thalamus – is a large, dual lobed mass of grey matter buried under the cerebral cortex. It is involved in sensory perception and regulation of motor functions. The thalamus is a limbic system structure, and it connects areas of the cerebral cortex that are involved in sensory perception and movement with other parts of the brain and spinal cord that also have a role in sensation and movement. As a regulator of sensory information, the thalamus also controls sleep and awake states of consciousness.

Therapeutic – a consequence of a medical treatment of any kind, the results of which are judged to be desirable and beneficial.

Therapy – is the attempted remediation of a health problem, usually following a diagnosis.

Thoracentesis – is a procedure to remove fluid from the space between the lining of the outside of the lungs (pleura) and the wall of the chest.

Thoracic – pertaining to the thorax (chest).

Thoracic spine – the 12 vertebrae in mid-torso that are attached to the rib cage.

Thoracoscope – an endoscope for examining the pleural cavity through an intercostal space.

Thoracoscopy – is a medical procedure involving internal examination, biopsy, and/or resection of disease or masses within the pleural cavity and thoracic cavity.

Thoracotomy – surgery to remove all or part of a lung.

Thoracotomy pain syndrome – continued pain and discomfort that can last from a few years to a lifetime. Treatment to aid pain relief for this condition includes intra thoracic nerve blocks/opiates and epidurals although results vary from person to person and are dependent on many factors.

Throat – is the anterior part of the neck, in front of the vertebral column. It consists of the pharynx and larynx.

Throat (pharyngeal) cancer – cancer that originates in the tissue of the throat.

Thrombocyte (platelet) – gathers at the wound and attempt to block the blood flow when bleeding suddenly occurs.

Thrombocytopenia – a relative decrease in the platelets of the blood.

Thrombosis – is the formation of a blood clot inside a blood vessel, obstructing the flow of blood through the circulatory system.

Thyroglobulin – one of the largest proteins in the body. This protein is found only in the thyroid gland. Thyroglobulin combines with iodine and is modified and broken down to release small molecules known as thyroid hormones. Thyroid hormones play an important role in regulating growth, brain development, and metabolism. Thyroglobulin also serves as a protein storehouse for iodine and inactive thyroid hormone until these substances are needed.

Thyroid (thyroid gland) – is a butterfly-shaped organ and is composed of two cone-like lobes or wings, connected via the isthmus. It is one of the largest endocrine glands. The thyroid gland is found in the neck, below the thyroid cartilage. The thyroid gland controls how quickly the body uses energy, makes proteins, and controls how sensitive the body is to other hormones.

Thyroid cancer – cancer originating in the tissue of the thyroid.

Thyroid hormone – hormones produced by the thyroid gland that are primarily responsible for regulation of metabolism. This includes heart rate, blood pressure, body temperature, and weight. Thyroid hormone is made by the thyroid gland but can also be made artificially in the laboratory. Natural thyroid hormone supplements from the dried thyroids of animals are still available. Natural thyroid hormones have become less popular, due to evidence that varying hormone concentrations in the thyroids of animals before they are slaughtered leads to inconsistent potency and stability.

Thyroid hormone treatment – treatment with natural or artificial thyroid hormone.

Thyroid-stimulating hormone (TSH) – is a hormone that stimulates the thyroid gland to produce thyroxin (T4), and then triiodothyronine (T3) which stimulates the metabolism of almost every tissue in the body.

Thyroidectomy – a surgical procedure that involves the removal of all or part of the thyroid gland.

Thyrotoxicosis – excess of thyroid hormone in the body. Having this condition also means that you have a low level of thyroid stimulating hormone, TSH, in your bloodstream, because the pituitary gland senses that you have "enough" thyroid hormone.

Thyroxin – a hormone of the thyroid gland that contains iodine and is a derivative of the amino acid tyrosine.

Tibia (shinbone) – the inner and larger of the two bones of the lower human leg; extending from the knee to the ankle.

Tinnitus – is the perception of noise or ringing in the ears. A common problem, tinnitus affects about 1 in 5 people. Tinnitus isn't a condition itself, it's a symptom of an underlying condition, such as age-related hearing loss, ear injury or a circulatory system disorder.

Tissue – an aggregate of cells, usually of a particular kind together with their intercellular substance, that form one of the structural materials of a plant, animal, or human and that in humans and animals include connective tissue, epithelium, muscle tissue, and nerve tissue.

Tissue flap reconstruction – is a way to rebuild the shape of a breast using skin, fat, and muscle from another part of the body. It is usually done after part, or all, of the breast is removed because of cancer.

TNM staging system – is a cancer staging system that describes the extent of cancer in a patient's body. T describes the size of the tumor and whether it has invaded nearby tissue, N describes regional lymph nodes that are involved, and M describes distant metastasis.

Tobacco – is an agricultural product processed from the leaves of plants in the genus Nicotiana. It can be consumed, used as a pesticide and, in the form of nicotine tartrate, used in some medicines.[1] It is most commonly used as a drug, and is a valuable cash crop for countries such as Cuba, India, China, and the United States. There are over 4,000 chemicals in cigarettes; 51 of them are known to be carcinogenic. Chew, snuff, and other types of smokeless tobacco are known to increase risk for oral cancer.

Tongue cancer – is a common and serious type of oral cancer. Tongue cancer usually begins in the squamous cells that cover the surface of the tongue. When cancer forms in the front two-thirds of the tongue, it's classified as a type of oral cancer. Cancer that develops in the back third of the tongue is considered a form of throat (oropharyngeal) cancer.

Tonsil – either of two small masses of lymphoid tissue in the throat, one on each side of the root of the tongue.

Toposiomerase inhibitors – are types of chemotherapy drugs that interfere with the action of topoisomerase enzymes which control the manipulation of the structure of DNA necessary for replication.

Topical – of, pertaining to, or applied externally to a particular part of the body; local.

Torisel® (Temsirolimus) – is given as an intravenous infusion. It works by blocking a cell protein known as mTOR, which normally promotes cell growth and division. This drug has been shown to be helpful against advanced kidney cancers that have a poorer prognosis because of certain factors.

Total-body irradiation – gives a dose of radiation to the whole body to destroy cancer cells throughout the body.

Total (complete) hysterectomy – surgery to remove the uterus and the cervix.

Total laryngectomy – a surgical procedure to remove the larynx (voice box).

Total (simple) mastectomy – surgical removal of the entire breast and usually a few lymph nodes that are located in the breast tissue.

Total nodal irradiation – irradiation of the entire trunk.

Total pancreatectomy – is the surgical removal of the pancreas. It is unusual to do and is only done when disease involves the entire pancreas, and no other surgical options are available. Part of the stomach, part of the small intestine, the duodenum, a small part of the jejunum, the common bile duct, the gallbladder, the spleen, and nearby lymph nodes are also removed.

Total thyroidectomy – surgery to remove the entire thyroid.

Toxic – containing poisonous material; capable of causing death or serious debilitation.

Toxicity – the degree to which a substance can damage an organism.

Toxicology – is a branch of biology, chemistry, and medicine concerned with the study of the adverse effects of chemicals on living organisms. It is the study of symptoms, mechanisms, treatments, and detection of poisoning, especially the poisoning of people.

Toxin – poisonous substance, especially a protein that is produced by living cells or organisms and is capable of causing disease when introduced into the body.

Trachea (windpipe) – is a tube that connects the pharynx and larynx to the lungs, allowing the passage of air.

Trachelectomy (cervicectomy) – is a surgical removal of the uterine cervix. As the uterine body is preserved, this type of surgery is a fertility preserving surgical alternative to a radical hysterectomy and applicable in selected younger women with early cervical cancer.

Tracheoesophageal puncture – often the preferred choice for restoring speech. This is a one-day surgery which can be done as long as ten years after larynx surgery. Its' purpose is to give people who find it difficult to learn esophageal speech an opportunity to regain the use of their voices. An opening is made from the windpipe into the esophagus, and a small plastic valve is inserted to provide a source of air. The patient diverts air into the esophagus and uses it to resonate in the pharynx.

Tracheostomy – is a surgical procedure to create an opening through the neck into the trachea. A tube is usually placed through this opening to provide an airway and to remove secretions from the lungs. This tube is called a tracheostomy tube or trach tube.

Transanal endoscopic microsurgery (TEM) – this operation can sometimes be used for early T1 N0 M0 stage I cancers that are higher in the rectum that could not be reached using the standard transanal resection. A specially designed magnifying scope is inserted through the anus and into the rectum, allowing the surgeon to do a transanal resection with great precision and accuracy.

Transarterial embolization (TAE) – a catheter is used to find the artery feeding the tumor and a substance is injected into the blood vessel, cutting off the blood supply to the tumor. This kills the tumor.

Transcutaneous electrical nerve stimulation (TENS) – is the use of electric current produced by a device to stimulate the nerves for therapeutic purposes.

Transdermal – entering through the dermis, or skin, as in administration of a drug via ointment or patch.

Transfusion – the introduction of blood directly into an individual's blood circulation through a vein.

Transitional cell carcinoma – is a cancer that forms in a type of epithelial tissue called transitional epithelium, or urothelium.

Transitional cell (urothelial) tumor – a type of kidney cancer that arises in the renal pelvis and is like bladder cancer.

Transplantation – a surgical procedure in which tissue or an organ is transferred from one body part to another.

Transurethral resection of the bladder tumor (TURBT) – a flexible cystoscope is inserted through the urethra and into the bladder (does not require cutting into the abdomen). An electrified wire loop is then passed through the scope. It is "heated up" and used to cut the tumor off the bladder wall, simultaneously coagulating the site to prevent bleeding. After surgery, more steps may be taken to try to ensure that the tumor has been destroyed. Any remaining cancer may be treated by burning the base of the tumor (fulguration) while looking at it with the cystoscope. Cancer can also be destroyed using the cystoscope and a high-energy laser. After transurethral surgery, the patient can usually return home the same day or the next day and can resume their usual activities in less than 2 weeks.

Transurethral resection of the prostate (TURP) – a palliative procedure in which an instrument is inserted up the urethra to remove the section of the prostate that is blocking urine flow.

Trauma – an injury to living tissue caused by an extrinsic agent. A disordered psychic or behavioral state resulting from severe mental or emotional stress or physical injury.

Treatment cycle – each cancer treatment is typically followed by a rest period of a few weeks to allow the body to recover from any side effects, and so the number of cells in the blood can go back to normal. The treatment and the rest period together make up the treatment cycle.

Treatment field – the area of the body that radiation beams are directed at during radiation therapy.

Triple-negative breast cancer – refers to any breast cancer that does not express the genes for estrogen receptor (ER), progesterone receptor (PR) or Her2/neu. Some types of triple negative breast cancer are known to be more aggressive with poor prognosis, while other types have prognosis very similar or better than hormone receptor positive breast cancers. Triple negative breast cancers have a relapse pattern that is very different from hormone-positive breast cancers: the risk of relapse is much higher for the first 3-5 years but drops sharply and substantially below that of hormone-positive breast cancers after that.

Trismus – lockjaw; is reduced opening of the jaws (limited jaw range of motion). It may be caused by spasm of the muscles of mastication or a variety of other causes.

TSH – is a hormone that stimulates the thyroid gland to produce thyroxine (T4), and then triiodothyronine (T3) which stimulates the metabolism of almost every tissue in the body.

Tubi-grip stocking – an elastic tubular support bandage that protects a port or central line.

Tumor – is an abnormal growth of body tissue. Tumors can be cancerous (malignant) or noncancerous (benign). Symptoms depend on the type and location of the tumor.

Tumor debulking – is a surgical procedure performed to remove as much of a tumor as is logistically possible. There are several factors that can influence the way this procedure is performed, including the type of tumor, location, and the patient's general health.

Tumor grade – is a way of classifying tumors based on certain features of their cells. The grade of a tumor is directly linked to prognosis. The more the cancer cells look like normal cells, the lower the tumor grade tends to be. Also, the fewer cancer cells that are in the process of dividing, the more likely it is that the tumor is slow growing, which contributes to a lower tumor grade.

Tumor suppressor genes – normal genes that slow down cell division, repair DNA mistakes, or tell cells when to die – a process known as apoptosis or programmed cell death.

Ulcer – is a discontinuity or break in a bodily membrane that impedes the organ of which that membrane is a part of from continuing its normal functions.

Ulceration – the formation or development of an ulcer.

Ultrasonic aspiration – using a hand-held ultrasonic aspirator will produce high frequency sound waves that cause the lesion to vibrate and break apart while leaving nerves and blood vessels intact. The instrument simultaneously "vacuums" the remaining fragments of the tumor.

Ultrasound – uses high-frequency sound waves to look at organs and structures inside the body. Health care professionals use them to view the heart, blood vessels, kidneys, liver, and other organs. During pregnancy, doctors use ultrasound tests to examine the fetus. Unlike x-rays, ultrasound does not involve exposure to radiation.

Ultrasound-guided biopsy – an ultrasound scanner is used to accurately guide a needle to the site of the biopsy. The needle will then be used to remove a tissue sample.

Unclassified – a type of renal cortical kidney cancer that makes up 3-5% of kidney tumors. These rare tumors look different under a microscope than other kidney cancer subtypes and are usually very aggressive.

Undifferentiated (anaplastic) – when cells are very immature and "primitive" and do not look like cells in the tissue from which it arose. Undifferentiated cancer is more malignant than a cancer of that type which is well differentiated.

Undifferentiated pleomorphic sarcoma – is most often found in the arms or legs. Less often, it can start inside at the back of the abdomen (the retroperitoneum). This sarcoma is most common in older adults. Although it mostly tends to grow locally, it can spread to distant sites.

Unresectable – cannot be surgically removed.

Unstable angina – is a condition in which your heart doesn't get enough blood flow and oxygen. It may lead to a heart attack.

Upper extremity – is the region extending from the deltoid region to the hand, including the arm, axilla, and shoulder.

Upper-crossed syndrome – a dysfunctional muscle pattern that is characterized by a forward head and rounded shoulders.

Ureter – tubes made of smooth muscle fibers that propel urine from the kidneys to the urinary bladder.

Urethra – is a tube that connects the urinary bladder to the genitals for the removal of fluids from the body.

Uricemia – an abnormal amount of uric acid in the blood.

Urinalysis – is the physical, chemical, and microscopic examination of urine. It involves several tests to detect and measure various compounds that pass through the urine.

Urinary incontinence – involuntary urination or leakage of urine.

Urinary tract – a continuous anatomical tract, including the kidneys, ureters, and urethra, involved in the formation and excretion of urine.

Urine – is a typically sterile liquid by-product of the body secreted by the kidneys through a process called urination and excreted through the urethra.

Urostomy – is an artificial opening for the urinary system. A urostomy is made to avail for urinary diversion in cases where drainage of urine through the bladder and urethra is not possible, e.g. after extensive surgery or in case of obstruction.

Uterine (endometrial) cancer – cancer that originates in the tissue of the uterus.

Uterus – is a hollow muscular organ located in the female pelvis between the bladder and rectum. The ovaries produce the eggs that travel through the fallopian tubes. Once the egg has left the ovary it can be fertilized and implant itself in the lining of the uterus. The main function of the uterus is to nourish the developing fetus prior to birth.

Uvula – a small, conical, fleshy mass of tissue suspended from the center of the soft palate.

Vagina – is the female body part that connects the womb (uterus) and cervix to the outside of the body. The vagina is a muscular tube lined with mucus membranes. Its opening is between the urethra (where urine exits the body) and the anus. The vagina allows for the flow of menstrual blood and for sexual intercourse, and is the passageway through which a baby is born.

Vaginal – having to do with the vagina.

Vaginal cancer – cancer originating in the tissue of the vagina.

Valvular heart disease – is characterized by damage to or a defect in one of the four valves of the heart: the aortic valve, the mitral valve, the tricuspid valve, or the pulmonic valve. In valvular heart disease, the valves become too narrow and hardened (stenotic) to open fully or are unable to close completely (incompetent). A stenotic valve forces blood to back up in the adjacent heart chamber, while an incompetent valve allows blood to leak back into the chamber it previously exited.

Vas deferens – the main duct through which semen is carried from the epididymis to the ejaculatory duct.

Vasospastic disorder (Raynaud's phenomenon) – causes discoloration of the fingers, and toes. It is an exaggeration of vasomotor responses to cold or emotional stress.

Ventral – opposite of dorsal. A position on or towards the front of the body.

Vertebral column – is a series of approximately 33 bones called vertebrae, which are separated by intervertebral discs. The column can be divided into five different regions, with each region characterized by a different vertebral structure.

Vertigo – is a symptom, rather than a condition itself. It's the sensation that you, or the environment around you, is moving or spinning.

Vesicoureteral reflux (VUR) – is a condition in which urine flows retrograde, or backward, from the bladder into the ureters/kidneys.

Visceral metastases – areas of cancer spread, to the liver, lungs, or other organs in the body.

Vitiligo – is a long-term skin condition characterized by patches of the skin losing their pigment. The patches of skin affected become white and usually have sharp margins. The hair from the skin may also become white. The inside of the mouth and nose may also be involved.

Vocal cord – are two bands of elastic muscle tissue. They are located side by side in the voice box (larynx) just above the windpipe (trachea). Like other tissues in the body, vocal cords can be strained and damaged.

Vocal cord stripping – is when the doctor uses a long surgical instrument to strip away the superficial layers of tissue on the vocal cords. This can be done to biopsy and treat some stage 0 cancers (carcinoma in situ) of the vocal cords. Most people can speak normally again after recovering from this operation.

Voice box (larynx) – the part of the respiratory tract between the pharynx and the trachea, having walls of cartilage and muscle and containing the vocal cords enveloped in folds of mucous membrane.

Volitional fatigue – better known as momentary muscle failure or the point at which you can't do another repetition without "cheating."

Vomit – to eject part or all of the contents of the stomach through the mouth, usually in a series of involuntary spasmic movements. The act or an instance of ejecting matter from the stomach through the mouth.

Votrient® (Pazopanib) – also blocks several tyrosine kinases. These kinases are involved in cancer cell growth and the formation of new blood vessels. It is taken as a pill once a day.

Wedge resection – a surgical procedure to remove a triangle-shaped slice of tissue. It may be used to remove a tumor or some other type of tissue that requires removal and typically includes a small amount of normal tissue around it. It is easy to repair, does not greatly distort the shape of the underlying organ and leaves just a single stitch line as a residual.

Whipple procedure (pancreatoduodenectomy) – a type of surgery used to treat pancreatic cancer. This operation is performed to treat cancerous tumors on the head of the pancreas, or those involving the common bile duct, and the duodenum.

White blood cell (leukocyte) – a type of immune cell made in the bone marrow and found in the blood and lymphatic tissue. Leukocytes help the body fight infections and other diseases.

Wide surgical excision – surgery to remove the cancer and a margin of normal tissue extending to 2-3 centimeters in all directions from the tumor site. This procedure usually takes away a significant amount of muscle and may involve resecting nerves that can affect function and leave areas of numbness.

Windpipe (trachea) – is a tube that connects the pharynx and larynx to the lungs, allowing the passage of air.

X-ray – a type of electromagnetic radiation, just like visible light. An x-ray machine sends individual x-ray particles through the body. The images are recorded on a computer or film. Structures that are dense (such as bone) will block most of the x-ray particles and will appear white. Metal and contrast media (special dye used to highlight areas of the body) will also appear white. Structures containing air will be black, and muscle, fat, and fluid will appear as shades of gray.

Xgeva® (Denosumab) – is a new medication that blocks a molecule involved in the formation of bone abnormalities caused by prostate cancer. It has recently been approved by the FDA for preventing bone complications related to metastatic disease.

Xeropthalmia – abnormal dryness of the conjunctiva and cornea of the eye, with inflammation and ridge formation, typically associated with vitamin A deficiency.

Xerostomia – is defined as dry mouth resulting from reduced or absent saliva flow.

Wilm's tumor – **is a pediatric form of kidney cancer and is very rare among** adults.

Yolk sac carcinomas – is the most common form of testicular cancer in children. These tumors are usually treated successfully in children, but when they develop in adults, it is a bigger concern. Yolk sac carcinomas respond very well to chemotherapy, even when they have metastasized.

Zoledronic acid (Zometa) – is the current standard of care for men with metastatic prostate cancer. It helps to prevent bone pain and fractures in men with metastatic prostate cancer.