

Cancer Exercise Specialist®

HANDBOOK

By Andrea Leonard
MS, CES, PES, CPT



Module One
14th Edition



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The Cancer Exercise Specialist® Handbook, Module One; Andrea Leonard, MS

The Cancer Exercise Specialist® Handbook, Module One

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The research findings in this document include recent updates in 2021 - 2023. The statistics quoted are based on data sources used by cancer.org and other international sources where the most recent source statistics are from 2020.



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



*Morton Beres
1935-2014*

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General Information

This CES series of handbooks are designed to help qualified individuals prepare for the 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 CES handbook.

Workshop Information

CES 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 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 www.thecancerspecialist.com under the professionals tab.

Qualification Information

CES qualifications encompass cognitive and practical competencies and are evaluated in multiple choice format during the examination. The candidate must successfully complete each of the four exams to receive their **CES Advanced Qualification**. Additionally, current CardioPulmonary Resuscitation (CPR) certification is required to maintain the qualification.

Multiple choice examination – Throughout each section of the online course there are multiple choice questions to assess your understanding of each section. Questions are drawn from the CES handbook and lecture/video content. At the end of the four modules, there will be a 125 question final examination that you must receive a grade of 80% or better on. Upon completion and passing of the course and exams, you will be able to print out a formal certificate. 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. In order to add your contact information to the International Cancer Exercise Specialist® Online Directory, please email CETI with contact information and credentials that you would like listed.

Cancellation Policy

The following policy applies to workshop cancellations:

The Cancer Exercise Training Institute has the right to cancel a workshop with two-weeks’ notice due to low attendance. We are not responsible for reimbursing travel expenses that you may have incurred.

- 1. Once you are registered for a live workshop or webinar, there will be **NO REFUNDS**.
- 2. If a workshop is cancelled due to low attendance, an attempt will be made to reschedule it for another date. You may participate in the home-study program which will allow you to obtain your CES Advanced Qualification and CEU's over the course of **180 days**. Following notification of workshop cancellation, you have **14 days** to request a refund. After 14 days there will be no refunds.
- 3. The Cancer Exercise Training Institute (CETI) has the right to cancel a workshop with a two-week notice due to low registration. CETI is not responsible for reimbursement of travel expenses incurred.
- 4. If you are unable to attend a workshop for any reason, you may convert your registration to a home-study which will allow you **180 days** to complete.

- 5. Once you have attended a live workshop, there will be **NO REFUNDS** given.
- 6. We want you to be happy with the course! However, if the timing doesn't work, or you are not satisfied with your purchase, you have **14 days** to request a refund if you have not moved beyond **Module 1**. After 14 days, or once you move beyond Module 1, there will be no refunds.

Cancer Exercise Specialist® Advanced Qualification

The Cancer Exercise Specialist® (CES) is a professional qualified to assess, design, and implement individual and group exercise programs for individuals diagnosed with cancer. The CES is skilled in evaluating health behaviors and risk factors, conducting comprehensive fitness assessments, writing appropriate exercise recommendations, and motivating individuals to modify negative health habits and maintain positive lifestyle behaviors for health promotion. The CES will have a complete understanding of the entire cancer process from diagnosis to treatment, recovery, prevention of lymphedema, and contraindications. The qualification process includes demonstrating competency through a comprehensive multiple-choice examination. It is granted work related experience within the health and fitness or medical field.

RECOMMENDED QUALIFICATIONS

1.	2.	3.	4.	5.	6.
Educational training comparable to an undergraduate degree in health and fitness or a closely related field	Adequate knowledge of and skill in risk factor identification, fitness appraisal, exercise recommendations, and basic nutrition	Demonstrated ability to incorporate suitable and innovative activities that will improve an individual’s functional capacity in conjunction with their cancer treatment and surgical procedures	Demonstrated ability to effectively counsel individuals regarding lifestyle modification	Demonstrated competence in the knowledge and skills required for the CES	Current CPR



Course Description

Health and fitness professionals will expand their knowledge base by learning all stages of cancer treatment, side-effects, and reconstructive procedures and how they apply to and/or contradict exercise programming.

No two clients will have the same exercise and physical activity recommendations; each person is unique given their many permutations and combinations of their own health challenges and pre-existing medical and orthopedic conditions.

Objectives:

- Demonstrate an understanding of the diagnosis and treatment of cancer
- Demonstrate an understanding of the different surgeries, including breast reconstruction and the impact of these surgeries on physical mobility
- Understand the signs and symptoms of upper and lower extremity lymphedema and how to prevent, identify, and manage it
- Perform a comprehensive postural assessment to determine muscle imbalances and address chronic pain issues
- Perform joint range of motion assessments with a goniometer to determine the cause of ROM limitations
- Develop a comprehensive rehabilitation program using a variety of approaches including Group Fitness, Personal Training, BOSU®, Pilates, and Yoga exercises
- Develop a strategic exercise program and progression for each client/patient

The Role of a Cancer Exercise Specialist®

Responsibilities:

- Improve overall physical strength and flexibility
- Correct muscle imbalances
- Prevent/manage lymphedema and other potential side-effects of treatments
- Increase range of motion and correct postural deviations
- Reduce pain and fatigue
- Design, prescribe, and teach personalized programs
- Stay in the “educational loop” – this is only the first step in your educational process as a Cancer Exercise Specialist®. The information is ever-changing, and it is critical for you to stay on top of current research and changes in the medical arena.

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) The CES certification is good for:

- a) one year
- b) two years

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. B

DR. BRIAN KUNAKOM



Dr. Kunakom is a Naturopathic Doctor at Bumrungrad International Hospital in Bangkok, Thailand. He did his undergraduate training at UC Santa Barbara and completed his Doctor of Naturopathic Medicine training at Bastyr University in Seattle, Washington. He is a physician who focuses on mitochondria health with advanced skills in Natural, Holistic, Physical, and Complementary Alternative Medical Practice. His reputation includes an extensive understanding of mitochondria health amongst the cancer population. He is distinguished by his advanced knowledge of subject matter in integrative oncology medicine treatments. During his years as a medical student, he had an interest in exercise medicine, which made him complete 2 full marathons along with receiving training with the Kinesio Taping Association for his certification as CKTP. Until today, he continues to volunteer at marathon events in Bangkok as part of the medical team.

Both of my parents have cancers. My father was diagnosed with prostate cancer in 2015. Two years later, my mother was diagnosed with three different types of cancer: breast, colon and lung. Because their cancers were all early stages, they only required surgery, and were considered in remission thereafter. Then in 2019, both of them had recurrences of their cancers. My mother's colon cancer metastasized to the brain and spine, while my father's prostate cancer recurred in the bones and lymph nodes.

As a Naturopathic physician and an integrative medicine practitioner, I realize the dichotomy between chronic disease management and cancer management. Chronic disease requires lifestyle modification as the foundation of health, along with regular surveillance throughout the patient's lifetime. However, conventional cancer care treats cancer as an acute disease, with treatments perceived by the general public as a quick cure. Patients are often unsatisfied with answers like "it is uncertain how long your treatments may take" or "there is a chance for recurrence". We commonly expect cancer to be curable and rarely put in the effort to reverse the disease process. This was no different for my parents or even myself.

When I first studied medicine and during my early years as a physician, my beliefs aligned with standard guidelines despite my naturopathic medicine training, supposing that clinical trials and meta-analyses have? clear success rates compared to anecdotal and alternative treatments. Clinical trials and meta-analyses usually entail large populations of participants who undergo intervention being compared to a control group; the larger the number of participants in the study, the more credible the results. Whenever patients allude to testimonials, the academic world would treat such cases as single-participant studies (also known as $n=1$) which would not give such experiences any credibility. It was only when I guided my own parents' treatments that I quickly realized that $n=1$ becomes significant when that participant is a family member or yourself.

As my parents received surgery, they were told that they were in remission, also perceived as "cured". Surveillance of cancer is usually frequent in the first year, with scans performed every 3-6 months and then annually. During this time, they followed the standard of care, which did not discuss lifestyle modification. They returned to their previous lifestyles of poor nutrition, lack of exercise, and high-stress work. When their cancers recurred, they felt betrayed and hopeless that their bodies had failed them.

Under standard care and statistics, my mother was expected to be cancer-free for only 18 months after surgery and whole brain radiation. There were no treatments indicated until we found another mass in her body. I found the "watch-and-wait" or surveillance game uncomfortable and debilitating.

This was when I decided to turn to integrative medicine to help decrease side effects, create synergies with conventional medicine, and hopefully improve their quality of life. I purchased a hyperbaric chamber, pushed them for fecal microbiota transplantation, raised funds to get them cell therapy, and placed an enormous financial burden on myself. It was a difficult journey, as my parents entrusted me with their medical decisions, though the standard of care recommended them to "watch-and wait". Our relationships suffered as a result.

That same year, I was invited to Asia Fitness Conference to discuss the theory of exercise on cancer patients. In preparation for my talk, I learned that cancer is primarily caused by environmental factors. Nutrition, exercise, and stress management are examples of action plans that every individual has the capability to take action from their homes. Sitting in the audience was my soon-to-be co-educator for the Cancer Exercise Specialist course, Steven Chew, who walked up to me after my presentation to introduce CETI and insisted I take the course myself. I took a leap of faith and flew to Hong Kong where I met my instructor and the Cofounder of CETI, Andrea Leonard.

Andrea Leonard is a cancer survivor, a teacher, an amazing athlete, and an inspiration to those affected by cancer. With no background in medicine, but through her own perseverance as a personal trainer, she was able to overcome the side effects of surgery and radioactive iodine therapy. Often the long-term side effects of such therapy include bone loss, muscle loss, permanent hypothyroidism, weight gain, and immune suppression, but Andrea is now amazingly healthy and fit, and is teaching CETI.

Cancer was once thought to be hereditary, but more and more we are finding it to be influenced by environmental factors. Even if a person is diagnosed with stage 1 cancer and has been “cured”, I have too often seen it recur after 10-15 years. Andrea’s story as an over 30-years cancer survivor through lifestyle modification is a shining example of the body’s ability to heal itself.

This personal effort by patients deserves credit whenever the treatment is successful. We often celebrate doctors for successful outcomes, however we too often ignore the role of the patient in those successful outcomes. The patients have to make the hard decision to accept chemotherapy, knowing that it would destroy their bodies for the mediocre chance of success. To enhance their chances of success, the patients have the greatest control over their lifestyle choices. While the doctor has control over the standard-of-care treatments, the patient is often left confused about if or what they should change in their day-to-day behavior. Both doctors and patients should recognize the role the patients and their lifestyles play in treatment success. As a physician, I have the courtesy to admit that we take lifestyle modification for granted.

Because I wanted to apply what I learned to my parents and patients, I decided to start exercising as well. As weeks turned into months, my mindset slowly changed. I started gaining mental clarity, strength, and aesthetics. Exercise started as a physical journey and has now transformed into a ritual that I found connects my mind, body, and spirit. It is as if I had opened my third eye with the epiphany that self-discovery of self-care is the first step to helping others achieve the same results. My patients became empowered by every session that they had with me, whether it was integrative treatments, nutrition, or exercise.

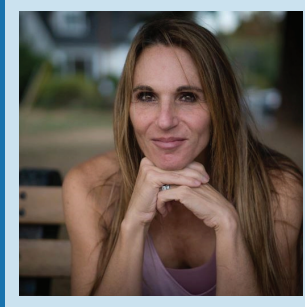
My relationship with my parents transformed from forcing them into treatments to realizing that everyone has his/her/their own timing for developing a healthy lifestyle. Taking on the responsibility of someone’s disease is no different from being a dictator. In the attempt to heal my parents, I have healed myself. I would be considered a co-survivor in a cancer survivorship model. When we are treating cancer patients, we are also treating those around them (in this case, myself)

I did not take the Cancer Exercise Specialist certification to improve my financial portfolio, but I needed CETI to become a better physician, son, friend, student, and a better human-being. To this day, words cannot express how proud I am to be one of the CETI’s educators. I am honored to be working with Andrea Leonard.

I understand that not everybody would have a transformative experience like myself, but at least the readers can know that CETI inspired a physician to become a better person. To every cancer survivor, co-survivor, healthcare practitioner, and fitness coaches, I hope that my story resonates with you and guides you through the important journey of cancer fitness as you go through this course. I look forward to seeing the growth of this community that empowers cancer patients.

Thank you for making CETI part of your fitness journey and welcome to CETI.

BIOGRAPHY



Andrea Leonard earned her BA from the University of Maryland in 1990 and earned her MS from Rocky Mountain University of Health Professionals in 2023. She was the PFP Club Industry 2019 Personal Trainer of the Year and has been certified as a Conditioning Specialist by the National Sports Professionals Association (NSPA), Personal Trainer by the American Council on Exercise (ACE), Health and Fitness Instructor by the American College of Sports Medicine (ACSM), Optimum Performance Trainer, Performance Enhancement Specialist and Corrective Exercise Specialist by the National Academy of Sports Medicine (NASM), and as a Special Populations Expert by The Cooper Institute.

Andrea is also a continuing education provider for ACE, AFAA, CanFitPro, CIMSPA, DRD-Puerto Rico, ESSA, FAI, ISSA, NASM, NFSA, NSCA, WITS, and YMCA.

A cancer survivor herself at age eighteen, Andrea watched her mother struggle through two breast cancer diagnoses over the course of twenty years (and in 2019 a third diagnosis - this time metastatic breast cancer). Watching the pain and suffering that her mother needlessly endured, “frozen shoulder,” narcotics addiction – due to chronic pain from an axillary node dissection, negative postural deviations from bi-lateral mastectomies and attempted reconstruction, staph infections, osteoporosis, etc. Andrea was bound and determined to help the millions of cancer survivors out there looking for answers on how to take back control of their life.

Andrea, along with a team of medical professionals from Georgetown University Hospital, Johns Hopkins Medical Center, and The George Washington Medical Center, spent three years working on her first book, “Essential Exercises for Breast Cancer Survivors.

Wanting to spread her knowledge about exercise, and the important role it plays in breast cancer recovery, Andrea founded the Breast Cancer Survivor’s Foundation (an Oregon-based 501-C3 corporation) in 2001. In 2004, after her father’s diagnosis of bladder and prostate cancer, she realized that there was an even greater need to help people suffering through many different types of cancer and she founded the Cancer Exercise Training Institute and the first edition of the “Cancer and Exercise Specialist Handbook,” was written. Andrea developed a curriculum for health and fitness professionals and began teaching live and virtual workshops to spread the gospel to others. Andrea has trained over 18,000 Cancer Exercise Specialists in 55 countries and continues to develop and expand course offerings to maintain CETI’s gold standard of education in the health and fitness industry.

Andrea has been a guest speaker for several international and national fitness organizations, including IDEA World, Functional Aging Summit, Medical Fitness Tour, TSI -Town Sports International Summit, Northwest Strength & Conditioning Clinic, Medical Fitness Association Annual Conference, and IHRSA – International Health, Racquet, & Sports club Association Annual Conference, as well as appearing regularly on AM Northwest. Andrea has been interviewed by The Oregonian, The Portland Tribune, The Lake Oswego Review, The West Linn Tidings, The Washington Post, The LA Times, The Dallas Morning News, The New York Times, NASM Training Edge Magazine, Capital Style Magazine, Heal Magazine, Club Solutions Magazine, The Examiner, Club Industry, PFP Magazine and more. You can learn more information about The Cancer Exercise Training Institute at www.thecancerspecialist.com

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 2020, an estimated 19.3 million people around the world were diagnosed with cancer, and almost 10 million died from the disease.³¹ By 2040, those figures will nearly double, with the greatest increase in low and middle-income countries, where more than two thirds of the world's cancers will occur.²³⁰ Cancer is the cause of about 30% of all premature deaths from noncommunicable diseases among adults aged 30-69.²³⁰ One third to one half of cancer cases could be prevented by reducing exposure to known risk factors.²³⁰

The most frequently diagnosed cancer is breast cancer (11.7% of all cases), followed by lung (11.4%) and colorectal cancers (10%).²³⁰ Lung cancer is the leading cause of death from cancer (24% of all deaths), followed by colorectal (9.4%) and liver cancers (8.3%).²³⁰ 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.²³⁰ Globally, the cancer burden will increase by at least 60% over the next two decades, straining health systems and communities.²³⁰ Cancer occurs in more than 400,000 children every year worldwide, and the rate is expected to increase.²³⁰

For both sexes combined, roughly one-half of the cases and over one-half of the cancer deaths in the world occurred in Asia in the year 2020, in part because close to 60% of the global population resides there.³¹ Europe accounts for 22.8% of the total cancer cases and 19.6% of the cancer deaths, although it represents only 9% of the global population, followed by North Americas' 13.3% of incidence and Latin America and the Caribbean's 7.2% of mortality worldwide.³¹ 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.³¹ By 2040, the global burden is expected to grow to 28.4 million new cancer cases and 16.3 million cancer deaths simply due to the growth and aging of the population.³¹

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.¹⁴⁵

1. **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 cells look flat, like fish scales, when viewed under a microscope. 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 10%:¹⁴⁵

- **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).¹⁴⁶ 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).¹⁴⁶ 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.¹⁴⁷ 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.

These connections are the focus of a study published in *The Lancet Diabetes and Endocrinology*. The researchers looked at data on 12 types of cancer from 175 countries and found approximately six percent of new cancer cases worldwide (nearly 800,000) in 2012 were caused by the combined effects of diabetes and overweight or obesity.¹⁴⁸ Among individual risk factors, being overweight was responsible for twice as many cancers (3.9 percent) as diabetes (2 %).¹⁴⁸ AICR research shows that adults with diabetes have about twice the risk of developing cancers of the liver, pancreas, and endometrium.¹⁴⁸ There's a clear but smaller increase in risk for colon and breast cancers. Excess body weight was responsible for 3.9% of cancer globally (544,300 cases in 2012) according to a new report.¹⁴⁹

In men, liver cancer was the most common cancer caused by diabetes and high BMI, accounting for 126,700 cases, and colorectal cancer was second, accounting for 63,200 of cancer cases. In women, 147,400 breast cancer cases constituted 29.7% of all cancers attributable to diabetes and high BMI.¹⁴⁹ Endometrial cancer was second, accounting for 121,700 new cancer cases or 24.5 per cent of all diabetes and high BMI related cancers.¹⁴⁹

In addition, being overweight and obesity cause 15% to 20% of all cancer-related deaths each year.¹⁵⁰ Several studies have explored how being overweight or obese may increase cancer risk and growth.¹⁵⁰ People who are obese have more fat tissue, which can produce hormones, such as insulin or estrogen, and may cause cancer cells to grow. How much a person weighs throughout various points in his or her life may also affect the risk for cancer. Research has shown that the following are modestly associated with an increased risk:¹⁵⁰

- **High birth weight**
- **Weight gain during adulthood**
- **Gaining and losing weight repeatedly**

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*.

GENETICS

There are at least 50 hereditary cancer susceptibility syndromes that have been identified; although heredity only accounts for about 5-10% of all cancers.¹⁵² In these cases, the cancer is caused by an abnormal gene that is being passed along from generation to generation. This takes place when an abnormal gene that can lead to cancer is inherited.

Genes are pieces of *DNA*. They contain the instructions on how to make the proteins the body needs to function, when to destroy damaged cells, and how to keep your body's cellular composition in balance. They control everything that makes you *YOU* and they can also affect your risk of getting cancer. When there is an abnormal change in a gene it's called gene mutation.

The 2 types of mutations are inherited and acquired (somatic):

- An inherited gene mutation is one that is transmitted through genes that have been passed from parents to their offspring
- Acquired (somatic) mutations are changes in DNA that develop throughout a person's lifetime

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 American Cancer Society) are cancers that are more likely to occur from an inherited gene:

- Many cases of an uncommon or rare type of cancer
- Cancers occurring at younger ages than usual
- 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)
- More than one childhood cancer in a set of siblings (like sarcoma in both a brother and a sister)
- Cancer occurring in the sex not usually affected (like breast cancer in a man)

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. 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.

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, colon and endometrial cancers tend to go together in a syndrome called hereditary non-polyposis colorectal cancer – Lynch syndrome).

The age at which someone is diagnosed is also important. For example, colon cancer is rare in people under thirty.¹⁵³ Having two or more cases in close relatives under thirty years of age could be a sign of an inherited cancer syndrome.¹⁵³ 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.¹⁵⁴

FAMILY CANCER SYNDROMES

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.
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.
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. 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, according to the National Institutes of Health.³²⁸ The mutations have also been found in some brain tumors and in osteosarcoma, a form of bone cancer. The risk of breast cancer in women with a CHEK2 mutation is believed to be at least double that of women without such a mutation.³²⁸ Most individuals who carry a mutation in CHEK2 have one normal copy of the gene and one mutated copy.⁴⁰ Because children inherit one copy of each gene from each of their parents, people with a CHEK2 mutation have a 50% chance of passing on the mutation to their children.³²⁸
7. **Cowden Syndrome (CS)** – is characterized by multiple tumor-like growths and an increased risk of certain cancers. Most patients with CS develop small, non-cancerous growths, or hamartomas, of the skin and mucous membranes, but these growths can also occur in the intestinal tract or brain. Individuals with CS also have an increased risk of developing benign and malignant tumors of the breast, uterus, and thyroid. CS is associated with mutations in the PTEN gene.
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.³²⁹ ERCC3 gene mutations have been found in several inherited syndromes, including a condition called xeroderma pigmentosum.³²⁹ People with this condition have a very high risk of developing skin cancer and other types of cancer.³²⁹
9. **Familial Adenomatous Polyposis (FAP, MIM 175100)** – accounts for approximately 1% of hereditary colorectal cancer. It is characterized by the development of hundreds to thousands of adenomatous polyps throughout the colon and rectum, with an extremely high lifetime risk of colon cancer. It is an autosomal dominant condition caused by germline mutations in the adenomatous polyposis coli (APC) gene and affects about 1 in every 5000–10,000 people (*Burn et al., 1991; Jarvinen, 1992*). Most individuals (75– 80%) will have an affected parent while the remainder is the result of a new mutation.¹⁵⁵ While penetrance is almost complete, there is significant variability within and between families.
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. FAMMM also increases the risk of melanoma of the eye and pancreatic cancer. FAMMM is also called dysplastic nevus syndrome.
11. **Familial Colorectal Cancer (FCC)** – up to 15% of colorectal cancer patients have family members with colorectal cancer, but do not have a known colorectal cancer syndrome such as familial adenomatous polyposis (FAP) or hereditary nonpolyposis colon cancer (HNPCC)⁹¹. Colon cancer in these families may appear to follow an autosomal dominant pattern of inheritance. As genetic research continues, genes may be identified to explain these family histories.
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.

- 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. Fanconi anemia is different from Fanconi syndrome, a rare kidney disorder.
- 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.
- 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 bi-lateral breast cancer while some had breast and ovarian cancer. Scientists who studied the genes of these families, discovered the genes **BRCA1** and **BRCA2**. Because some women (and families) have HBOC based on cancer history, but don't have mutations in these genes, scientists believe that there must be at least one more gene that may cause HBOC. This had been named **BRCA3** but has not yet been identified. Mutations in either **BRCA1** or **BRCA2** can lead to HBOC. The risk of breast and ovarian cancer is very high when there are mutations in either gene, but seem to be higher with **BRCA1** mutations.

Along with breast and ovarian cancer, this syndrome can also lead to fallopian tube cancer, primary peritoneal cancer, male breast cancer, pancreatic cancer, prostate cancer, as well as some others. Male breast cancer, pancreatic cancer, and prostate cancer can be seen with mutations in either gene, but are more common in people with **BRCA2** mutations. In the United States, mutations in the **BRCA** genes are more common in people of Ashkenazi Jewish descent. Women with a strong family history of breast cancer and/or ovarian cancer may choose to undergo genetic counseling to estimate their risk for having a mutation in one of the **BRCA** genes. The genetics professional estimates the risk based on the patient, as well as their family history of cancer. If they seem to be at high risk, they may recommend genetic testing. If a mutation is present, the woman has roughly an 87% chance of developing breast cancer and a 50% chance of developing ovarian cancer during their lifetime.^{34, 39, 40} She may take extra steps to identify cancer early (mammogram, ultrasound, MRI, etc.) or may even consider prophylactic *mastectomy* and *hysterectomy*.

If someone in a family is found to have a BRCA mutation, it means that their close relatives (parents, siblings, and children) have a 50% chance of having a mutation, too.^{34, 39, 40}

- 16. Hereditary Diffuse Gastric Cancer** – HDGC is an inherited genetic condition that is rare. This means that the cancer risk and other features of HDGC can be passed from generation to generation in a family. The gene most commonly associated with HDGC is called **CDH1**. A mutation (alteration) in the **CDH1** gene gives a person an increased risk of developing gastric cancer and other cancers associated with HDGC. Researchers believe that other genes, including **CTNNA1**, may be associated with HDGC. Studies are ongoing to learn more about all of these genes, and testing for inherited genetic mutations in these newer genes is currently not recommended except in clinical trials. Normally, every cell has 2 copies of each gene: 1 inherited from the mother and 1 inherited from the father. HDGC follows an autosomal dominant inheritance pattern, in which a mutation happens in only 1 copy of the gene. This is called a germline mutation. This means that a parent with a gene mutation may pass along a copy of their normal gene or a copy of the gene with the mutation. Therefore, a child who has a parent with a mutation has a 50% chance of inheriting that mutation. A brother, sister, or parent of a person who has a mutation also has a 50% chance of having the same mutation. However, if the parents test "negative" for the mutation (meaning each person's test results found no mutation), the risk to the siblings significantly decreases but their risk may still be higher than an average risk.

- 17. Hereditary Leukemia and Hematologic Malignancies Syndromes** – there are about a dozen inherited genetic mutations that can lead to leukemia and related blood diseases such as myelodysplastic syndrome, acute myeloid leukemia and aplastic anemia. It is estimated that about 5-10% of all leukemia cases are hereditary. Leukemia patients with a family history of the disease should consider genetic testing to learn if their disease has an inherited component. This information may impact a patient's treatment plans.

- 18. Hereditary Non-Polyposis Colorectal Cancer (HNPCC), or Lynch Syndrome** – is the most common inherited syndrome that increases a person's risk for colon cancer^{44, 45, 47}. Most of these cancers occur before age 50.^{44, 47} Although the name says "non-polyposis," people with HNPCC can get polyps, but they only have a few, not the hundreds that are seen in another syndrome that causes colon cancer called *familial adenomatous polyposis*. HNPCC also leads to a high risk of endometrial (uterine) cancer. HNPCC is also linked to: cancer of the *ovary, stomach, small intestine, pancreas, kidney, brain, ureter tubes, and bile duct*. HNPCC can be caused a mutation in one of several genes, including **MLH1, MSH2, MLH3, MSH6, PMS1, PMS2, and TGFBR2**. Most of these genes are involved in DNA repair. Mutations in the genes that cause HNPCC can be found through genetic testing known as the Amsterdam criteria and the revised Bethesda guidelines.

Another option for people with colorectal or endometrial cancer is to have the tissue biopsied to look for changes that may be caused if one of these genes is faulty. These changes are known as microsatellite instability (or MSI). If no MSI is found, it implies that HNPCC is not present and that the genes that would be likely to cause it are normal.

If MSI is present, they may have HNPCC, and so are referred for genetic counseling and possible testing. Someone who is known to carry an HNPCC gene mutation may start screening for colorectal in their early 20s.⁴⁴ Women with HNPCC may start screening for endometrial cancer or undergo a hysterectomy. If someone in a family is found to have HNPCC, it means that their close relatives (parents, siblings, and children) have a 50% chance of having a mutation, too.^{44, 45, 47}

- 19. Hereditary Retinoblastoma** – is caused by an inherited RB1 gene mutation or an RB1 gene mutation that happens in the egg or sperm before conception and is passed on to the child. Children with hereditary retinoblastoma will usually develop retinoblastoma in both eyes, and have an increased risk of developing bone cancer, soft tissue sarcoma and melanoma later in life.
- 20. Juvenile Polyposis Coli** – is a rare, childhood-onset disease and an autosomal dominant disorder that results from mutations in various cancer susceptibility genes, including the SMAD4/DPC4 and BMPR1A genes. The condition is associated with the development of hamartomatous polyps that can be present throughout the gastrointestinal tract. Juvenile polyposis is associated with an increased chance for gastrointestinal and pancreatic cancers. Most patients appear to be sporadic cases (happening for the first time in a family).
- 21. Li-Fraumeni Syndrome** – is a rare syndrome that can lead to the development of a number of: *osteosarcoma, soft-tissue sarcomas, leukemia, brain & central nervous system cancers*, cancer of the *adrenal cortex*, and *breast cancer*. The cancers most often occur in childhood, although breast cancer occurs in young adults. People with Li-Fraumeni can also be affected by more than one cancer in their lifetime. They also seem to be at higher risk of *cancer from radiation therapy*, and so doctors treating these patients may try to avoid giving them radiation when possible.

This syndrome is most often caused by inherited mutations in the gene for p53 (*TP53*, a tumor suppressor gene).^{41, 45, 47} A normal gene for p53 stops the growth of abnormal cells. It can also be caused by mutations in a gene called CHEK2.⁴⁶

22. Lynch Syndrome – about 2% to 3% of colorectal cancers are caused by Lynch syndrome. People with Lynch syndrome (also called hereditary non-polyposis colorectal cancer, or HNPCC) have a mutation in 1 out of 4 genes that normally correct mistakes when DNA is copied during cell division. These genes are called DNA mismatch repair (MMR) genes. People with Lynch syndrome have a high risk of colorectal cancer. When colorectal cancer develops in people with Lynch syndrome, it usually happens before age 50. Lynch syndrome also increases the risk of endometrial cancer, pancreatic, ovarian, stomach, and small intestine cancers.

23. Multiple Endocrine Neoplasia (MEN) Syndromes – received their name because they predispose people to develop tumors of the endocrine glands. The endocrine system is comprised of glands that secrete hormones into the bloodstream that control numerous processes within the body. The endocrine system is instrumental in regulating mood, growth and development and metabolism, as well as sexual function and reproductive processes. The major glands of the endocrine system affected by the MEN syndromes are the pituitary, thyroid, parathyroid, adrenals and pancreas. Currently, there are two distinct MEN syndromes: MEN1 and MEN2. In some ways, the two syndromes are similar, but there are important differences.

24. MUTYH-Associated Polyposis (MAP) – is a rare, hereditary condition in which a person has numerous adenomatous polyps (abnormal tissue growths) in their colon and rectum. People with harmful mutations in the MUTYH (formerly called MYH) gene can develop several different types of polyps in their large intestine, including adenomas, sessile serrated polyps, and hyperplastic 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.

25. 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.

- 26. PalB2** – carrying the PalB2 gene can dramatically increase a woman's risk of breast cancer. Women carrying the PalB2 gene have a 33% chance of getting breast cancer by age 70: the risk being even higher in women with a family history of breast cancer.¹⁵⁷ If a mutation carrier has a strong family history, the risk goes up to 60% by age 70.¹⁵⁷ The PalB2 mutation follows behind the BRCA1 and BRCA2 genes as the top genetic risk factor for breast cancer.¹⁵⁷ Women who undergo a prophylactic mastectomy may reduce their risk of breast cancer by 90%.⁹¹⁻⁹³
- 27. Peutz-Jeghers Syndrome** – is caused by a mutation in the STK11 (also called LKB1) tumor suppressor gene and causes a large number of polyps to develop in the gastrointestinal tract. It also causes dark spots on the lips, inside the mouth and on other mucous membranes. Peutz-Jeghers syndrome increases the risk of colorectal, stomach, pancreatic, small intestine, and breast cancers. It also increases the risk of bowel obstruction.
- 28. POT1** – encodes protection of telomeres protein 1 (POT1), which together with other components of the telomere associated protein complex (shelterin), regulates telomerase access to the telomere and suppresses the DNA damage response.³³⁰ POT1 tumor predisposition (POT1-TPD) is characterized by an increased lifetime risk for multiple cutaneous melanomas, chronic lymphocytic leukemia (CLL), angiosarcoma (particularly cardiac angiosarcomas), and gliomas.³³⁰ Additional cancers (e.g., colorectal cancer, thyroid cancer, breast angiosarcomas) have been reported in individuals with POT1-TPD but with very limited evidence.³³⁰ The age of onset for first primary cutaneous melanoma ranges from 15 to 80 years. The majority of POT1 associated cancers are diagnosed in adulthood.³³⁰
- 29. Rb1** – an altered form of Rb1, retinoblastoma gene, is associated with cancer of the eye in infants, and may increase bladder cancer risks.⁹¹ Somatic inactivation of RB contributes to the development of these tumor types as well as prostate, breast, lung, and bladder cancer.
- 30. Turcot Syndrome** – is related to Lynch syndrome and familial adenomatous polyposis (FAP). People with Turcot syndrome develop many polyps in the colon. Turcot syndrome is caused by a mutation in the APC, MLH1 or PMS2 gene. It increases the risk of colorectal cancer and brain cancer.
- 31. Von Hippel-Lindau Disease (VHL)** – is a multi-system disorder characterized by abnormal growth of blood vessels (called hemangioblastomas or angiomas). Hemangioblastomas may develop in the retina, certain areas of the brain, the spinal cord, and other parts of the nervous system. Other types of tumors can develop in the adrenal gland, kidney, and pancreas. Individuals with VHL also have a higher risk to develop certain types of cancer, especially kidney cancer. Nearly all individuals with VHL are found to have mutations in the VHL gene.¹⁵⁸
- 32. Werner Syndrome** – causes premature aging that begins during the teenage years. It is caused by a mutation in the WRN gene. People with Werner syndrome have an increased risk of developing bone cancer, melanoma, soft tissue sarcoma and thyroid cancer. Wiskott-Aldrich syndrome - affects blood cells and cells of the immune system. People with Wiskott-Aldrich syndrome have lower numbers of platelets, which can cause them to bruise and bleed easily. They also have a higher risk for infection because their immune cells don't work properly. Wiskott-Aldrich syndrome increases the risk of leukemia and lymphoma and is caused by mutations in the WAS gene.
- 33. Xeroderma Pigmentosum (XP)** – affects the skin so it can't repair sun damage like it normally would. When someone has XP, their skin is more sensitive to ultraviolet radiation from the sun. People with XP have a high risk of developing melanoma and non-melanoma skin cancers. XP is linked to mutations in several genes including the XPC, ERCC2 and POLH genes.



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

The most common system of staging is the TNM (tumor, node, metastases) system. TNM was developed and is maintained by the Union for International Cancer Control (UICC). It is also used by the American Joint Committee on Cancer (AJCC) and the International Federation of Gynecology and Obstetrics (FIGO). The following explains what the letters and numbers mean, however, the specific definitions for each category are different for each type of cancer that is staged using the TNM system:

PRIMARY TUMOR (T)

The letter "T" plus a number (0 to 4) describes the size and location of the tumor, including how much the tumor has invaded nearby tissues. Tumor size is measured in centimeters (cm). A larger tumor or a tumor that has penetrated deeply into the surrounding tissue receives a higher number. For some types of cancer, lowercase letters, such as "a," "b," or "m" (for multiple), are added to the "T" category to provide more detail.

REGIONAL LYMPH NODES (N)

The letter "N" plus a number (0 to 3) stands for lymph nodes. Lymph nodes near where the cancer originated are called regional lymph nodes. Lymph nodes in other parts of the body are called distant lymph nodes. In most cases, the greater the number of lymph nodes with cancer, the greater the number assigned. In some cases, the location of the lymph nodes with cancer may determine the "N" category.

DISTANT METASTASIS (M)

Metastasis (M). The letter "M" indicates whether the cancer has spread to other parts of the body (distant metastasis). If the cancer has not spread, it is labeled M0. If the cancer has spread, it is considered M1.

TUMOR GRADE

Tumor grade describes how normal or abnormal cancer cells look under a microscope. When the cells look more normal, the less aggressive the cancer is and the more slowly it grows and spreads. If the cells look more abnormal, the more aggressive the cancer and the faster it is likely to grow and spread. Tumor grade should not be confused with cancer stage. Stage refers to how large a cancer tumor is and how far the cancer has spread.²⁹¹ Systems for describing tumor grade can differ depending on the type of cancer.

- **Grade X:** Grade cannot be assessed (undetermined grade)
- **Grade 1:** Grade 1: Well-differentiated (low grade)
- **Grade 2:** Moderately-differentiated (intermediate grade)
- **Grade 3:** Poorly-differentiated (high grade)
- **Grade 4:** Undifferentiated (high grade)

STAGES OF CANCER

Most types of cancer have four stages: stages I (1) to IV (4). Some cancers also have a stage 0 (zero).

- **In situ (stage 0)** – cancer is still in its' original location and has not spread to nearby tissues
- **Localized (stage I)** – is typically a small cancer or tumor that has not penetrated deeply into nearby tissues or lymph nodes
- **Regional (stage II & III)** – is typically a larger tumor that has penetrated deeply into nearby tissue. It may have also spread to lymph nodes but not to other parts of the body
- **Distant (stage IV)** – the cancer has spread to other organs or parts of the body. It may also be called advanced or metastatic cancer



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 is 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 Cancer Exercise Specialist

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Although the survival rates for many cancers continue to improve, sadly not everyone diagnosed with cancer will survive. When cancer progresses and becomes terminal the CES still has so much to offer, particularly if you have been working with a client previously and have an established relationship.

"You matter because you are you. You matter to the last moment of your life. We will do all we can not only to help you die peacefully, but to live until you die." - Dame Cicely Saunders, Founder of the Modern Hospice Movement.

Let us first understand what palliative care is. The word palliative comes from the Latin word 'pallium' and means 'cloak', something in which you wrap yourself or another human being. This cloak symbolizes the care of the dying person and their family. The World Health Organization's definition of palliative care is an approach that improves the quality of life of patients and their families facing the problems associated with life-threatening illness, through the prevention and relief of suffering by means of early identification and impeccable assessment and treatment of pain and other problems, psychological, psychosocial, and spiritual.

Palliative care: provides relief from pain and other distressing symptoms:

- Affirms life and regards dying as a normal process
- Intends to neither hasten or postpone death
- Integrates the psychosocial and spiritual aspects of patient care

- Offers a support system to help patients live as actively as possible until death
- Uses a multidisciplinary (MDT) approach to address the needs of patients and their families
- Palliative care may include chemotherapy and radiotherapy to manage distressing symptoms

The MDT usually consists of different professionals, e.g. physician, nurse, physiotherapist, occupational therapist, social worker, dietician, chaplain, and complementary therapists. To be able to provide holistic care there is need for the whole team. The CES could be a helpful addition to this team. It is very important to refer clients back to their palliative care team if you have any concerns about changes to their condition, always err on the side of caution, as advised in previous modules, without being alarmist.

Palliative care has its roots in the modern hospice movement initiated by Dame Cicely Saunders. She was an English nurse, social worker, and later physician who, in her work found that the patients did not have just physical pain but also psychological, social and existential problems. She founded St. Christopher's hospice in London in 1967. Apart from being the first hospice it was also the first educational and research unit in this subject and continues to be.

The CES can help people to remain as active and independent for as long as their disease progression allows as well as assisting in symptom management alongside the client's healthcare team. It is much easier to maintain function than

regain it once it has been lost, therefore an assessment focusing on function (i.e. walking ability, getting in-out of chair, etc.) is best done proactively (Tiberini and Richardson, 2015).

It's often very supportive to set person-centered, realistic, short-term, flexible goals with your client which can help them maintain a sense of control and purpose. Maintaining the ability to dress oneself, walk short distances, manage the stairs etc. can be very important goals to work towards, even if the goal isn't achieved due to disease progression. Palliative care patients report functional loss as their most distressing symptom. The main aims of the CES working along-side a Physical therapist and Occupational therapist will be:

- **Functional rehabilitation** – to maintain or improve independence, reducing dependence on carers and encouraging self-management and a sense of control.
- **Non-pharmacological management** – symptom-interventions for pain, breathlessness, fatigue, and lymphoedema alongside nursing and medical care.
- **Exercise prescription** – individual programs aimed at improving muscle strength, flexibility, balance and mobility.
- **A key part of your support as a CES** – being watchful for deterioration in their mobility, refer your client back to their OT or PT for a mobility assessment as your client may benefit from a mobility aid (Zimmer frame, walking stick etc.). OT's can provide equipment and advice on how to make everyday task such as washing and dressing easier and safer (Tiberini and Richardson, 2015).

As a CES you may be pivotal in supporting people to achieve their final wishes, for example, I have supported an elderly train enthusiast to have one final ride on a steam train with his wife, another lady to walk on the beach and dip her toes in the sea one last time. In my experience it's a real privilege to be with and support people at this time in their lives.

Here is a link to some YouTube videos of both seated and standing exercise sessions from St Christophers Hospice, UK to give you some ideas around exercise prescription:

<http://www.youtube.com/playlist?list=PLPgtdSsS-chwP2n3xjicNv1LaeU3A-Rzy>

You may also be able to support your clients in the management of symptoms such as breathlessness and fatigue, again alongside the MDT. Here are some helpful tips from the UK charity Macmillan on managing breathlessness and fatigue:

macmillan.org.uk – cancer information and support – impacts of cancer A to Z – Breathlessness

macmillan.org.uk – cancer information and support – impacts of cancer A to Z - Fatigue

References: Tiberini, R and Richardson H. Rehabilitative Palliative Care: Enabling people to live fully until they die – a challenge for the 21st century, hospice UK, 2015.

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 themselves, 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. Often people are coping with their own problems, or maybe they are afraid of their own mortality, and simply can't "handle" it.

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 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 bonding 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 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 themselves. 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 Miriam-Webster, the immune system is the bodily system that protects the body from foreign substances, cells, and tissues by producing the immune response and that includes especially the thymus, spleen, lymph nodes, special deposits of lymphoid tissue (as in the gastrointestinal tract and bone marrow), macrophages, lymphocytes including the B cells and T cells, and antibodies. The human body is like a battlefield: every minute of every day there is a battle going on within our bodies. The immune system is our own personal army that defends us against infection and other harmful agents. The enemies are the pathogens, viruses, bacteria, and mutated cells that are programmed to do us harm. When our “army” is called into action, it responds by causing body aches, fever, inflammation, and swelling. It is “ramping-up” to fight a battle. Researchers at Northwestern University have concluded that immune cells known as macrophages stimulate cells in the heart muscle, helping to keep the heart pumping and maintain a steady beat.¹⁶⁰ Swedish researchers have also found evidence that immune cells clear out dead brain cells after a stroke and secrete substances that may allow the brain to repair damage.¹⁶⁰ The biggest problem with cancer is that cancer cells can find a way to not only evade our immune system’s defenses, but to use our immune cells (our army) to aid in their attack on our bodies.

Much like we have the Army, Navy, Marines, and Air Force, there are two “branches” of our immune systems; *innate and acquired*. Think of the innate system as the Navy fighter pilots that are on standby. They are our bodies first line of defense and are ready to attack as soon as they sense a threat. Among the cells in the *innate immune system*:

- **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.
- **Neutrophils** – are a type of white blood cell (WBC or granulocyte) that protects 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.
- **Dendritic cells** – 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.
- **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.
- **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.

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. Among the cells in the *acquired immune system*:

- **B-cells** – develop and mature in the bone marrow and make the antibodies that fight viruses and bacteria. They are at the center of the adaptive humoral immune system and are responsible for mediating the production of antigen-specific immunoglobulin (Ig) directed against invasive pathogens.
- **T-cells** – also form in bone marrow but mature in the thymus. There are two main types of T-cells: helper T-cells that stimulate B-cells to make antibodies, and killer T-cells that attack cells directly.

The immune system is critical in the fight against cancer. Researchers are not clear on what exactly causes our immune system to start losing the battle against cancer cells.

Humans coexist with a vast bacterial, fungal, and viral microbiome (complex ecosystem of thousands of different microorganisms that call our bodies home). The microbiome has been associated with obesity, inflammatory bowel disease, multiple sclerosis, diabetes (type 1 and type 2), allergies, asthma, and even autism. It is just now being viewed in relationship to cancer. In November 2016, Dr Jennifer Wargo, an Associate Professor at the University of Texas MD Anderson Cancer Center, presented results from her study examining more than 100 fecal samples from people with advanced malignant melanoma. Jennifer's study builds on the hypothesis that by altering gut bacteria we may be able to improve a patient's response to immunotherapies, increasing the numbers that could potentially benefit from a new line of cancer drugs.

Microbiome facts:

- The human microbiome is composed of the trillions of bacteria, archaea, viruses and eukaryotic microbes that live in and on our bodies
- Initial estimates were that microorganisms could outnumber human cells in the body by 10 to 1, but more recent figures suggest the ratio is actually much lower – 3 to 1 or even 1 to 1
- It is calculated that there are more than 10,000 different species occupying the human ecosystem
- There is an extraordinary diversity between the healthy microbiomes of different individuals
- The microbiomes of different organs within the body are distinct from one another
- 99% of the body's microbial mass is in the gut – which is why it's the most well-studied

In 1863, Rudolf Ludwig Carl Virchow, a German physician, anthropologist, biologist, and pathologist, hypothesized that the origin of cancer was at sites of chronic inflammation, in part based on his hypothesis that some classes of irritants, together with the tissue injury and ensuing inflammation they cause, enhance cell proliferation.¹⁶¹ Researchers are currently exploring what role the microbiome might play in the development of cancer. The microbiome appears to differ between those that have cancer and those that don't. Several species of bacteria are also potentially connected with cancer, with researchers finding them in higher proportions in people with the disease. Many researchers believe that our microbes' influence our immune system with their ability to increase or diminish inflammation and to manipulate the capabilities of our immune cells.¹⁶² Recent data have expanded the concept that inflammation is a critical component of tumor progression.¹⁶²

Many cancers arise from sites of infection, chronic irritation, and inflammation. While multiplication of cells alone does not cause cancer, sustained cell growth in an environment rich in inflammatory cells, growth factors, activated stroma, and oxidative stress certainly increases the risk of uncontrolled growth of abnormal tissue.

During tissue injury associated with a wound or injury, cell growth increases as the tissue works to regenerate; cell growth and inflammation subside after the area is healed or the stressors are removed. On the flip side, rapidly dividing cells that sustain somatic DNA damage, continue to grow in microenvironments that promote and support inflammation. This provides incredible potential that a certain microbiome may be a risk factor in the development of cancer and could possibly be used as a new diagnostic tool.

What causes changes in the gut microbiome?¹⁶

- **Climate Change** – climate change is altering the soil microbiome.³⁰¹ The bacterial, archaeal, and fungal hyphal community in soil respond to climate change by changing its community structure, becoming less plentiful, and going dormant.³⁰¹ Under typical conditions, in 1 g of soil, there are approximately 40,000–50,000 species of the microbiome.^{301,302} Conditions of climate change affect the respirations of the microbiome that influence the levels of carbon and nitrogen in the soil.^{301,302} The direct change in carbon and nitrogen levels affects the diversity and composition of the soil microbiome, decreasing the quality of the soil microbiome and fertility, and determining the quality of our food.³⁰¹ A change in environmental and living conditions has been shown to cause gut dysbiosis, interfering with the desirable condition for the gut microbiota and making us more susceptible to inflammatory diseases.³⁰⁴

As a result of having insufficient nutrients in our soil, we are witnessing greater food shortages and an increased risk of malnutrition.³⁰⁵ According to Genton, 2015, malnutrition alters the composition and function of the intestinal microbiota.³⁰⁵ In the initial stages, gut dysbiosis will present with mild symptoms such as abdominal pain and diarrhea. However, chronic dysbiosis increases the risk of inflammatory bowel disease, celiac disease, eczema, leaky intestine syndrome, obesity, diabetes, and autoimmune diseases.³⁰⁶

- **Food intake** – diet is now considered one of the most relevant factors influencing the gut microbiome.³⁰⁹ Significant changes in the gut microbiota have been associated with changes in diet, primarily the consumption of dietary fiber from fruits, vegetables, and other plants.³⁰⁹ A diversified and complex diet is associated with a more diversified microbiome.³⁰⁹ Zimmer et al conducted a study on the fecal flora of a large cohort of healthy individuals that were on a strict vegetarian or vegan diet with classical microbiological culture and compared them with age and gender-matched subjects consuming an omnivorous diet.³⁰⁹ The fecal microbiota of vegetarian and vegan subjects showed significantly lower microbial counts of Bifidobacterium, Bacteroides, E. coli and Enterobacteriaceae species and lower stool pH compared with omnivores.³⁰⁹ Compared to an omnivore diet, a vegetarian/vegan diet is associated with a higher carbohydrate and fiber content in which the undigestible polysaccharides can be fermented into short-chain fatty acids by the gut microbiota.³⁰⁹

- **Stress** – psychological and physical stressors activate the hypothalamic-pituitary-adrenal (HPA) axis, resulting in a series of hormonal responses including the release of corticotrophin-releasing hormone which induces the release of adrenocorticotrophic hormone systemically with then stimulates glucocorticoid synthesis (cortisol) in the adrenal cortex.³⁰⁷ Additionally, catecholamines (noradrenaline and adrenaline) are also released following psychological and physical stressors.³⁰⁷ The GI tract, or what we now refer to as the gut microbiota, is sensitive to stress and stress mediators.³⁰⁷ Enteric bacteria respond to the release of stress-related neurochemical mediators by the host which can influence the response to a bacterial infection.³⁰⁷ Current research suggests that bacteria act as delivery vehicles for neuroactive compounds, and therefore can affect host physiology by providing neurochemicals.³¹⁰
- **Exercise** – high-intensity exercise is a physiological stressor that can lead to immunosuppression and gastrointestinal distress.³¹¹ The degree of intestinal distress can range from mild to severe, and symptoms include nausea, bloating, cramping, vomiting, abdominal angina, and bloody diarrhea.³¹¹ Ticinesi et al., conducted a study that revealed exercising to exhaustion can disrupt the balance of both the gut microbiota and the immune system.³¹² Another study by Dalton et al., concluded that intense exercise creates increased gastrointestinal damage, mild endotoxemia, and intestinal permeability due to possible ischemia–reperfusion injury resulting from a momentary interruption of splanchnic blood flow.³¹² Abrupt spurts of exercise produce multiple metabolites and inflammatory mediators whereas regular, habitual exercise and fitness lead to suppression of basal inflammatory cytokines; suggesting a link between exercise biology and host immunity.³¹² Regular exercise has an anti-inflammatory effect that improves the immunological profile in type 2 diabetes mellitus, coronary artery disease, peripheral arterial disease, and obesity.³¹⁴
- **Chronic illness** – substantial studies conducted over the last two decades have shown that the gut microbiome differs in healthy subjects when compared to those who suffer from diseases.³¹⁵ Type 2 diabetes, cancer, arthritis, autism, depression, anxiety, sleep disorder, HIV, hypertension, obesity, non-alcoholic liver disease, and cardiometabolic diseases have all been connected to dysbiosis of the gut microbiota.³¹⁵

- **Antibiotic Therapies** – antibiotics can bring about long-lasting adverse effects, compromising the diversity, composition and altered functions of the gut microbiota. The use of antibiotics releases chemicals into the gut that cause a disruption in the intestinal microbiota that could be temporary or permanent depending on the type of medication administered.³¹⁶ In a 2022 report, 16S rRNA gene sequencing was used to evaluate the short- and long-term effects of ampicillin, vancomycin, metronidazole and neomycin on the murine intestinal microbiota.³¹⁷ Huang et al. found changes in the intestinal microbiota, indicating the influence of antibiotics' action.³¹⁷ The resulting dysbiosis of the gut's normal microbiota brought about a struggle for sustainability among different bacterial populations within the gut.³¹⁷ The studies also identified the persistent changes in the microbiota following completion of chemotherapy with the use of quinolone and metronidazole compounds.³¹⁷ In addition, the combination of chemotherapy treatment and antibiotics may even result in a long-term dysbiosis, compared with the treatment with one type of antibiotic alone.³¹⁷
- **Gut-Brain Axis** – the bi-directional communication that takes place between the central nervous system and gut microbiota.³¹⁸ Dysbiosis and inflammation of the gut have been linked to the onset of anxiety and depression.³¹⁸ Hormones, neurotransmitters and immunological factors that are released from the gut send signals to the brain either directly or via autonomic neurons.³¹⁸ In recent years studies have focused on alterations in the gut microbiome and the effect on various CNS disorders; depressive disorders, schizophrenia, and autism.^{318,319,320} Patients that are prescribed mood-altering drugs may benefit from using probiotics. The gut dysbiosis manifested by the prescription drugs, or the neurological disturbance itself, may be diminished by introducing probiotics with beneficial gut flora.³¹⁸
- **Advanced Age** – studies conducted by Jeffery et al. have revealed that the gut microbiota changes with age and that Bacteroidetes species and the Firmicutes phylum predominate in the gut microbiota of elderly individuals.³²² The proportion of Bacteroides species and the relative abundance of Clostridium groups were higher in the elderly than in healthy young adults.³²² Older individuals also showed a reduction of Ruminococcus, Prevotella and related genera.³²² Bacteroidetes account 53% of the core microbiota in elderly individuals, compared with 8%-27% in healthy young adults.³²² Evidence indicates that members of the Firmicutes and Bacteroidetes phyla stimulate the inflammasome pathway in the intestine and result in an inflammatory response as well as a reduction in intestinal barrier integrity.^{323,324} Leakage of microbial products may upregulate the circulating levels of pro-inflammatory factors (such as interferons, TNF α , interleukin-6 and interleukin-1) and promote an ongoing low-grade inflammatory state, which has been linked to cognitive decline and dementia.^{322,325} Susceptibility to immune-mediated diseases increases as one ages due to an increase in the secretion of pro-inflammatory cytokines IL-1 β , IL-6, and TNF- α , a decrease in levels of the anti-inflammatory cytokines IL-10 and IL-4, a decrease in the production of antibodies. These changes have been linked to cognitive decline and depressive behavior.^{322,326}

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

2013	2014	2016	2016	2017	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. ¹⁶⁴	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. ¹⁶⁵	NYU Langone Medical Centre 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 do not. ¹⁶⁶	Researchers from Kumamoto University in Japan find that people whose esophageal tumors test positive for Fusobacterium nucleatum have poorer survival chances. ¹⁶⁷	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. ¹⁶⁸	Routy et al; 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. ²⁰²
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. ²⁹²	Microbiome affects cancer metastasis by regulating Matrix metalloproteinases (MMPs). PD-L1, programmed cell death protein 1 ligand; CEA, carcinoembryonic antigen. ²⁹³	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. ²⁹⁴	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. ²⁹⁵	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. ²⁹⁶	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. ²⁹⁷

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 stated under the surgical recovery time). ALWAYS have a Medical Clearance from before you begin training; this includes conducting an assessment. Also keep in mind that while the incision may look as if it is completely healed, there may still be internal trauma and healing taking place.

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 may help in understanding potential muscle imbalances. It is not mandatory, but it can certainly be informative. If your client has undergone a mastectomy for breast cancer, they will have a horizontal incision where their breast was. If there is scar tissue or adhesions in the area, or if the pectoralis muscles are in spasm, the skin/muscles will tighten, and the shoulders will become protracted. This can cause the back muscles to be over-stretched and weak. Understanding this will help you to determine which muscles should be stretched and which should be strengthened; or both.

This, along with lymph node removal under the armpit, may also cause limited shoulder range of motion in the affected arm. Your client must work to regain shoulder range of motion prior to adding any external load in that plane of motion.

Another example is a prostatectomy. If your client tells you that they had a radical prostatectomy, you must ask if it was retropubic or perineal. If it was a retropubic prostatectomy, they will have a vertical incision in the lower abdomen. If it is perineal, the incision will be between the anus and the scrotum. In the first scenario, your client may be flexed forward at the waist if there is scar tissue or adhesions. Your goal will be to get them standing erect with good posture prior to doing any 'crunch-type' exercises. If on the other hand it was a perineal prostatectomy, they will need to avoid riding a bicycle and high-impact activities for 12-weeks, strengthen their pelvic floor muscles, and be careful when it comes to introducing squats and lunges. ALWAYS begin with body weight and just a few repetitions and then gradually add resistance and more repetitions.

3. 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.

4. 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 20+ lbs. and it will be very difficult to lose weight as well as build muscle. They should see a registered dietitian, 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 bodyfat will increase their risk for lymphedema if they have had lymph nodes removed or irradiated and it also increases their risk for comorbidities. You should set realistic expectations with them but strive for success. They will 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. There are additional, and more specific, side-effects that can be looked up based on the medication that they are on and are listed in Module 2 under Cancer Treatments.

5. 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 perimenopause there is a good chance that they will resume their menses. They will probably gain 20+ lbs. and it will be very difficult to lose weight as well as build muscle. They should see a registered dietitian, 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 bodyfat will increase their risk for lymphedema if they have had lymph nodes removed or irradiated and it also increases their risk for comorbidities. 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. There are additional, and more specific, side-effects that can be looked up based on the medication that they are on and are listed in Module 2 under Cancer Treatments.

6. Did your client have their spleen removed?

If your client has had their spleen removed, 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. 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.

7. 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 (if this is chronic - Dumping Syndrome - they can exercise at a low intensity) while making sure to drink plenty of water and replenish their electrolytes.

8. 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.

9. 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.

10. 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. You can read about this in Module 2 under Cancer Treatments.

If they are taking cortisone or cortisone-like drugs, they will have an elevated risk for osteoporosis, diabetes, and infections. You will need to take all of the aforementioned precautions.

11. 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 in 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.

12. 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.

13. Does your client have breast implants?

If your client has breast implants, you must 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.

PROSTATE CANCER

Prostate cancer is the second most commonly occurring cancer in men and the fourth most commonly occurring cancer overall.³¹ There were 1,414,259 new cases and 375,304 deaths worldwide in 2020.³¹ Most men over the age of 50 will have some experience with prostate disease - with either an enlarged prostate or cancer. African American men have the highest prostate cancer incidence in the world (about 60% higher than in non-Hispanic whites).³¹ They are also more likely to have advanced disease at the time of diagnosis and are more likely to die of prostate cancer. Prostate cancer death rates have been decreasing since the early 1990s in men of all races/ethnicities, though they remain more than twice as high in Blacks than in any other group.³¹ To fully understand the role of genetics and environment in the prostate cancer disparity experienced by African American men, the rates of prostate cancer among African American men and one of their ancestral populations in west Africa have been studied. Data sources were from the World Health Organization (WHO) and reported hospital records in the literature. Based on the WHO's worldwide cancer data, west African men have much lower prostate cancer incidence and mortality compared to African American men.¹⁶⁹

For example, compared to Nigerian men, African American men are >10 times likely to develop prostate cancer and 3.5 times likely to die from the disease. However, contrary to the global ranking by WHO, there is documented evidence in the literature indicating that prostate cancer in at least one west African country is similar to rates found in the United States and in Caribbean Islands.^{31, 169} Another important risk factor is a positive family history. If a man has a father or brother with the disease, his risk for developing it is twice that of a man with no family history.

Cancer of the prostate is referred to as an indolent cancer, one that grows extremely slowly, sometimes taking as long as two to four years to double in size. Because the median age for diagnosis is 72, many men will elect to forgo aggressive treatment and opt for “watchful waiting” instead. When a man enters his fifties, or thereabouts, the testicles begin to suddenly secrete testosterone, the male sex hormone. This causes the prostate to grow, increasing in size by half nearly every ten years. More than 50% of men between the ages of 60-70 suffer from a non-cancerous condition called benign prostatic hyperplasia. As the prostate enlarges, it compresses the urethra and the channel for the urine to pass through. Men typically feel an urgency to go to the bathroom but are unable to void.

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) to 10 (very aggressive cancer).

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

Procedures:

- **Minimally Invasive Surgery** – is defined as a surgical procedure performed through small incisions, usually made in the abdominal wall, the result of which is the least possible damage to organs and surrounding tissue. The general advantages of minimally invasive surgery for clients are minimal blood loss, quicker recovery, and a better cosmetic result. The main goals of laparoscopic radical prostatectomy are to cure the patient and preserve his quality of life both in the short term, easier recovery after the operation, and in the long term – preservation of continence and potency. The surgeon begins the laparoscopic radical prostatectomy by making one incision (one centimeter, or less than half an inch, in length) around the navel to insert a thin, lighted tube with a telescopic camera on its tip (called a laparoscope) into the body. The camera projects an extremely clear, highly magnified visualization of the surgical area onto a screen in the operating room, by which the surgical team operates.

A harmless gas is introduced into the abdomen to create a space large enough to perform the surgery. The operation is performed with specialized surgical instruments inserted through four tiny incisions in the pelvic area, and the prostate (and, if necessary, lymph nodes and surrounding tissue) is removed.

Although it is not always possible due to the size and location of the cancer, one of the primary goals of radical prostatectomy is to be “nerve-sparing.” This means that the surgeon preserves the web of tiny nerves that control erection and keeps them intact. This extremely delicate and precise technique is made possible with the laparoscopic approach because of the quality of the visualization of the surgical field, due to the magnification of the surgical area and reduced bleeding.

Advantages of a Minimally Invasive Approach:

- Incisions are usually made in the abdominal wall (least damage to organs and surrounding tissue)
- Less blood loss during surgery
- Less pain following the operation
- Shorter recovery period
- Faster hospital discharge (65 percent of clients are discharged the day after surgery, and 30 percent two days after surgery)
- Quicker return to normal activities and work (usually within three weeks)
- Better cosmetic result – 4 or 5 tiny incisions versus an 8 inch or larger incision from open surgery
- In 90 percent of clients, the Foley catheter (a thin tube inserted into the bladder to drain urine) can be removed within one week. With open surgery, the catheter usually stays in for 2 or 3 weeks following the procedure.

- **Radical Prostatectomy** – surgical removal of the prostate, the surrounding tissue, and seminal vessels (holds the liquid that mixes with sperm to form semen). The incision is made either through the lower abdomen (retropubic prostatectomy), or in a perineal prostatectomy, through the perineum, the area between the scrotum and the anus. The perineal approach is used less often because it's more likely to lead to erection problems and because the nearby lymph nodes can't be removed. Should a tumor extend through the prostate's fibrous capsule to infiltrate neighboring lymph nodes or scatter to distant sites, prostatectomy is no longer a viable option.

An advantage to the retropubic approach is that it enables the surgeon to biopsy the nodes in the pelvic area. If no evidence of nodal involvement is found, the prostate is removed right then and there. The patient will probably stay in the hospital for a few days after the surgery, and their activities will be limited for several weeks. Many men with localized prostate cancer will choose radiation therapy as their initial treatment. Following treatment, if they have an elevated PSA and a positive prostate biopsy, the cancer may not have been completely eliminated, or may have returned. A radical prostatectomy that is performed following radiation treatment is known as a **salvage radical prostatectomy**. This procedure has been shown to eliminate prostate cancer for ten years or more.

Most men will remain in the hospital for 2-3 days and it takes roughly three months for full recovery (slightly less if done laparoscopically). Depending on a man's age and general condition of health, it may be enough the first week for them to walk 6 or 8 times for 5-10 minutes inside of their home. They can gradually increase time and distance as their stamina improves. For two weeks following surgery they will have a catheter; when walking they will need to use the leg bag and fasten it comfortably under loose fitting pants. Patients can start doing pelvic floor muscle exercises again as soon as their catheter has been removed (usually one to three weeks after surgery). Patients should not participate in strenuous activity or heavy lifting for at least one month after surgery and should not ride a bicycle for at least 12 weeks after surgery.

Potential side effects of radical prostatectomy:

- 65-90% impotence rate
 - Shortening of the penis by 1-2 cm.
 - Bladder spasms
 - Heart attack
 - Stroke
 - Blood clots in the legs
 - 1 in 20 men are left without urinary control
 - Virtually all clients can expect to be incontinent for 3-4 months after surgery
 - Infertility
 - Inguinal hernia
 - 1 in 5 men must contend with long-term stress incontinence
- **Pelvic lymph node dissection (pelvic lymphadenectomy)** – surgical biopsy of the lymph nodes in the pelvic area performed through the retropubic approach.

Potential side effects of pelvic lymph node dissection:

- Lower extremity lymphedema
- Infection
- Nerve damage
- Seroma

- **Transurethral resection of the prostate (TURP)** – surgical removal of the prostatic tissue to relieve symptoms. The surgeon passes a flexible cystoscope 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 to 3 days to help urine drain while the prostate heals. The patient can usually leave the hospital after 1 to 2 days and return to work in 1 to 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).

Potential side effects of TURP:

- Recurring urinary tract infections
- 1 in 10 men will experience partial impotence or incontinence
- 9 in 10 men will experience retrograde ejaculation (semen discharges into the bladder instead of through the urethra and out the penis)
- Difficulty urinating – may last several months
- Bloody urine after surgery
- TURP Syndrome (blindness, fixed pupils, confusion, convulsions, coma, acute renal failure, and reflex bradycardia from fluid absorption)
- Low sodium in blood
- **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:

- Fatigue
- Weight gain
- Potential impotence
- Breast tenderness or growth
- Hot flashes or flushing
- Decreased sexual desire
- Osteoporosis and reduction of muscle tone over prolonged periods
- Lower extremity lymphedema

Types of treatment used:

- Radiotherapy
- Radiopharmaceutical therapy (alpha emitter radiation therapy)
- Immunotherapy
- Bisphosphonate therapy
- Biologic therapy
- Chemotherapy
- Hormonal ablation therapy (medical castration)
- Provenge® (Sipuleucel-T)
- Cryosurgery
- High-intensity-focused ultrasound therapy
- Proton beam radiation therapy
- Photodynamic therapy
- Chimeric antigen receptor (CAR) T-cell therapy

“Hormone-refractory” prostate cancer or HRPC (also known as “androgen-independent” prostate cancer or AIPC) is prostate cancer that is no longer responding to hormonal therapy. Standard therapy for the management of HRPC has become the combination of Taxotere® (Docetaxel) and prednisone given daily for 3 weeks for 8 cycles of therapy.

LUNG CANCER

Lung cancer is the most commonly occurring cancer in men and the third most commonly occurring cancer in women. There were 2,206,771 new cases and 1,796,144 deaths worldwide in 2020.³¹ Tobacco use is to blame for 85% of all lung cancers.³¹ The other 15% arise mainly from occupational and environmental exposures to radon, asbestos, and second-hand cigarette smoke.³¹ Lung cancer has replaced breast cancer as the prime cause of cancer death for women.³¹ The incidence of lung cancer decreases when smoking is stopped; after about fifteen years the risk is the same as that of non-smokers.

While cigarette smoking is by far the most important risk factor for lung cancer, risk increases with both quantity of cigarettes smoked and duration of smoking. Cigar and pipe smoking also play a role in lung cancer. 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 according to the World Health Organization.³¹ Other risk factors include exposure to secondhand smoke, asbestos, metals that contain chromium, cadmium, and arsenic, radiation, air pollution, diesel exhaust, and even some organic chemicals.³¹ Risk is also increased among people who have a history of tuberculosis.³¹

Nearly half of all lung cancer clients will be diagnosed with metastatic disease.^{21, 31} Lung cancer cells that break off from the original tumor often form a secondary tumor in the brain. An isolated secondary tumor is potentially curable if treated properly with chemotherapy and surgery. Only 15% of lung cancers are diagnosed at a localized stage, for which the five-year survival rate is 54%.^{21, 3} The five-year survival rate for small cell lung cancer is 6% compared to the 18% for non-small cell.^{21, 31} There are 2 main types of lung cancer:

- **About 80% to 85% of lung cancers are non-small cell lung cancer (NSCLC)** ²¹
 - **Adenocarcinoma** – is a cancer that forms in epithelial cells that produce fluids or mucus. It occurs mainly in current or former smokers but is also the most common form of lung cancer in people who have never smoked, particularly women. About 40% of all lung cancers are adenocarcinomas.^{88, 89} It typically begins in the outer perimeter of the lungs and under the bronchial lining. Adenocarcinoma tends to grow slower than other types of lung cancer and is more likely to be found before it has spread.
 - **Squamous-cell carcinoma (epidermoid)** – usually takes root in the bronchi and are often linked to a history of smoking. It spreads slower than any other type of lung cancer. It is most common in men and account for 25-30% of all lung cancers.^{88, 89}
 - **Large cell carcinoma** – is named for its large, abnormal-looking cells. It can appear in any part of the lung. Because it tends to grow and spread quickly it can be harder to treat. Large-cell carcinoma accounts for 15-20% of all lung cancers.^{88, 89} A subtype of large cell carcinoma, known as **large cell neuroendocrine carcinoma**, is a fast-growing cancer that is very similar to small cell lung cancer.
- **About 10% to 15% are small cell lung cancer (SCLC)** – it is also referred to as oat-cell cancer because the tiny cells, when viewed under a microscope, look like oats. The tumor will typically appear in the central portion of the lung and is extremely virulent, spreading to the lymph nodes and other organs extremely quickly.
- **Mesothelioma** – is a relatively rare cancer that affects the membrane lining the chest or abdominal cavity. There may be a connection between asbestos exposure and mesothelioma.

Procedures:

- **Mediastinoscopy** – is a relatively non-invasive procedure done under general anesthesia; a small incision is made at the top of the breastbone and a mediastinoscope is inserted into the chest to take biopsies from the enlarged nodes on the right side of the chest.
- **Thoracoscopy** – is a surgical procedure to look at the organs inside the chest to check for cancer. An incision is made between two ribs, and a thoracoscope is inserted into the chest. Tissue or lymph node samples may be removed and checked under a microscope for signs of cancer. In some cases, this procedure is used to remove part of the esophagus or lung. If certain tissues, organs, or lymph nodes can't be reached, a thoracotomy may be done. In this procedure, a larger incision is made between the ribs and the chest is opened.
- **Thoracotomy** – is the first step in many thoracic surgeries; and as such requires general anesthesia with endotracheal tube insertion and mechanical ventilation. Thoracotomies are thought to be one of the most difficult surgical incisions to deal with post-operatively, because they are extremely painful and the pain can prevent the patient from breathing effectively, leading to atelectasis or pneumonia.
- **Thoracentesis** – removal of fluid from the space between the lining of the chest and the lung using a needle. A pathologist views the fluid under a microscope to look for cancer cells.
- **Video-assisted thoracoscopic surgery (VATS)** – a procedure that may be done before or instead of a thoracotomy. The procedure involves inserting a videoscope with a camera attached (as well as small surgical instruments) into the chest, through small incisions made between the ribs. One of the incisions is enlarged if a lobectomy or pneumonectomy is done to allow the specimen to be removed. Because only small incisions are needed, there is usually less pain after the surgery and a shorter hospital stay – typically 4 to 5 days. The VATS method may be used to confirm the diagnosis of lung cancer, biopsy lymph nodes, perform a wedge resection to remove the cancer and the lung tissue surrounding the cancer, and to remove the segment (lobe) of the lung that contains the cancer.
- **Lymph node biopsy** – the removal of all or part of a lymph node to look for signs of cancer
- **Segmentectomy (segmental resection)** – removes just part of one lobe of the lung. Surgical oncologists may prefer a segmental lung resection if the patient's lungs aren't functioning well enough for more extensive surgery. A wedge resection removes a pie slice-shaped piece of the lobe that includes the tumor. Sublobar resections offer better outcomes for respiratory function but could leave cancer cells behind.
- **Lobectomy** - the standard minimal surgery for lung tumors in which a section (lobe) is taken out. A bilobectomy is the removal of two lobes and is only done for tumors of the right lung where the tumor involves two adjacent lobes. This can result in a right upper and middle bilobectomy or a right middle and lower bilobectomy.
- **Pneumonectomy** - surgical removal of the entire lung on either the left or right side. It is performed when the cancer is located in the center of the lung and can't be removed using a more localized operation. A pneumonectomy is only performed in patients who have good lung function and can recover and live without the need for supplemental oxygen.
- **Sleeve resection** – may be used to treat some cancers in large airways in the lungs. According to the American Cancer Society, if you think of the large airway with a tumor as similar to the sleeve of a shirt with a stain a couple of inches above the wrist, the sleeve resection would be like cutting across the sleeve above and below the stain and then sewing the cuff back onto the shortened sleeve. A surgeon may be able to do this operation instead of a pneumonectomy to preserve more lung function.
- **Endobronchial Stenting** – inserts a plastic tube into the airway as a palliative treatment for breathlessness

Patients typically will need to spend 5 to 7 days in the hospital after any major lung surgery. Full recovery from lung cancer surgery typically takes several weeks to 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 lung cancer surgery:

- Pneumonia
- Infection/bleeding associated with incision
- Blood clots in legs or lungs
- Allergic reaction to anesthesia
- Lung collapse caused by tension pneumothorax (air between the lungs and chest wall)
- Hemorrhage
- Air/fluid leaking into the surgical area (bronchopleural fistula)
- Accumulation of fluid in the chest
- Chronic pain
- Abnormal heart rhythms
- Difficulty breathing and need for prolonged stay on the breathing machine

Types of treatment used:

- Chemotherapy
- Immunotherapy
- Radiation therapy
- Targeted therapy
- Somatostatin analogs
- Laser therapy
- Stereotactic radiosurgery

CANCER OF THE COLON/RECTUM

Colorectal cancer is the third most commonly occurring cancer in men and the second most commonly occurring cancer in women.³¹ There were over 1,931,590 million new cases and 935,173 deaths worldwide in 2020.³¹ Incidence rates have been decreasing for most of the past two decades due to colorectal screening tests that allow for early detection and removal of polyps before they turn into cancer.³¹ Incidence rates have, however, increased by nearly 2% in people younger than age 50.³¹

Colorectal cancer refers to cancer of the large intestine. The first five feet of the intestine is called the colon (bowel) and the last six to eight inches is called the rectum. It is sometimes difficult to pinpoint a tumor in the large bowel and, therefore, the colon and rectum are often grouped together as the colorectum. Colon cancer and rectal cancer have many features in common. Most colorectal cancers start as a growth on the inner lining of the colon or rectum. These growths are called polyps. 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 changing into cancer depends on the type of polyp it is. The 2 main types of polyps are:

- **Adenomatous polyps (adenomas)** – have the propensity to change into cancer and are called a pre-cancerous condition
- **Hyperplastic polyps and inflammatory polyps** occur more often but generally are benign

Other factors that can increase someone's risk of developing colorectal cancer include a polyp larger than 1 cm, having more than 2 polyps, or if dysplasia is seen in the polyp after it's removed. The digestive system processes food for energy, and the last part of it absorbs fluid to form solid waste that is then eliminated from the body. After food is chewed and swallowed, it travels to the stomach. There it is partly broken down and sent to the small intestine. The small intestine also breaks down the food and absorbs most of the nutrients. It leads to the large intestine (also called the large bowel or colon). The colon absorbs water and nutrients from the food and serves as a storage place for waste matter. The solid waste moves from the colon into the rectum. From there the waste passes out of the body through the anus. 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 – the portion just above the rectum. The most common warning signs for colon cancer are changes in bowel habits, such as constipation or diarrhea, decreased appetite, weight loss, excessive fatigue, or changes such as persistent narrowing of the size of the stools. Additionally, gas pains, cramps, or bleeding that last for more than two weeks. Studies indicated that certain lifestyle factors increase the risk of colorectal cancer:

- A diet high in red, processed, or heavily cooked meats
- Lack of exercise
- Obesity, particularly having excess fat in the waist area, rather than the hips or thighs
- Type II diabetes
- Being black
- Personal history of chronic inflammatory bowel disease (ulcerative colitis or Crohn disease), cancer of the colon, rectum, or ovaries
- Having a personal history of high-risk colorectal polyps
- Cigarette smoking - a 30-40% greater risk than nonsmokers to die of colorectal cancer
- Heavy alcohol consumption
- Inherited genetic conditions (Lynch Syndrome & hereditary non-polyposis colorectal cancer or familial adenomatous polyposis (FAP))
- Family history

Consumption of milk and calcium (higher blood levels of vitamin D) seem to decrease the risk of colorectal cancer.¹⁷⁰ Regular use of NSAIDs (nonsteroidal anti-inflammatory drugs) such as aspirin may also reduce the risk.¹⁷⁰ Unfortunately, these drugs can have their own serious adverse health consequences, so they are not recommended for people at “average” risk. Starting at age 50, men and women with “average” risk should begin screening to detect and allow for the removal of colorectal polyps that could potentially become cancerous.

Types of Colorectal Cancer:

There are many types of colorectal cancer, the most common of which is adenocarcinoma (95% of all colorectal cancers).³¹ Rarer types include carcinoid tumors, gastrointestinal stromal tumors, colorectal lymphoma. Hereditary colorectal cancers, meaning that several generations of a family have had colorectal cancer, include hereditary nonpolyposis colorectal cancer (HNPCC) and familial adenomatous polyposis (FAP).

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 that are responsible for sexual and bladder function, so particular care must be taken to avoid damaging them as much as possible. Rectal cancer is also more likely to recur after surgery.

- **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 secrete. 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 percent mucus. The mucus may cause cancer cells to spread more quickly and become more aggressive than typical adenocarcinomas. Mucinous adenocarcinomas account for 10 percent to 15 percent of all rectal and colon adenocarcinomas.
- **Signet ring cell adenocarcinoma** – account for fewer than 1 percent 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.

- **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). More than 50 percent of GISTs develop in the stomach. While most other GISTs form in the small intestine, the rectum is the third most common location. GISTs are classified as sarcomas, or cancers that begin in the connective tissues, which include fat, muscle, blood vessels, deep skin tissues, nerves, bones, and cartilage.
- **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 percent of all colorectal cancers and about 5 percent of lymphomas. This colorectal cancer type usually develops later in life and is more common in men.
- **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 percent 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. For example, 10 percent of people with these tumors may experience flushing in the face, diarrhea, wheezing, and rapid heartbeat due to certain hormone-like substances that are released by the tumor.
- **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 percent of all colorectal cases.
- **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 percent to 3 percent of all cancers that develop in the digestive system.

Procedures:

- **Endoscopic mucosal resection** – the removal of a stage 1 or stage 2 colorectal cancer with a colonoscope is called endoscopic mucosal resection (EMR).
- **Polypectomy** – some early colon cancers (stage 0 and some early stage I tumors) or polyps can be removed by surgery through a colonoscope. When this is done, the surgeon does not have to cut into the abdomen. For a polypectomy, the cancer is removed as part of the polyp, which is cut at its stalk (the area that resembles the stem of a mushroom). Local excision removes superficial cancers and a small amount of nearby tissue. If the polyp is too large to be removed in this manner, surgery will be required.
- **Local excision** – is a slightly more involved procedure than a polypectomy. Instruments are used through the colonoscope to remove small cancers on the inside lining of the colon along with a small amount of surrounding healthy tissue on the wall of colon.
- **Resection** – the surgeon removes part or all of the colon along with the cancer and nearby tissues.
- **Colectomy** – is a surgical procedure to remove all or part of your colon. Your colon, part of your large intestine, is a long tubelike organ at the end of your digestive tract. Colectomy may be necessary to treat or prevent diseases and conditions that affect your colon.

There are various types of colectomy operations:

- **Total colectomy** – involves removing the entire colon
- **Partial colectomy** – involves removing part of the colon and may also be called subtotal colectomy
- **Hemicolectomy** – involves removing the right or left portion of the colon
- **Proctocolectomy** – involves removing both the colon and rectum
- **Open colectomy** – this is done through a long, vertical incision on the abdomen
- **Laparoscopic-assisted colectomy** – this is done with small incisions. A tiny video camera is put into 1 of the incisions. This is done to help the surgeon see the colon. This surgery may be a choice for some cancers. People often have less pain and recover quicker because of the small incisions.
- **Total Colectomy** – involves removing the entire colon.

Patients will stay in the hospital until they regain bowel function which may take a couple of days to a week. It will take several weeks for full recovery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should avoid lifting anything over ten pounds for the first 1-2 months.

- **Colostomy** – depending on the type and extent of the colorectal surgery performed; a colostomy may be necessary. During this procedure, the colon is connected to a hole in the abdomen (called a stoma) to divert stool away from a damaged or surgically repaired part of the colon or rectum. Some colostomies may be reversed once the repaired tissue heals. Other colostomies are permanent, and the stoma is attached to a colostomy bag (a soft external pouch that collects waste).

Patients will remain in the hospital for 3-10 days and full recovery may take 6-8 weeks. Patients should begin walking soon after surgery and incorporate it daily. Patients should not lift anything heavier than three pounds, strain, or do strenuous exercises for 12 weeks after surgery.

- **Ileostomy** – connects the last part of the small intestine (ileum) to the abdominal wall.

Patients will remain in the hospital for 3-10 days and full recovery may take 6-8 weeks. Patients should begin walking soon after surgery and incorporate it daily. Patients should not lift anything heavier than three pounds, strain, or do strenuous exercises for 12 weeks after surgery.

- **Proctectomy** – is performed to remove all or part of the rectum.

Patients will remain in the hospital for 4-7 days and full recovery may take 6-8 weeks. Patients should begin walking soon after surgery and incorporate it daily. Patients should not lift anything heavier than three pounds, strain, or do strenuous exercises for 6 weeks after surgery.

- **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. If radiation and chemotherapy have been given before surgery, it is common for a temporary ileostomy to be made (where the last part of the small intestine, the ileum, is brought out through a hole in the abdominal wall). Usually this can be reversed (the intestines reconnected) about 8 weeks later.

Most patients spend 4-6 days in the hospital after a low anterior resection, depending on how the surgery was done and their overall health. Full recovery may take 3-6 weeks. Patients should begin walking and performing Kegel exercises soon after surgery and incorporate both daily. Continuing to do Kegel exercises after the ileostomy is closed will keep anal sphincter muscles strong. Patients should not lift anything heavier than ten pounds, strain, or do strenuous exercise for at least 6 weeks after surgery.

- **Abdominoperineal Resection** – is more involved than a low anterior resection. It can be used to treat some stage I cancers and many stage II or III rectal cancers in the lower third of the rectum (nearest to the anus), especially if the cancer is growing into the sphincter muscle (the muscle that keeps the anus closed and prevents stool leakage). Here, the surgeon makes one incision in the abdomen, and another in the perineal area around the anus. This incision allows the surgeon to remove the anus and the tissues surrounding it, including the sphincter muscle. Because the anus is removed, the patient will need a permanent colostomy to allow stool a path out of the body. This procedure may also be done laparoscopically

Most people spend several days in the hospital after an APR, depending on how the surgery is done and their overall health, with full recovery taking 3 to 6 weeks. Patients should begin walking soon after surgery and incorporate it daily. Patients should not lift anything heavier than three pounds, strain, or do strenuous exercises for 6 weeks after surgery.

- **Pelvic Exenteration** – if the cancer has spread to other organs near the rectum, the lower colon, rectum, and bladder are removed. In women, the cervix, vagina, ovaries, and nearby lymph nodes may be removed. In men, the prostate may be removed. Artificial openings (stoma) are made for urine and stool to flow from the body to a collection bag. Given the radical and prolonged nature of this procedure, patients and providers must be prepared for a long and potentially complicated hospital course. Many patients require a stay in the intensive care unit immediately postoperatively for close monitoring, particularly in the setting of potentially dramatic fluid shifts.

Recovery from this procedure takes a long time. Most women will remain in the hospital for 7-10 days after the surgery. They will not be able to sit for 6-8 weeks, but can lie on their back or side, or stand. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid, sit-ups, crunches, planks, and high-impact activities during that time. Most women don't begin to feel like themselves for about 6 months after surgery; and some up to a year or two.

Potential side effects of pelvic exenteration:

- Lower extremity lymphedema
 - Blood clots in legs or lungs
 - Infections at stoma site
 - Deterioration of muscle flap
 - Adhesions
 - Impaired sexual function
 - Injury to the spleen
 - Urinary-tract infections
 - Sexuality is severely affected
 - Instant menopause - weight gain, increased risk of lymphedema, diabetes, and osteoporosis, hot flashes, night sweats, and infertility
- **Colo-Anal Anastomosis** – some stage I and most stage II and III rectal cancers in the middle and lower third of the rectum require removing the entire rectum (proctectomy). The colon is then connected to the anus (colo-anal anastomosis). The rectum must be removed to do a total mesorectal excision (TME), which is required to remove all the lymph nodes near the rectum. Sometimes when a colo-anal anastomosis is done, a small pouch is made by doubling back a short segment of colon (colonic J-pouch) or by enlarging a segment (coloplasty). This small reservoir of colon then functions as a storage space for fecal matter like the rectum did before surgery. When special techniques are needed to avoid a permanent colostomy, a temporary ileostomy opening may be required for about 8 weeks while the bowel heals. A second operation is then done to reconnect the intestines and close the ileostomy opening.

Patients will remain in the hospital for 24-48 hours and full recovery from an anastomosis may take between 6-8 weeks. Patients should begin walking soon after surgery and incorporate it daily. Patients should not lift anything heavier than three pounds, strain, or do strenuous exercises for 6 weeks after surgery.

Potential side effects of Colo-Anal Anastomosis:

- Obstruction
- Peritonitis
- Parastomal herniation
- Abscess formation
- Skin irritation
- Anastomotic leak
- Sepsis
- Small bowel obstruction

Potential side effects of colorectal surgery:

- Bleeding/hemorrhage
- Blood clots
- Drug reactions (anesthesia)
- Damage to nearby organs (small intestine, spleen, and ureters)
- Pain
- Abdominal adhesions
- Infection
- Diarrhea and constipation
- Bowel obstruction
- Fistula
- Sexual problems for both men and women
- Bladder problems (incontinence and frequency)
- Anastomotic leak
- Flap and stoma necrosis
- Decreased quality of life
- Parastomal herniation
- Skin irritation

Types of treatment used:

- Chemotherapy
- Chemo-Radiation
- Radiation therapy
- Targeted therapy
- Immunotherapy
- Radiofrequency ablation
- Microwave ablation
- Ethanol ablation
- Cryosurgery
- Embolization

CANCER OF THE BLADDER

Globally, bladder cancer is the sixth most commonly occurring cancer in men and the 17th most commonly occurring in women.³¹ There were 573,278 new cases and 212,536 deaths worldwide in 2020.³¹ Bladder cancer develops because of uncontrolled growth of abnormal cells in the bladder. This disease typically begins in the urothelium, the lining inside the ureter, bladder, urethra, and parts of the kidneys. Cancer may also develop in other types of cells in the bladder. The type of bladder cancer depends on which cells and layers are affected.³¹ Men are four times more likely to develop bladder cancer than women.³¹ Sixty per cent of cases of bladder cancer occur in higher-income countries, with the highest incidence rates seen in North America and Europe, and the lowest in Asia, Latin America, and the Caribbean.³¹

The most common symptom is low back pain, blood in the urine, increased frequency or urgency of urination, and pain or feelings of irritation during urination. Smoking is the most well-established risk factor for bladder cancer; approximately four times that of nonsmokers. Half of all bladder cancers in both men and women are attributed to smoking.^{31, 91} Higher bladder cancer incidence may also be found amongst people who work in the dye, rubber, leather, and aluminum industries, painters, people with certain bladder birth defects, and those who live in communities with high levels of arsenic in the drinking water.^{31, 91} Seventy to eighty percent of bladder cancers are superficial at the time of diagnosis (it hasn't penetrated the bladder's wall).^{31, 91}

Individuals with a family member who has, or has had, bladder cancer are at an increased risk for developing this cancer.⁹¹ It may be attributed to the fact that family members with bladder cancer have all been exposed to the same carcinogen or they may all have certain genetic abnormalities associated with bladder cancer. Specifically, mutations in genes known as GNT and NAT may trigger changes in the body's breakdown of some toxins, which can in turn lead to malignancies in the bladder wall.

Most can be treated without having to remove the bladder, and the five-year survival rate approaches 77% (ASCO).¹⁷¹ However, if the cancer has invaded the bladder wall, consideration must be given to removing the bladder or beginning a combination of radiation and chemotherapy. Cancer that is confined to the lining of the bladder is called superficial bladder cancer. Cancer that begins in the transitional cells may spread through the lining of the bladder and invade the muscle wall of the bladder or spread to nearby organs and lymph nodes; this is called invasive bladder cancer.

Types of Bladder Cancer:

- **Transitional cell carcinoma (TCC)**, also known as urothelial carcinoma - is the most common form of bladder cancer and accounts for 90% of all cases.^{31,191} About 70% of the cases are non-invasive and contained in the lining of the bladder.^{31,91} The other 30% of TCC cases are more advanced.^{31,91} In these clients, either the cancer has penetrated the bladder's lining and grown into the muscular wall of the bladder (called muscle-invasive bladder cancer), or it has metastasized to other organs. There are two subtypes of TCC:
 - **Papillary carcinoma** – grows out from the inner surface of the bladder toward the hollow center in fingerlike projections. Often, these tumors are called “noninvasive papillary cancers,” meaning they don’t grow into the deeper layers of the bladder wall. 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% of all cases
- **Squamous cell carcinoma** – looks like the flat cells on the surface of the skin. Almost all squamous cell carcinomas of the bladder are invasive and accounts for 1-2% of all cases.^{31,91}
- **Small cell carcinoma** – is extremely rare, accounting for fewer than 1 percent of all bladder cancers.^{31,91} This type of bladder cancer begins in neuroendocrine cells, which are like nerves.
- **Sarcoma** – is another very rare type of bladder cancer that begins in the muscle layer of the bladder wall

Procedures:

- **Transurethral resection of the bladder tumor (TURBT)** – is the most common treatment used for early stage or superficial bladder tumors. 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.

Patients will usually stay in the hospital for 1-2 days after the surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Avoid strenuous activities, such as bicycle riding, jogging, weightlifting, or aerobic exercise for about 3 - 4 weeks. For the first three weeks, patients should avoid anything that makes them strain.

Potential side effects of TURBT:

- Bleeding and pain during urination right after surgery
- 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.
- **da Vinci Cystectomy** – uses state-of-the-art technology to help your doctor perform a more precise operation than conventional instrumentation allows. It offers numerous potential benefits over a conventional open surgery, including:
 - Significantly less pain
 - Less blood loss, risk of infection, and scarring
 - Fewer blood transfusions
 - Shorter hospital stay and recovery time
- **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.

- **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.

Patients will need to stay in the hospital for about a week after the surgery (8-9 days for radical procedure). Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not do any heavy lifting or excessive stair climbing during this period. Full recovery will take about six weeks, but they should not do any heavy lifting for 12 weeks.

Potential side effects of cystectomies:

- Bowel obstruction
- Lower extremity lymphedema
- Dehydration and electrolyte abnormalities
- Ureter blockage
- Urinary tract infection
- Sexual dysfunction for men and women
- Infertility
- Painful intercourse (women)
- Decreased sexual arousal
- Bleeding
- Blood clots in the legs
- Decline in kidney function
- Vitamin B12 deficiency
- Incontinence

Reconstructive surgery after a radical 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.³³³ Urine is collected and stored in a small bag, called a urostomy pouch, which can be emptied at the patient's convenience.³³³ The pouch is attached to the skin around the stoma and worn outside the body.³³³ The two main types of urostomy include:
 - **Ileal Conduit** – a piece of intestine is removed to create a passageway for urine.³³³ 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.³³³
 - **Cutaneous ureterostomy** – one or both ureters are attached directly to a stoma in the abdomen.
 - **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.
 - **Kock pouch** – the pouch, valves, and outlet are made from the end of the small intestine (terminal ileum).
 - **Indiana pouch** – the pouch is made from the large intestine (ascending colon). The outlet is made from the end of the small intestine (terminal ileum), and the natural ileocecal valve is used.
 - **Mitrofanoff procedure** – this type of diversion can have several different variations. The pouch can be made from the bladder, large or small intestines, or a combination. The outlet is made from the appendix, a fallopian tube, or part of the ureter.
 - **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.
- A good pouching system should stay secure with a good leak-proof seal that lasts 3-7 days and allow the patient to shower or bathe with the pouch on (patients should discuss swimming with their doctor). When it is fitted properly it should be odor-resistant and protect the skin around the stoma.
- Patients will need to stay in the hospital for 4-7 days after the surgery. Walking is essential to recovery and can begin after returning home from the hospital. Strenuous activities should be avoided, and patients shouldn't lift anything heavier than 10 pounds for about four weeks.
- Bacteria can enter urostomies and continent urinary diversions and may cause a urinary tract infection. Symptoms of infection include:
- Fever
 - Chills
 - Nausea
 - Vomiting
 - Poor appetite
 - Back or lower side pain
 - Frequent, painful urination
 - Cloudy, dark, or strong-smelling urine

Types of treatment used:

- Chemotherapy
- Targeted therapy
- Immunotherapy
- Radiation therapy

CANCER OF THE KIDNEY

There were 431,288 new cases and 179,368 deaths worldwide in 2020.³¹ Kidney cancer is considered the most-deadly cancer of the urinary tract and is responsible for about 3% of malignancies in adults.³¹ Each kidney contains more than a million microscopic blood-processing filtering units called nephrons.³¹ Each nephron is associated with a microscopic renal tubule, which joins several other tubules from other nephrons to form collecting ducts. These ducts deposit the urine in the renal pelvis. When cancer arises in the main part of the kidney that contains the renal tubules, it is called a renal cortical tumor. Cancer that arises in the renal pelvis is called a transitional cell (urothelial) tumor. Renal cortical tumors are a diverse group of tumors that can exhibit very different clinical behaviors; their risk of metastasizing varies. These tumors can be benign or malignant.

Early-stage kidney cancer usually has no symptoms, but as the tumor grows there may be blood in the urine, a pain or lump in the lower back or abdomen, fatigue, loss of appetite or unexplained weight loss, fever, swelling in the legs and ankles, in men, a cluster of enlarged veins around a testicle (typically the right one) called a varicocele. As with many other cancers, tobacco use is a strong risk factor; with the largest risk for cancer of the renal pelvis (particularly among heavy smokers). Thirty percent of kidney cancer cases may be attributed to obesity.³¹ In addition, high blood pressure, chronic renal failure, acquired cystic disease, diethylstilbestrol (synthetic estrogen), coffee, alcohol, low physical activity, hypertension, type II diabetes, and occupational exposure to certain chemicals increases the risk of kidney cancer according to the World Cancer Research Journal.¹⁷² A small percentage of renal cell cancers are hereditary.

Von Hippel-Lindau VHL is inherited through the dominant autosomal feature. This syndrome is caused by germinal mutations of the VHL tumor suppressor located on the chromosome 3p25-26; these mutations can virtually always be detected. Forty six percent of patients with VHL have kidney cancer.^{173,158} Although they usually have low tumor levels, their progress in metastasis is about 30%.^{173,158} Renal cortical tumors (renal cell carcinoma or RCC) are the most common type of kidney cancer and are categorized as follows: .

- **Conventional, or clear cell RCC** – accounts for 80% of cases and appear very pale when viewed under a microscope.^{31, 91, 172}
- **Papillary RCC** – is the second most common type and makes up 10-15% of cases.^{31, 91, 172} 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 grows more slowly. Type 2 is more aggressive and may follow a more unpredictable growth pattern. Papillary carcinomas have been associated with genetically inherited syndromes, including hereditary papillary renal cell carcinoma (HPRCC) and hereditary leiomyomatosis and renal cell carcinoma (HLRCC). 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.
- **Chromophobe RCC** – accounts for 5-10% of kidney tumors.^{31, 91, 172} 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.

- **Collecting duct RCC** – make up less than 1% of all cases. This is a very rare and aggressive type of renal cell carcinoma that forms irregular tubes inside the tumor. It is more common in younger adults and doesn't respond to conventional therapies for renal cortical tumors.
- **Unclassified RCC** – make up 3-5% of kidney tumors^{31,91,172}. These rare tumors look different under a microscope than other kidney cancer subtypes, cannot be classified based on their appearance, and are usually very aggressive.
- **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. They are managed differently than renal cortical tumors, depending on several factors including tumor grade, location, and size. About 9 out of 10 transitional cell carcinomas of the kidney are curable if they are found at an early stage.^{31,91} The chances for cure drop dramatically if the tumor has grown into the ureter wall or main part of the kidney or if it has a more aggressive appearance when seen under a microscope. Kidney cancer rarely strikes children and young adults; the exceptions are a pediatric kidney cancer called Wilms's tumor and some forms of hereditary kidney cancer syndromes. Wilms's tumors almost always occur in children. This type of cancer is very rare among adults.
- **Wilms Tumor** – is a rare kidney cancer that mainly affects children. Also known as nephroblastoma, it's the most common cancer of the kidneys in children. Wilms tumor most often affects children ages 3 to 4.³³⁴ It becomes much less common after age 5, but it can affect older children and even adults.³³⁴ Wilms tumor mostly occurs in just one kidney. But it can sometimes be in both kidneys at the same time.³³⁴ Factors that may increase the risk of Wilms tumor include:
 - **Being Black** – in North America and Europe, Black children have a slightly higher risk of getting Wilms tumor than do children of other races. Asian-American children appear to have a lower risk than children of other races.
 - **Having a family history of Wilms Tumor** – having someone in the family who's had Wilms tumor increases the risk of getting the disease.

Procedures:

- **Laparoscopic nephrectomy** – this procedure is done through several small incisions instead of one large one. A newer approach is to do the laparoscopic surgery remotely using a robotic system. The surgeon sits at a panel near the operating table and controls robotic arms to perform the operation. Typically, one of the incisions is made larger to remove the kidney (it is still smaller than it would be with the traditional, open approach). This approach may not be an option for tumors larger than about 10 cm (4 inches) across or tumors that have grown into the renal vein or spread to lymph nodes around the kidney. The benefits include a shorter hospital stay, a quicker recovery time, and less pain.

The patient will most likely be in the hospital for up to 7 days following open-nephrectomy procedures and another 3-6 weeks for full recovery (slightly less if performed laparoscopically). Patients will be encouraged to return to light activities as soon as they feel up to it. Strenuous activity and heavy lifting should be avoided for 6 weeks following the procedure.

People with one kidney should avoid sports that involve higher risks of heavy contact or collision such as: field hockey, football, ice hockey, lacrosse, martial arts, rodeo, skiing/snowboarding, soccer, and wrestling. This may also include extreme activities such as skydiving. Anyone with a single kidney who decides to participate in these sports should be extra careful and wear protective padding.

- **Partial nephrectomy (nephron-sparing surgery)** – excises only the cancerous portion of the kidney and a margin of healthy surrounding tissue. This is often the treatment of choice in tumors up to 7 cm (a little less than 3 inches) when possible. The most common incision sites are under the ribs on the same side as the cancer, the middle of the abdomen, or in the back behind the cancerous kidney. This surgery may also be performed laparoscopically. Partial nephrectomy may be an option if you have a small kidney cancer or if you only have one kidney but might not be an option if the tumor is in the middle of the kidney or is very large, if there is more than one tumor in the same kidney, or if the cancer has spread to the lymph nodes or distant organs.

When partial nephrectomy is possible, it's generally preferred over radical nephrectomy since retaining as much kidney tissue as possible may reduce your risk of later complications, such as kidney disease and the need for dialysis. Partial nephrectomy yields comparable results to complete nephrectomy in clients with small tumors (less than 4 centimeters), while maintaining functioning kidney tissue.

- **Radical nephrectomy** – is the most common procedure to treat renal cell carcinoma; typically used for tumors that are larger in size and have advanced locally, or to other parts of the body. The surgeon removes the kidney, the adjacent adrenal gland, the surrounding fat, nearby lymph nodes, and Gerota's fascia (a filmy sac that envelopes the kidney and its ureter tube). The most common incision sites are under the ribs on the same side as the cancer, the middle of the abdomen, or in the back behind the cancerous kidney. If the tumor has grown from the kidney through the renal vein (the vein leading away from the kidney) and into the inferior vena cava (the large vein that empties into the heart), the heart may need to be stopped for a short time to remove the tumor. The patient is put on cardiopulmonary bypass (a heart-lung machine) that circulates the blood while bypassing the heart.

Regional lymphadenectomy (lymph node dissection) – is the removal of nearby lymph nodes to see if they contain cancer. Some doctors do this when doing a radical nephrectomy. More lymph nodes may be removed if the tumor has features suggesting it is at high risk of spreading.

Potential side effects of all nephrectomies:

- Bleeding
- Infection
- Damage to internal organs and blood vessels (spleen, pancreas, aorta, vena cava, large or small bowel)
- Pneumonia
- Incisional hernia
- Kidney failure
- Lymphedema

Types of treatment used:

- Cryotherapy/Cryosurgery (cryoablation)
- Radiofrequency ablation (RFA)
- Targeted therapy
- Chemotherapy
- Radiation therapy
- Immunotherapy

CANCER OF THE PANCREAS

There were 495,773 new cases and 466,003 deaths worldwide in 2020.³¹ Pancreatic cancer is truly “silent and deadly.” It will silently host the presence of a growing cancer for some time. When symptoms finally appear, they are frequently mistaken for other disorders such as hepatitis, gallstones, and diabetes. By the time the tumor has been detected, it has usually spread outside the pancreas. Worldwide, pancreatic cancer is the seventh leading cause of cancer-related deaths. However, its toll is higher in more developed countries. In the United States, for example, pancreatic cancer is the third leading cause of cancer-related deaths and is predicted to become second around 2020, with an overall survival of less than 5% at five years.³¹

Pancreatic cancer most commonly presents at an advanced stage, and consequently surgical resection is only possible in about 20% of patients.^{31,91} Surgery offers the only possibility of cure or long-term survival, which, with chemotherapy, is 20%-25% at five years.^{31,91} Only about 20% of pancreatic cancers are contained within the pancreas.³¹ More than ninety-five percent of pancreatic cancers arise in the exocrine tissue, typically producing jaundice from an accumulation of bile in the bloodstream. Tumors in the body or tail of the pancreas are far away from the common bile duct and typically won't trigger jaundice in the early stages.

The number of cases of exocrine cancer is increasing in the United States as well as other parts of the world^{31,91}. Though it only accounts for about three percent of all new cancer cases, it is the fifth leading cause of death from cancer.^{31,91} The other five percent arise in the endocrine pancreas and are referred to as islet-cell carcinoma.^{31,91} This type of tumor is less aggressive than exocrine pancreatic cancer and has a more favorable prognosis.^{31,91} Recurrence of cancer of the pancreas is very likely. Unless the cancer is found at a very early stage, only three percent of clients will survive more than five years after diagnosis.^{31,91}

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% of all pancreatic cancers are attributed to cigarette smoking with incidence rates being almost twice as high for smokers compared to non-smokers^{31,91,148,-150}. Risk also increases with a family history of pancreatic cancer and a personal history of pancreatitis, diabetes, obesity, older age (above 65), and possibly high levels of alcohol consumption. Individuals with Lynch syndrome, Multiple Endocrine Neoplasia type 1 (MEN 1) syndrome, von-Hippel-Lindau syndrome, Peutz-Jeghers syndrome, Hereditary Breast and Ovarian Cancer syndrome, and Familial Atypical Mole-malignant Melanoma (FAMMM) syndrome may also be predisposed to pancreatic cancer.^{31,91,148-150}

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.

Several studies have shown that removing only part of the cancer does not help clients live longer.⁹⁰ Only about 20% of people diagnosed with pancreatic cancer are able to have surgery because most pancreatic cancers are found after the disease has already spread.⁹⁰ Pancreatic cancer surgery is one of the most difficult operations a surgeon can do and is also one of the hardest for clients to undergo⁹⁰. There may be complications and it may take several weeks for clients to recover. Clients need to weigh the potential benefits and risks of such surgery carefully. After the pancreas is removed, the recovery period will be a long one; and the doctor will prescribe a permanent low-sugar, low-fat diet, often with the addition of vitamin K. Because of the restricted diet, it is often difficult to gain weight, which makes recovery slower than usual.

The prognosis and treatment options will depend on the following:

- Whether or not the tumor can be surgically removed
- The stage of the cancer (the size of the tumor and whether it has metastasized)
- The general health of the patient
- Whether the cancer has just been diagnosed or if it's a recurrence

Pancreatic cancer can be controlled only if it is found before it has spread, when it can be completely removed by surgery. If the cancer has metastasized, palliative treatment can improve the patient's quality of life by controlling symptoms and complications of this disease.

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. According to the American Cancer Society, when the operation is done in small hospitals or by doctors with less experience, as many as 15% of patients may die because of surgical complications. In contrast, when the operation is done in cancer centers by surgeons experienced in the procedure, less than 5% of patients die as a direct result of surgery.

Most patients will remain in the hospital for one to two weeks with the first post-surgery night spent in the intensive care unit before being transferred to the surgical floor. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients usually remain fatigued for about two months after this operation and should not lift anything over a few pounds for at least six weeks.

Potential side effects of the Whipple procedure:

- Leaking from the various connections that the surgeon makes
 - Infections
 - Bleeding
 - Trouble with the stomach emptying after eating
 - Trouble with digestion (pancreatic enzyme may be necessary)
 - Weight loss
 - Change in bowel habits
 - Diabetes
-
- **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.
 - **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.
 - **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.

Most patients will remain in the hospital for 3-5 days for laparoscopic procedure (up to 10 days for open surgery), with an additional two months (average) for full recovery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything weighing over ten pounds for the first 8 weeks after surgery.

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
- Immunocompromisation 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.
- **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
- Immunotherapy / tumor vaccines
- Cryosurgery
- Targeted therapy

DIABETES

Exercise can help the client/patient to improve their blood sugar while reducing the risk of heart disease and nerve damage. With diabetes mellitus there is a serious condition that occurs from the buildup of fat in the arteries because of the improper utilization of carbohydrates. When this happens there can be complications such as atherosclerosis, high blood pressure, and myocardial infarctions. Exercise will help to keep the weight down and properly utilize calories, thus reducing the accumulations of fat in the arteries and blood vessels and reducing these other health risks. Obesity is a big concern, particularly with Type II diabetes. When a person is obese, the reception of the glucose-utilizing cells to insulin decreases. Therefore, the glucose is not utilized properly and remains in the blood. When people lose weight through an exercise program diabetes can be reduced and sometimes even cured.

Diabetes can impair blood flow to the feet and lead to nerve damage. Without proper care, a small injury can lead to an open sore that may be difficult to treat. Sometimes amputations are necessary if the infections

severely damage the tissue and bone. Because of peripheral neuropathy, the network of nerves is damaged, and sensation is reduced. Balance and coordination can be negatively impacted and there may be muscle weakness and loss of reflexes, especially in the ankles, leading to changes in the way a person walks. This can cause the development of a blister or sore on the feet without even realizing it. It also becomes an area of concern when having a pedicure and/or shaving. If the skin is nicked or cut and blood is drawn, there is a possibility of bacteria getting into the wound.

Blood sugar needs to be tracked before, during, and after exercise. The records will reveal how their body is responding to the exercise and help to prevent dangerous blood sugar fluctuations. When the patient/client is taking Insulin or any other medication that can cause low blood sugar, they should check their blood sugar thirty minutes prior to exercising. This will help to determine if the blood sugar level is stable, rising, or falling, and if it will be safe for them to exercise. Here are some general guidelines to follow based on their blood sugar levels:

Lower than 100 – 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.

100-250 – 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.

CANCER OF THE CERVIX

Cervical cancer is the fourth most frequent cancer in women with 604,127 new cases in 341,831 deaths worldwide in 2020.³¹ Approximately 90% of deaths from cervical cancer occurred in low- and middle-income countries.³¹ Cervical cancer occurs when abnormal cells on the cervix grow out of control. The cervix is the lower part of the uterus that opens into the vagina. Cervical cancer can often be successfully treated when it's found early. Most cervical cancer is caused by a virus called human papillomavirus, or HPV.³¹ You can get HPV by having sexual contact with someone who has it. There are many types of the HPV virus. Not all types of HPV cause cervical cancer. Some of them cause genital warts, but other types may not cause any symptoms. You can have HPV for years and not know it. It stays in your body and can lead to cervical cancer years after you were infected. The main types of cervical cancer are squamous cell carcinoma and adenocarcinoma. Squamous cell carcinoma begins in the thin, flat cells that line the cervix. Adenocarcinoma begins in cervical cells that make mucus and other fluids.

Today we are fortunate to have the **Pap smear** as a screening test not only for malignant cervical cells, but for those that may progress to cervical cancer as well. A suspicious **Pap smear** is followed by a cervical biopsy to come up with a definitive diagnosis of cancer. Sometimes, however, the results of a biopsy may be inconclusive and necessitate removal of a larger tissue sample. In countries where screening is not available, cervical cancer is usually more advanced and has a poorer prognosis.

Determining the extent of the cancerous growth is somewhat primitive compared to staging for other types of cancers. A pelvic exam will determine how big the tumor is and if it has invaded any adjacent tissues. A CT scan will more than likely be conducted to determine metastasis in the lymphatic system. Some gynecologic oncologists believe in staging the disease by sampling pelvic and abdominal lymph nodes which helps to determine the exact area to receive radiation therapy, while others don't think that a lymph node dissection should be a "routine" procedure for staging clients. There are usually no visible signs or symptoms of cervical cancer. As the cancer grows there may be unusual bleeding or discharge. You may have longer menstrual periods, a heavier flow, bleeding between periods and after intercourse, or bleeding after menopause. The bleeding is usually bright red and unpredictable as to when it appears, its amount, or its duration. Although these symptoms may not be cancer, they should be checked by the doctor.

Procedures:

- **Colposcopy** – if the pap smear indicates that there are suspicious cells. The doctor will usually examine the vagina and cervix with a colposcope. It is essentially a microscope on a stand that gives a lighted, magnified view showing greater detail than can be seen with the naked eye. At the same time the doctor may also remove tissue for a biopsy.
- **Loop electrosurgical excision procedure (LEEP)** – an office procedure that uses an electrically charged wire loop to slice off the outermost layer of the cervix.
- **Surgical conization** – surgery to remove a cone-shaped section of tissue from the cervix and cervical canal with either a scalpel (cold knife conization) or a laser. The cone biopsy often doubles as a diagnostic and therapeutic measure in that if the margins of the cone-shaped specimen are negative, no further treatment is warranted. It can also be used as the only treatment in women with early (stage IA1) cancer who want to preserve their ability to have children (fertility). After the biopsy, the tissue removed (the cone) is examined under the microscope. If the margins (outer edges) of the cone contain cancer (or pre-cancer) cells, further treatment will be needed to make sure that all the cancer is removed.

Recovery from surgical conization can last for up to 4-6 weeks and vigorous exercise and housework should be avoided. Patients should not lift anything weighing over ten pounds during this time.

If the patient starts bleeding after exercise, she should contact her doctor immediately.

Potential side effects of colposcopy, LEEP, and surgical conization:

- Bleeding
- Mild pain
- Abdominal cramping

- **Total hysterectomy** – when the uterus is removed through an incision in the abdomen, it is called a *simple or total abdominal hysterectomy*. If the uterus is removed through the vagina, it is known as a *vaginal hysterectomy*. Removing the ovaries and fallopian tubes, a *bilateral salpingo-oophorectomy*, is not actually part of a hysterectomy; it is a separate procedure that is often done during the same operation.

To stage the cancer, lymph nodes in the pelvis and around the aorta will also need to be removed. This can be done through the same incision as the abdominal hysterectomy. If a vaginal hysterectomy is done, lymph nodes can be removed by laparoscopy. Conventional abdominal hysterectomy leaves a five-inch vertical scar from just below the belly button to the pubic bone; or, if it's a bikini incision, from side to side.

- **Laparoscopic hysterectomy** – requires three or four small incisions no more than half an inch long. A viewing instrument is inserted through an incision in the navel. This minimally invasive procedure causes far less discomfort for patients and the majority will go home on the day of surgery with only a 1 to 2-week recovery period.
- **Radical hysterectomy** – removal of the uterus and cervix along with the tissues next to the uterus (the *parametria* and the *uterosacral ligaments*) and the upper part of the vagina next to the cervix. *The ovaries and fallopian tubes are not removed unless there is some other medical reason to do so.* This surgery is usually performed through an abdominal incision. Often, some pelvic lymph nodes are removed as well.
- **Laparoscopic-assisted radical vaginal hysterectomy** – combines a radical vaginal hysterectomy with a laparoscopic pelvic node dissection. Laparoscopy allows the inside of the abdomen and pelvis to be seen through a tube inserted into very small surgical incisions. Small instruments can be controlled through the tube, so the surgeon can remove lymph nodes through the tubes without making a large cut in the abdomen. The laparoscope can also make it easier for the doctor to remove the uterus, ovaries, and fallopian tubes through the vaginal incision. Laparoscopy can also be used to perform a radical hysterectomy through the abdomen. Lymph nodes are removed as well. This is called *laparoscopically assisted radical hysterectomy with lymphadenectomy*.

Most patients will remain in the hospital from 3 to 7 days. The average hospital stay after an abdominal radical hysterectomy is about 5 to 7 days. Complete recovery can take about 6 to 8 weeks. A laparoscopic procedure and vaginal hysterectomy usually require a hospital stay of 1 to 2 days and 2 to 3 weeks for recovery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid, sit-ups, crunches, planks, and high-impact activities during that time.

Potential side effects for all hysterectomy procedures:

- Unusual bleeding
- Wound infection
- Damage to urinary and intestinal systems
- Pelvic pain
- Difficulty with bowel movements and urination
- Lower extremity lymphedema
- Instant menopause if ovaries are removed - infertility, weight gain, increased risk of lymphedema, diabetes, osteoporosis, hot flashes, and night sweats
- **Radical trachelectomy** – allows for some women of childbearing years, whose cancer is confined to their cervix, to be treated without losing their ability to have children. This procedure removes the cervix and the upper part of the vagina, as well as regional lymph nodes. They place a “purse-string” stitch that acts as an artificial opening of the cervix. The operation can be done through the vagina or the abdomen. Most patients remain in the hospital for three days and full recovery may take 4-6 weeks.

Most patients will remain in the hospital from 3 to 5 days with full recovery taking 5-6 weeks. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid sit-ups, crunches, planks, and high-impact activities during that time. For many women it will take 4-6 months before they feel like themselves again.

Potential side effects of radical trachelectomy:

- Lower extremity lymphedema
- Bladder problems
- Menstrual problems
- Late miscarriage/pre-term delivery
- Must have C-section for childbirth
- **Pelvic exenteration** – a more extensive operation that may be used to treat recurrent cervical cancer. This procedure involves the removal of the cervix, uterus, ovaries, fallopian tubes, vagina, bladder, lower ureter tubes, rectum, anus, pelvic floor, and usually the pelvic lymph nodes. Because the bladder and rectum are removed, artificial openings are made to empty both urine (urostomy) and stools (colostomy). If the vagina is removed, a new vagina can be surgically created out of skin, intestinal tissue, or muscle and skin grafts.

Recovery from this procedure takes a long time. Most women will remain in the hospital for 7-10 days after the surgery. They will not be able to sit for 6-8 weeks, but can lie on their back or side, or stand. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid, sit-ups, crunches, planks, and high-impact activities during that time. Most women don't begin to feel like themselves for about 6 months after surgery; and for some up to a year or two.

Potential side effects of pelvic exenteration:

- Lower extremity lymphedema
- Blood clots in legs or lungs
- Infections at stoma site
- Deterioration of muscle flap
- Adhesions
- Impaired sexual function
- Injury to the spleen
- Urinary-tract infections
- Sexuality is severely affected
- Instant menopause - infertility, weight gain, increased risk of lymphedema, diabetes, osteoporosis, hot flashes, and night sweats

- **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 after leaving the uterus. This technique is called intraoperative lymphatic mapping, or sentinel node mapping. If this node is free of cancer cells, the goal is to avoid removing additional lymph nodes. If the node does contain cancer cells, then the surgeon continues to remove additional lymph nodes for further examination. Sentinel node mapping may help avoid the unnecessary removal of lymph nodes in some women, leaving these nodes in place to continue their important role in draining fluids and fighting infection.

- **Para-aortic Lymph Node Biopsy** – if cancer is found in any pelvic lymph nodes during surgery, some of the lymph nodes along the aorta may be removed as well.

Potential side effects of node biopsy:

- Lower extremity lymphedema

Types of treatment used:

- Chemotherapy
- Chemoradiation
- Radiation therapy
- Immunotherapy
- Brachytherapy
- Targeted therapy
- Hormonal therapy

CANCER OF THE UTERUS/ENDOMETRIUM

Globally, endometrial cancer is the sixth most common type of cancer and ranks 14th among causes of cancer-related deaths in women.³¹ There were 417,367 new cases and 97,370 deaths worldwide in 2020.³¹ It is known to be more common in postmenopausal women, and the researchers found that in all countries, incidence rates were 4 to 20 times higher in women aged 50 and older than in women under 50.³¹

Unlike cervical cancer, there is no noninvasive stage with endometrial cancer. In atypical uterine hyperplasia, normal endometrial cells multiply out of control until they build up and cause the uterine wall to thicken. Depending on the degree of the hyperplasia, a woman will have anywhere from a 5-30% chance of developing endometrial cancer over the five to ten years.³¹ Although atypical hyperplasia is not cancer, it is treated as though it were through either surgery or hormonal treatment, depending on whether the patient is menopausal, or unable to bear children. Endometrial cancer usually affects menopausal women. Seventy-five percent of all cases occur after the age of 50 and only 4% before the age of 40.³¹

Mortality rates have declined over the last decade due to prevention and early detection with a Pap test.³¹ According to the World Health Organization, the overall survival rate for whites is 23 % higher (84%) than that of African Americans (61%).³¹ If caught early, the five-year survival rate is 95%.³¹

The most common symptoms are abnormal bleeding or spotting, especially in postmenopausal women. Pain during urination, intercourse, or in the pelvic area is also a symptom. Obesity increases the risk of endometrial cancer most likely by increasing the amount of estrogen in the body. Other things that may increase estrogen levels are late menopause, estrogen therapy, never having children, and a history of polycystic ovary syndrome. Taking Tamoxifen for breast cancer may also increase the risk slightly because of its estrogen-like effects on the uterus. Lynch syndrome and diabetes also increase the risk. On the flip side, pregnancy, use of oral contraceptives, and IUDs seem to reduce the risk for endometrial cancer. According to the American Cancer Society, 68% of the cases are diagnosed at an early stage due to postmenopausal bleeding.¹⁷⁴

Procedures:

- **Laparoscopic hysterectomy** – requires three or four small incisions no more than half an inch long. A viewing instrument is inserted through an incision in the navel. This minimally invasive procedure causes far less discomfort for patients and the majority will go home on the day of surgery with only a 1 to 2-week recovery period
- **Total hysterectomy** – when the uterus is removed through an incision in the abdomen, it is called a **simple or total abdominal hysterectomy**. If the uterus is removed through the vagina, it is known as a **vaginal hysterectomy**. Removing the ovaries and fallopian tubes, a **bilateral salpingo-oophorectomy**, is not actually part of a hysterectomy; it is a separate procedure that is often done during the same operation.

To stage the cancer, lymph nodes in the pelvis and around the aorta will also need to be removed. This can be done through the same incision as the abdominal hysterectomy. If a vaginal hysterectomy is done, lymph nodes can be removed by laparoscopy. Conventional abdominal hysterectomy leaves a five-inch vertical scar from just below the belly button to the pubic bone; or, if it's a bikini incision, from side to side.

- **Radical hysterectomy** – removal of the uterus and cervix along with the tissues next to the uterus (the **parametria** and the **uterosacral ligaments**) and the upper part of the vagina next to the cervix. **The ovaries and fallopian tubes are not removed unless there is some other medical reason to do so.** This surgery is usually performed through an abdominal incision. Often, some pelvic lymph nodes are removed as well.
- **Laparoscopic-assisted radical vaginal hysterectomy** – combines a radical vaginal hysterectomy with a laparoscopic pelvic node dissection. Laparoscopy allows the inside of the abdomen and pelvis to be seen through a tube inserted into very small surgical incisions. Small instruments can be controlled through the tube, so the surgeon can remove lymph nodes through the tubes without making a large cut in the abdomen. The laparoscope can also make it easier for the doctor to remove the uterus, ovaries, and fallopian tubes through the vaginal incision. Laparoscopy can also be used to perform a radical hysterectomy through the abdomen. Lymph nodes are removed as well. This is called **laparoscopically assisted radical hysterectomy with lymphadenectomy**.

Most patients will remain in the hospital from 3 to 7 days. The average hospital stay after an abdominal radical hysterectomy is about 5 to 7 days. Complete recovery can take about 6 to 8 weeks. A laparoscopic procedure and vaginal hysterectomy usually require a hospital stay of 1 to 2 days and 2 to 3 weeks for recovery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid sit-ups, crunches, planks, and high-impact activities during that time.

Potential side effects for all hysterectomy procedures:

- Infertility
- Unusual bleeding
- Wound infection
- Damage to urinary and intestinal systems
- Pelvic pain
- Difficulty with bowel movements and urination
- Lower extremity lymphedema
- Instant menopause if ovaries are removed - infertility, weight gain, increased risk of lymphedema, diabetes, osteoporosis, hot flashes, and night sweats

- **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 after leaving the uterus. This technique is called intraoperative lymphatic mapping, or sentinel node mapping. If this node is free of cancer cells, the goal is to avoid removing additional lymph nodes. If the node does contain cancer cells, then the surgeon continues to remove additional lymph nodes for further examination. Sentinel node mapping may help avoid the unnecessary removal of lymph nodes in some women, leaving these nodes in place to continue their important role in draining fluids and fighting infection.
- **Pelvic and Para-aortic lymph node dissection** – removes lymph nodes from the pelvis and the area next to the aorta to see if they contain cancer cells that have spread from the endometrial tumor. This procedure is usually done at the same time as the operation to remove the uterus. If the patient has an abdominal hysterectomy, the lymph nodes can be removed through the same incision. In women who have had a vaginal hysterectomy, the lymph nodes may be removed by laparoscopic surgery.

Potential side effects of node biopsy/dissection:

- Lower extremity lymphedema
- **Tumor debulking** – if the cancer has spread throughout the abdomen the goal is to remove as much of the tumor as possible before radiation and chemotherapy. Distant metastasis includes disease spread to distant lymph nodes, upper abdomen, omentum (fatty tissue covering the abdominal organs), and to organs like the lung, liver, bone, and/or brain. Tumor debulking is very helpful with other cancers, but it isn't clear yet whether it will help clients with endometrial cancer live longer.

Potential side-effects of tumor debulking:

- Upper and lower extremity lymphedema
- Nearby organs may be injured
- Adhesions
- Digestive problems if stomach is removed
- Respiratory compromise (lung-lobe removal)
- Instant menopause if ovaries are removed
- Infertility
- Constipation and bladder problems

- **Panniculectomy** – obesity is common among clients with endometrial cancer. In certain cases, the gynecologic surgeon collaborates with a plastic surgeon to combine hysterectomy and staging with a reconstructive procedure known as panniculectomy, or “tummy tuck,” to remove excess skin and underlying fat in the abdominal area. This option for combination surgery is associated with better staging results and fewer complications.

Potential side effects of panniculectomy:

- Bleeding at wound sites
- Swelling
- Scarring
- Persistent pain
- Numbness
- Infection
- Fluid accumulation
- Blood clotting
- Nerve damage

Types of treatment used:

- Radiation therapy
- Brachytherapy
- Hormonal therapy
- Targeted therapy

CANCER OF THE OVARIES

Ovarian cancer is the eighth most commonly occurring cancer in women and the 18th most commonly occurring cancer overall.³¹ There were 313,959 new cases and 207,252 deaths worldwide in 2020.³¹ Usually by the time ovarian cancer is detected, it has spread to other organs within the pelvis. Incidence rate has slowly been decreasing at a rate of about 0.9% per year since the mid-1980s.³¹ Ovarian cancer accounts for about 5% of cancer deaths for women and causes more deaths than any other female reproductive cancer.³¹

Ovarian tumors are never biopsied with a needle, or cut into, because doing so could allow cancerous cells to escape.^{47,49,79} Most ovarian cancer clients are past menopause, thus making a hysterectomy a viable option when necessary.^{47,49,79} As with pancreatic cancer, ovarian cancer is considered silent and deadly. Often there are no symptoms of early ovarian cancer, which makes it difficult to detect at an early stage when there is the greatest chance for a cure. An ovarian tumor can grow for some time before pressure or pain can be felt. Symptoms, when they do occur, can include abdominal swelling or bloating, discomfort in the lower part of the abdomen, feeling full after a light meal, nausea or vomiting, lack of appetite, gas or indigestion, unexplained weight loss, diarrhea, constipation, or 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 the most important risk factors.^{31,47,49,79} Women who have tested positive for mutations in the inherited BRCA1 and BRCA2 genes have about a 50% chance of developing ovarian cancer in their lifetime.^{31,47,49,79} Those with pelvic inflammatory disease and Lynch syndrome are also at an increased risk.^{31,47} Several large studies have linked an increase in ovarian cancer to the use of estrogen hormone replacement therapy.^{31,47,49,79} Smoking cigarettes increase the risk of mucinous ovarian cancer.⁴⁷ On the flip side, pregnancy and long-term use of oral contraceptives seem to reduce the risk.⁴⁷

TREATMENT OPTIONS:

- **Laparotomy** – to explore the abdomen for ovarian cancer, a surgery called laparotomy is necessary. In laparotomy, an incision is made in the abdomen, the area is examined, cancerous tissue is removed, and if necessary, fluid is drained from the abdominal region. It is during laparotomy that tumor debulking is performed.
- **Laparoscopy** – is done to:
 - remove one of the fallopian tubes and ovaries along with the omentum (a thin fold of abdominal tissue that encases the stomach), large intestine and other abdominal organs. (This procedure is called an omentectomy.) Lymph nodes may also be removed.
 - explore the abdomen for additional cancer and evaluate the extent of the disease
 - drain any fluid buildup in the abdominal area
 - retrieve small samples of abnormal tissue to perform a biopsy
 - determine if you might benefit from debulking (removal of as much of the tumor as possible) and chemotherapy.
- **Tumor debulking** – when a malignant ovarian mass has spread to other organs, the surgeon will remove the reproductive organs, the omentum, and the lymph nodes, and cut out, or debulk, as much of the tumor as possible. The goal, of course, is to eliminate any visible traces of cancer. If the tumor left behind measures half an inch or less, it's called optimal residual cancer. Larger tumors are referred to as suboptimal residual cancers. Chemotherapy cannot penetrate a large, bulky ovarian tumor because the flow of the treatment is blocked. By removing as much of the tumor as possible through debulking, the chemotherapeutic treatment can penetrate the tumor more effectively. This means that the tumor will be much more responsive to chemotherapeutic treatment, which improves treatment success and potentially adds years to a patient's survival. In some cases, a piece of colon is removed and then the 2 ends that remain are sewn back together (resected). If the ends can't be sewn back together right away, the top end of the colon is attached to an opening (stoma) in the skin of the abdomen to allow body wastes out. This is known as a colostomy. Most often, this is only temporary, and the ends of the colon can be reattached later in another operation. Debulking surgery may also involve removing a piece of the bladder. If this occurs, a catheter (to empty the bladder) will be placed during surgery. This will be left in place for a time after surgery until the bladder recovers enough to be able to empty on its own. Then, the catheter can be removed. Debulking may also require removing the spleen and/or the gallbladder, as well as part of the stomach, liver, and/or pancreas.

Most patients will remain in the hospital from 3-7 days after laparotomy and tumor debulking with full recovery taking 10-12 weeks. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid, sit-ups, crunches, planks, and high-impact activities during that time.

Potential side-effects of tumor debulking:

- Upper and lower extremity lymphedema
- Immunocompromisation if spleen is removed
- Nearby organs may be injured
- Diabetes if pancreas is removed
- Adhesions
- Digestive problems if stomach is removed
- Fistula (abnormal connection)
- Instant menopause if ovaries are removed - infertility, weight gain, increased risk of lymphedema, diabetes, and osteoporosis, hot flashes, and night sweats
- **Second-look laparotomy** – exploratory surgery to look for evidence of any residual cancer, following the completion of chemotherapy for stage III ovarian cancer. The abdomen and pelvis are carefully inspected, tissue samples are taken, and lymph nodes are biopsied. This operation is usually done through a vertical incision in the abdomen. It is generally recommended that before clients are scheduled for this procedure, they undergo a CT scan, a CA-125 tumor-marker blood test, and a physical exam to reveal any evidence that the cancer has withstood the chemotherapy.
- **Laparoscopic hysterectomy** – requires three or four small incisions no more than half an inch long. A viewing instrument is inserted through an incision in the navel. This procedure causes far less discomfort for patients and the majority will go home on the day of surgery with only a 1 to 2-week recovery period.

Most patients will remain in the hospital from 3 to 7 days. The average hospital stay after an abdominal radical hysterectomy is about 5 to 7 days. Complete recovery can take about 6 to 8 weeks. A laparoscopic procedure and vaginal hysterectomy usually require a hospital stay of 1 to 2 days and 2 to 3 weeks for recovery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Pelvic floor and core exercises will be extremely important to incorporate regularly. Patients should not lift anything weighing over ten pounds for the first 6 weeks after surgery and should also avoid sit-ups, crunches, planks, and high-impact activities during that time.

- **Total hysterectomy** – when the uterus is removed through an incision in the abdomen, it is called a *simple or total abdominal hysterectomy*. If the uterus is removed through the vagina, it is known as a *vaginal hysterectomy*. Removing the ovaries and fallopian tubes, a *bilateral salpingo-oophorectomy*, is not

actually part of a hysterectomy; it is a separate procedure that is often done during the same operation.

To stage the cancer, lymph nodes in the pelvis and around the aorta will also need to be removed. This can be done through the same incision as the abdominal hysterectomy. If a vaginal hysterectomy is done, lymph nodes can be removed by laparoscopy. Conventional abdominal hysterectomy leaves a five-inch vertical scar from just below the belly button to the pubic bone; or, if it's a bikini incision, from side to side.

- **Radical hysterectomy** – removal of the uterus and cervix along with the tissues next to the uterus (the *parametria* and the *uterosacral ligaments*) and the upper part of the vagina next to the cervix. *The ovaries and fallopian tubes are not removed unless there is some other medical reason to do so.* This surgery is usually performed through an abdominal incision. Often, some pelvic lymph nodes are removed as well.
- **Laparoscopic-assisted radical vaginal hysterectomy** – combines a radical vaginal hysterectomy with a laparoscopic pelvic node dissection. Laparoscopy allows the inside of the abdomen and pelvis to be seen through a tube inserted into very small surgical incisions. Small instruments can be controlled through the tube, so the surgeon can remove lymph nodes through the tubes without making a large cut in the abdomen. The laparoscope can also make it easier for the doctor to remove the uterus, ovaries, and fallopian tubes through the vaginal incision. Laparoscopy can also be used to perform a radical hysterectomy through the abdomen. Lymph nodes are removed as well. This is called *laparoscopically assisted radical hysterectomy with lymphadenectomy*.

Potential side effects of total hysterectomy:

- Unusual bleeding
- Wound infection
- Damage to urinary and intestinal systems
- Pelvic pain
- Difficulty with bowel movements and urination
- Lower extremity lymphedema
- Instant menopause if ovaries are removed - infertility, weight gain, increased risk of lymphedema, diabetes, osteoporosis, hot flashes, and night sweats

Types of treatment used:

- Chemotherapy
- Intra-abdominal chemotherapy
- Radiation therapy
- Hormonal therapy
- Immunotherapy
- Targeted therapy

CANCER OF THE STOMACH

One in 5 men and one in 6 women worldwide develop stomach cancer during their lifetime, and one in 8 men and one in 11 women die from the disease.³¹ There were 1,089,103 new cases and 768,793 deaths worldwide in 2020.³¹ Stomach cancer was the leading cause of cancer death in the United States until the early 1930's.³¹ This may be attributed to the increased use of refrigeration that has made fresh fruits and vegetables more available and decreased the use of salted and smoked foods. There are a number of doctors that believe the decline may also be linked to frequent antibiotic use; they can kill the bacteria called *Helicobacter pylori* (H PYLORI), which is thought to be a major cause of stomach cancer.¹⁷⁵

According to the American Cancer Society, the average age of people when they are diagnosed is 68. About 6 of every 10 people diagnosed with stomach cancer each year are 65 or older.¹⁷⁶ The risk that a man will develop stomach cancer in their lifetime is about 1 in 95.¹⁷⁶ For women the chance is about 1 in 154.¹⁷⁶ Almost all gastric cancers are adenocarcinomas (cancers that begin in cells that make and release mucus and other fluids).¹⁷⁶ Other types of gastric cancer are gastrointestinal carcinoid tumors, gastrointestinal stromal tumors, and lymphomas. Long-term infection of the stomach with H PYLORI may lead to inflammation and pre-cancerous changes of the inner lining of the stomach.¹⁷⁵ Stomach cancer is more common in Japan, China, Southern and Eastern Europe, and South and Central America and is less common in Northern and Western Africa, South Central Asia, and North America. In the United States,¹⁷⁶ stomach cancer is more common in Hispanic Americans, African Americans, and Asian/Pacific Islanders than it is in non-Hispanic whites.¹⁷⁶ Smoking increases stomach cancer risk, especially those in the upper portion of the stomach near the esophagus; the rate of stomach cancer is about doubled in smokers.^{147,176}

Hereditary diffuse gastric cancer greatly increases the risk of developing stomach cancer.¹⁷⁶ This condition is rare, but the lifetime stomach cancer risk among affected people is about 70% to 80%.¹⁷⁶ Women with this syndrome also have an increased risk of getting a certain type of breast cancer.¹⁷⁶ This condition is caused by mutations in the *CDH1* gene.¹⁷⁶ Lynch syndrome, an inherited genetic disorder, also increases the risk of colorectal cancer.^{146,152} For unknown reasons, people with type A blood have a higher risk of getting stomach cancer.¹⁷⁶ Familial adenomatous polyposis (FAP) is a hereditary syndrome in which people get many polyps in the colon; and sometimes in the stomach and intestines as well.^{146,152} People with this syndrome are at greatly increased risk of getting colorectal cancer and have a slightly increased risk of getting stomach cancer; it is caused by mutations in the *APC* gene.^{146,152}

People who carry mutations of the inherited breast cancer genes *BRCA1* or *BRCA2* may also have a higher rate of stomach cancer.^{78,79,146,152} People with Li-Fraumeni syndrome have an increased risk of several types of cancer, including developing stomach cancer at a relatively young age.^{146,152} Li-Fraumeni syndrome is caused by a mutation in the *TP53* gene. People with Peutz-Jeghers syndrome (PJS) develop polyps in the stomach and intestines, as well as in other areas including the nose, the airways of the lungs, and the bladder.^{146,152} The polyps in the stomach and intestines are a special type called *hamartomas*. They can cause problems like bleeding or blockage of the intestines. PJS can also cause dark freckle-like spots on the lips, inner cheeks and other areas. People with PJS have an increased risk of cancers of the breast, colon, pancreas, stomach, and several other organs. This syndrome is caused by mutations in the gene *STK11*.^{146,152}

An increased risk of stomach cancer is seen in people with diets that have large amounts of smoked foods, salted fish and meat, and pickled vegetables.¹⁷⁶ Nitrates that are commonly found in cured meats can be converted by certain bacteria, such as *H pylori*, into compounds that have been shown to cause stomach cancer in lab animal.¹⁷⁶ Eating lots of fresh fruits and vegetables appears to lower the risk of stomach cancer.¹⁷⁶

Because stomach cancer is uncommon in the U.S. nowadays, doctors don't routinely screen for it anymore. Unfortunately, because the symptoms can be easy to ignore, cancer of the stomach can be present for a long time before it is detected. Symptoms may include indigestion, a sense of discomfort or vague pain, fullness, bloating, or belching, slight nausea, heartburn, indigestion, or loss of appetite. If these symptoms are persistent for a period of two weeks or more, you should consult your doctor. Later signs of the disease may include a dark stool which may signal blood in the stools, vomiting with or without blood, rapid weight loss, and severe abdominal pain. Gastric cancer is often diagnosed at an advanced stage because there are no early signs or symptoms.

Procedures:

- **Endoscopic resection** – endoscopic mucosal resection and endoscopic submucosal resection can be used only to treat some very early-stage cancers, where the chance of spread to the lymph nodes is very low. The cancer is removed through an endoscope that's passed down the throat to the stomach and does not require an incision.
- **Partial gastrectomy** – is often recommended if the cancer is only in the lower part of the stomach. It is also sometimes used for cancers that are only in the upper part of the stomach. Only part of the stomach is removed, sometimes along with part of the esophagus or the first part of the small intestine (the duodenum). The remaining section of stomach is then reattached. Some of the omentum (an apron-like layer of fatty tissue that covers the stomach and intestines) is removed as well, along with nearby lymph nodes, and possibly the spleen and parts of other nearby organs.
- **Total gastrectomy** – this procedure is done if the cancer has spread throughout the stomach, or if it is in the upper part of the stomach near the esophagus. It is the surgical removal of all the stomach and, occasionally, the spleen, parts of the esophagus, the pancreas, and intestines may also be removed. The end of the esophagus is attached to part of the small intestine; this enables patients to continue to swallow, eat and digest food. Most procedures are done through a large incision from beneath the breastbone down to the belly button; sometimes this can be done using laparoscopy, which allows the stomach to be removed through several smaller cuts in the abdomen.

Gastrectomy may also be performed as a minimally invasive procedure laparoscopically or through robot-assisted surgery.

Most patients will remain in the hospital for about 3-5 days for a partial and 5-8 days for a total gastrectomy. Complete recovery can take about 3-6 months. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Stair climbing is another excellent form of activity that should be gradually increased along with walking distance. Stairs should be climbed slowly, resting, or stopping as the client needs.

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
- **Lymph node dissection** – in either a partial, or total gastrectomy, the nearby lymph nodes and some of the omentum (an apron-like layer of fatty tissue that covers the stomach and intestines) are usually removed. Lymph node removal is a very important part of the operation. In the United States, it is recommended that a gastrectomy be accompanied by nearby lymph node removal (called a D1 lymphadenectomy) with the goal of removing at least 15 nodes.¹⁷⁶

Potential side effects of lymph node dissection:

- Torso and lower extremity lymphedema

If a stomach cancer tumor is blocking the stomach and can't be removed completely, prophylactic surgery may be done to help patients eat normally. Procedures include:

- **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
- **Endoluminal laser therapy** – the tumor is reduced with a laser attached to an endoscope that is inserted through an incision in the abdomen

Types of treatment used:

- Chemotherapy
- External beam radiation
- Intensity-modulated radiation therapy
- Respiratory gating
- Monoclonal antibodies
- Targeted therapies
- Immunotherapy

Feeding Tube Placement:

- Many people find that having a feeding tube eases the pressure and discomfort associated with eating. Medicines can also be given through a feeding tube. Some people with stomach cancer are not able to eat or drink enough to get adequate nutrition. A minor operation can be done to place a feeding tube through the skin of the abdomen and into the distal part of the stomach (known as a gastrostomy tube or G tube) or into the small intestine (jejunostomy tube or J tube). Liquid nutrition can then be put directly into the tube.

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 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 thoroughly. This makes it easier for the 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 Gastrectomy:

- Recommend that they drink about 8 to 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, but can get most vitamins and minerals as an oral supplement (such as a pill) and B12 can also be administered as a monthly shot.





CANCER OF THE LIVER

The liver regulates most chemical levels in the blood and excretes a product called bile. This helps carry away waste products from the liver. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down, balances, and creates the nutrients and metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic.

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 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.

Between 1990-2015, new cases of liver cancer increased by 75% of which 47% were driven by changing population age structures and 35% direct population growth, according to ASCO (the American Society of Clinical Oncology).¹⁷⁷ There were 905,667 new cases and 830,180 deaths worldwide in 2020.³¹ According to the Cancer Treatment Centers of America, men are twice as likely to be diagnosed with the disease.¹⁷⁸ Liver cancer is much more common in countries in sub-Saharan Africa and Southeast Asia than in the U.S. however, in the U.S. liver cancer rates are highest in Asian Americans and Pacific Islanders.¹³⁵ White Americans have the lowest risk for liver cancer.¹³⁵ In many of these countries, liver cancer is the most common type of cancer. The liver is popular territory for secondary tumors from other organs, surpassed only by the lungs.

Primary liver cancer is relatively uncommon. Often the disease has been preceded by years of chronic liver disease; 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 the potential post-operative complications, reliably take the medications that prevent rejection and opportunistic infections, comply with frequent clinic visits and laboratory tests, and not engage in activity that would injure the liver, such as drinking alcohol. The conditions listed below are generally considered to be absolute contra-indications to liver transplantation:^{135,178}

- Severe, irreversible medical illness that limits short-term life expectancy
- Severe pulmonary hypertension (mean pulmonary artery pressure greater than 50mmHg)
- 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 may include pain in the right side of the upper-abdomen or around the right shoulder blade, hard lump below the ribs on the right side, abdominal swelling, swollen veins on the abdomen, weight loss, weakness, loss of appetite, jaundice, fatigue, and fever. Most liver cancers are due to alcohol-related cirrhosis, and possibly non-alcoholic fatty liver disease associated with obesity, diabetes, and metabolic related disorders, according to the American Cancer Society.¹⁷⁷ Worldwide, Hepatitis B and C are the major risk factors worldwide but are associated with less than half of the cases in the United States.¹⁷⁷ The risk may also be increased with the consumption of food contaminated with aflatoxin, a toxin produced by mold during the storage of agricultural products in a warm and humid environment.¹⁷⁷

The main types of primary liver cancer are:

- **Hepatocellular carcinoma (HCC)** – makes up most primary liver cancers.¹⁷⁷ They begin in hepatocyte cells. Sometimes they begin as a single tumor; other times they start in multiple spots in the liver.¹⁷⁷ The latter is more common in people with liver damage, such as cirrhosis.¹⁷⁷
- **Fibrolamellar HCC** – is a rare subtype that often has a higher chance for successful treatment than other types of liver cancer.¹⁷⁷
- **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.¹⁷⁷ They are treated in the same way as HCC.
- **Angiosarcomas and hemangiosarcomas** – begin in blood vessels in the liver. These cancers are fast-growing and are not diagnosed until they are in advanced stages.¹⁷⁷
- **Hepatoblastoma** – is very rare type of liver cancer most often is found in children.¹⁷⁷

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:

- **Partial hepatectomy (liver resection)** – removal of the part of the liver where cancer is found. In some cases, the surgeons will remove one half of the liver (hemi hepatectomy). In other cases, they will only need to cut out a small section (segmentectomy). The gallbladder is also taken out, as it is attached to the liver on the border between the right and left sides. Occasionally, part of the diaphragm muscle may be removed. The liver can repair itself easily if it is not damaged. The portion of the liver that remains after resection will start to grow, even if up to three-quarters of it is removed. The liver will usually be back to normal size within a few months, although its shape may be slightly changed. This surgery is only done if all the tumor can be removed while leaving enough healthy liver behind to function. Unfortunately, liver cancer is seldom contained, and has spread to multiple sites within the liver or other organs.

Four out of five people with liver cancer have cirrhosis ¹⁷⁷. For a patient with severe cirrhosis, removing even a small amount of liver tissue around the tumor might not leave enough healthy liver behind to perform essential functions. People with cirrhosis are eligible for surgery only if the cancer is small and they still have a reasonable amount of liver function.

Most patients will remain in the hospital for about 5-10 days. If the patient has a laparoscopy the recovery time is shorter, and they may be able to return to their usual activities within a week. Complete recovery can take about 6-8 weeks. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 8 weeks after surgery.

Potential side-effects of partial hepatectomy:

- Pain
 - Weakness
 - Fatigue
 - Bleeding
 - Infection
 - Temporary liver failure
 - Pleural effusion (fluid build-up in lungs)
 - Fever
 - Pulmonary infection
 - Ascites
 - Urinary tract infection
 - G.I. bleeding
 - Biliary tract hemorrhage
 - Bile leakage
 - Subphrenic infection (infection in the peritoneal space between the anterior part of the liver and the diaphragm)
- **Liver transplant** – is removal of the entire liver and replacement with a healthy donated liver. Unfortunately, the opportunities for liver transplants are limited. Only about 6,000 livers are available for transplant each year, and most of these are used for patients with diseases other than liver cancer. According to the American Cancer Society, most livers used for transplants come from people who have just died.¹⁷⁷ In recent years, a small number of patients have received part of a liver from a living donor (usually a close relative) for transplant. The liver can regenerate some of its lost function over time if part of it is removed. Still, the surgery does carry some risks for the donor. Less than 250 living donor liver transplants are done in the United States each year and only a small number of them are for patients with liver cancer.¹⁷⁷

At this time, liver transplants are reserved for those with small tumors (either one tumor smaller than 5 cm across or two to three tumors no larger than 3 cm) that have not invaded nearby blood vessels.¹⁷⁷ In most cases, transplant is used for tumors that cannot be totally removed, either because of the location of the tumors or because the liver is too diseased for the patient to withstand removing part of it. The 5-year survival rate for these clients is around 60% to 70%.¹⁷⁷ Not only is the risk of a new liver cancer significantly reduced, but the new liver will function normally.

If the patient must wait for a donated liver, other treatment is given as needed. Unfortunately, not many livers are donated to people with cancer; they are reserved for people with more curable diseases¹⁷⁷.

Most patients will be in the intensive care unit for two days and spend remain in the hospital for about 8-10 days, with full recovery taking 6 months or longer. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 8 weeks after surgery.

Potential side-effects of liver transplant surgery:

- Hemorrhage
- Hepatic artery and portal vein thrombosis (blood clot)
- Graft rejection/Graft vs. Host Disease
- Leaks or shrinking of the bile ducts
- Infection
- Immunocompromisation
- Mental confusion or seizures
- Post-Transplant Lymphoproliferative Disorder (PTLD)
- Non-melanoma skin cancer (skin cancers are the most common malignancy in the post-transplant population. The rate of skin cancer in patients who have undergone organ transplantation is 27% at 10 years, reflecting a 25-fold increase in risk relative to the normal population¹⁷⁷ Considering this substantial risk, it is strongly recommended that all transplant recipients minimize sun exposure.
- Side-effects from immunosuppressant drugs (with transplant). After transplantation clients will be taking 7-10 different types of medications. Dosages and numbers are reduced over time and it is common by six months to be down to 1-2 medications. Clients will be taking immunosuppressants for the rest of their lives in virtually all cases. Alcoholic beverages must be avoided due to the toxicity of the liver as well as the fact that it can interfere with the metabolism of certain medications. While long term post-transplant immunosuppression decreases rejection episodes in LT recipients, it also puts the patients at increased risk of infection, malignancies, and specific adverse side effects unique to each agent.

AGENT	CLASSIFICATION	INDICATIONS
Medrol® (Prednisone, Prednisolone, Methyl prednisolone)	Corticosteroids	Induction of immunosuppression, treatment of acute cellular rejection, maintenance of immunosuppression
Prograf®, Astagraf® (Tacrolimus)	CNI (calcineuron inhibitor)	Maintenance of immunosuppression
Neoral®, Sandimmune®, Gengraf® (Cyclosporine)	CNI (calcineuron inhibitor)	Maintenance of immunosuppression
Cellcept®, Myfortic® (Mycophenolate mofetil)	Anti-metabolite	Maintenance of immunosuppression, treatment of rejection
Imuran® (Azathioprine)	Anti-metabolite	Maintenance of immunosuppression
Rapamune® (Sirolimus)	mTORI	Maintenance of immunosuppression, treatment of rejection
Afinitor® (Everolimus)	mTORI	Maintenance of immunosuppression, treatment of rejection
Campath-1H® (Alemtuzumab)	T cell depleting monoclonal antibody	Induction of immunosuppression
Thymoglobulin®, ATGAM® (ATG)	T cell depleting polyclonal antibody	Induction of immunosuppression, treatment of steroid resistant rejection
Simulect® (Basiliximab)	IL-2Ra, monoclonal antibody	Induction of immunosuppression, treatment of steroid resistant rejection

Potential side effects of Corticosteroids:

- Osteoporosis
- Diabetes
- High blood pressure
- Weight gain/loss
- Abdominal pain
- Immunocompromisation
- Cataracts and glaucoma
- Thinning of the skin
- Bruising easily
- Rapid heartbeat
- Stomach irritation
- Nausea, vomiting, and diarrhea
- Insomnia
- Fluid retention
- Mood changes
- Muscle weakness

Potential side effects of CNI:

- Alopecia – results in hair falling out in patches
- Gingival hypertrophy – increase in the size of gums
- Hypertension
- Diabetes
- Hirsutism
- Hyperlipidemia – refers to any of several acquired or genetic disorders that result in a high level of lipids (fats, cholesterol and triglycerides) circulating in the blood

Potential side effects of Anti-metabolites:

- Loss of appetite
- Nausea, vomiting, diarrhea, and constipation
- Sores in the mouth or throat
- Temporary hair loss
- Change in the way foods taste
- Weakness
- Fatigue
- Low platelet, red, and white blood cell count
- Immunocompromisation
- Skin rash
- Fever and flu-like symptoms
- Numbness or tingling in the hands and feet
- Depression
- Difficulty sleeping
- Shortness of breath

Potential side effects of mTORIs:

- Nausea, vomiting, diarrhea, and constipation
- Stomach, muscle, and joint pain
- Shaking
- Acne
- Skin rash
- Trouble sleeping
- Increased thirst or hunger
- Frequent urination
- Vision changes and hearing problems
- Irregular heartbeat
- Mood changes
- Swelling of the ankles and feet
- Severe headache
- Dizziness
- Missed, heavy, and/or painful periods

Potential side effects of monoclonal antibodies:

- Allergic reactions such as hives or itching
- Flu-like signs and symptoms - chills, fatigue, fever, and muscle aches and pains
- Nausea, vomiting, and diarrhea
- Skin rashes and sores
- Low blood pressure
- Low blood cell counts
- Inflammatory lung disease
- Severe internal bleeding
- Congestive heart failure and heart attacks
- High blood pressure

Potential side effects of T cell depleting monoclonal antibodies:

- Overactive or underactive thyroid
- Infusion associated reactions including headaches, rashes, fever, and nausea
- Infections - respiratory and urinary
- Low white blood cell count
- Hemolytic anemia - disorder in which red blood cells are destroyed faster than they can be made
- Immunocompromisation
- Changes in blood pressure and heart rate
- Rash
- Bacterial, fungal, and viral infections
- Musculoskeletal pain

Potential side effects of T cell depleting polyclonal antibodies:

- Chills
- Low levels of white blood cells (leukopenia)
- Headache
- Abdominal pain
- High blood pressure (hypertension)
- Nausea
- Shortness of breath
- High levels of potassium in the blood (hyperkalemia)
- Muscle pain
- Insomnia
- Low blood pressure
- Rash
- Sweating
- General feeling of being unwell (malaise)
- Acne

Types of treatment used:

- External beam radiation
- Ablation therapy (radiofrequency and alcohol)
- Embolization (arterial, chemo, and radio)
- Cryosurgery
- Proton therapy
- Chemotherapy
- Hepatic artery infusion
- Hyperthermia
- Targeted therapy
- Immunotherapy

KAPOSI SARCOMA

Thanks to effective HIV treatment, the number of cases of Kaposi's sarcoma (KS) has fallen dramatically.³¹ Nonetheless, KS remains one of the most common cancers in people living with HIV.³¹ There were 34,270 new cases and 15,086 deaths worldwide in 2020.³¹ Because most KS cases have developed in association with human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS), HIV/AIDS is listed as the underlying cause of death.³¹ Therefore, KS death rates are difficult to isolate. KS is a cancer that develops from the cells that line lymph or blood vessels. It usually appears as tumors on the skin or on mucosal surfaces such as inside the mouth, but these tumors can also develop in other parts of the body, such as in the lymph nodes, the lungs, or digestive tract. The abnormal cells of KS form purple, red, or brown blotches or tumors on the skin. These affected areas are called lesions. The skin lesions of KS most often show on the legs or face, but they can also appear in the genital area, mouth or lymph nodes. In severe Kaposi's sarcoma, lesions may develop in the digestive tract and lungs.

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.

The underlying cause of KS is infection with a virus called human herpesvirus 8 (HHV-8). In healthy people, HHV-8 infection usually causes no symptoms because the immune system keeps it under control. In people with weakened immune systems, however, HHV-8 has the potential to trigger KS. There are four main types of KS:

1. Epidemic (AIDS-associated) – the virus that causes AIDS - have the highest risk of KS. The immune system damage caused by HIV allows cells harboring HHV-8 to multiply
2. Latrogenic (transplant related) Kaposi sarcoma is quite rare.. It's most common in people who have weakened or damaged immune systems, such as those who have an organ transplant. This happens because of the immunosuppressants they need to take to prevent rejection. In this population, though, the disease tends to be milder and easier to treat.
3. Another type of KS – Classic (Mediterranean) occurs in older men (50-70 yrs.) of Eastern European Jewish or descent; with a ratio of approximately 10 to 15 males to 1 female.³¹ Known as classic KS, this cancer progresses slowly and typically causes few serious problems. Pressure from the lesions may block the flow of lymph and blood in the legs and cause painful swelling. Lesions in the digestive tract may cause gastrointestinal bleeding. As many as 33% of patients with classic KS may develop another type of cancer before the KS lesions appear or later in life; usually non-Hodgkin lymphoma.³³

4. Endemic KS affects people of all ages and mainly occurs in certain parts of Africa. The lesions that develop may involve the skin, oral mucosa, lymph nodes, and visceral organs such as the gastrointestinal tract, lung, liver, and spleen. Most patients with HIV disease who present with the mucocutaneous lesions of KS feel healthy and are usually free of systemic symptoms, as compared with HIV patients who first develop an opportunistic infection. The sites of disease at presentation of epidemic KS are much more varied than the sites seen in other types of this neoplasm. While most patients present with skin disease, KS involvement of lymph nodes or the gastrointestinal tract may occasionally precede the appearance of the cutaneous lesions. The disease often progresses in an orderly fashion from a few localized or widespread mucocutaneous lesions to more numerous lesions and generalized skin disease with lymph node, gastrointestinal tract, and other organ involvement. Pleuropulmonary KS is an ominous sign usually occurring late in the course of the disease, especially in patients whose death is directly attributed to KS.

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:

- **Surgical excision** – removal of the lesion through minor surgery not usually recommended and lesions can reoccur.

Types of treatment used:

- Electrodesiccation
- Cryotherapy/Cryosurgery
- Radiation (external beam, photon, or electron)
- Injection of chemotherapy drug directly into lesions
- Application of vitamin A-like drug (retinoid)
- Immunotherapy
- Highly active antiretroviral therapy (HAART)
- Biologic and targeted therapy
- Chemotherapy
- Antiretroviral therapy

According to the Mayo Clinic, Lesions treated in any of these ways are likely to return within a couple of years¹⁷⁹. When this happens, treatment can often be repeated. Radiation is the usual treatment for those with multiple skin lesions. The type of radiation used, and the locations of lesions being treated vary from person to person. When more than 25 lesions are present, chemotherapy with standard anti-cancer drugs may be helpful. Chemotherapy is also used to treat Kaposi's sarcoma in the lymph nodes and digestive tract.

HIV Cannot be spread by:

- Air or water
- Mosquitoes, ticks or other insects
- Saliva, tears, or sweat that is not mixed with the blood of a person with HIV
- Shaking hands; hugging; sharing toilets; sharing dishes, silverware, or drinking glasses; or engaging in closed-mouth or "social" kissing with a person with HIV
- Drinking fountains
- Other sexual activities that don't involve the exchange of body fluids (for example, touching)

CANCER OF THE BRAIN AND NERVOUS SYSTEM

There were 308,102 new cases and approximately 251,329 deaths worldwide in 2020.³¹ Roughly 2/3 of all brain tumors are benign (non-cancerous).³¹ 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 potentiate 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 behavior 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.

There are basically two types of brain cancers; those which start in the brain, and those that metastasize to the brain from cancer in some other part of the body. Those that start in the brain are referred to as primary brain tumors, while those that metastasize to the brain are referred to as secondary brain tumors. Another serious condition can result from the tumor impeding the normal flow of cerebrospinal fluid, causing it to build up and the brain to swell. This condition is called hydrocephalus. It increases the intracranial pressure which will ultimately damage the fragile brain tissue.

The best-known environmental risk factor for brain tumors is radiation exposure, most often from radiation therapy to treat some other condition; most radiation-induced brain tumors are caused by radiation to the head given to treat other cancer.³¹ They occur most often in people who received radiation to the brain as children as part of their treatment for leukemia; these brain tumors usually develop around 10 to 15 years after the radiation.³¹

Neurofibromatosis type 1 (NF1) is a genetic disorder also known as von Recklinghausen disease and is the most common syndrome linked to brain or spinal cord tumors.¹⁸⁰ People with this condition have higher risks of schwannomas, meningiomas, and certain types of gliomas, as well as neurofibromas (benign tumors of peripheral nerves).¹⁸⁰ Changes in the NF1 gene cause this disorder. These changes are inherited from a parent in about half of all cases. In the other half, the NF1 gene changes occur before birth in people whose parents did not have this condition. Neurofibromatosis type 2 (NF2) is much less common than NF1, is associated with vestibular schwannomas (acoustic neuromas), which almost always occur on both sides of the head.¹⁸⁰ It is also linked with an increased risk of meningiomas or spinal cord ependymomas.¹⁸¹ Changes in the NF2 gene are responsible for neurofibromatosis type 2.¹⁸¹ Like NF1, the gene changes are inherited in about half of cases or may occur before birth in children without a family history.¹⁸⁰ People with Tuberous sclerosis may have subependymal giant cell astrocytomas (SEGAs), which are low-grade astrocytomas that develop beneath the ependymal cells of the ventricles). They may also have other benign tumors of the brain, skin, heart, kidneys, and other organs.³¹ This condition is caused by changes in either the TSC1 or the TSC2 gene.³¹ These gene changes can be inherited from a parent, but most often they develop in people without a family history.³¹

People with Von Hippel-Lindau disease tend to develop benign or cancerous tumors in different parts of the body, including hemangioblastomas (blood vessel tumors) in the brain, spinal cord, or retina, as well as tumors of the inner ear, kidney, adrenal gland, and pancreas.^{146,152} It is caused by changes in the VHL gene. Most often the gene changes are inherited, but in some cases the changes happen before birth in people whose parents don't have them.^{146,152}

People with Li-Fraumeni syndrome are at higher risk for developing gliomas, breast cancer, soft tissue sarcomas, leukemia, adrenal gland cancer, and certain other types of cancer; it is caused by changes in the TP53 gene.^{146,152}

Types of adult cancerous brain tumors:

- **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.
- **Astrocytomas** – are the most common form of adult brain tumor. They take hold in the star-shaped glial cells called astrocytes. Treatment will depend on the grade. **Low grade** (well-differentiated tumors) are slow growing and rarely metastasize. **Intermediate grade** (anaplastic astrocytomas) grow more rapidly and the cells exhibit malignant traits. **High grade** (glioblastoma multiforme) are very rapidly growing malignant tumors that will inevitably invade surrounding tissue.
- **Brain-stem gliomas** – only represent about 5% of all adult brain tumors.³¹ They are usually made up of astrocytomas but may contain other types of cells as well.
- **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.
- **Craniopharyngiomas** – develop in the brain near the pituitary gland and are usually benign. They may sometimes be considered malignant because they may create pressure on, or damage, the hypothalamus and affect vital functions (such as body temperature, hunger, and thirst). These tumors occur most often in children and adolescents, or adults over age 50.³¹
- **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.³¹
- **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**.
- **Gliomas** – about 3 out of 10 of all brain tumors are gliomas.³¹ These tumors originate in the glial cells that form the supportive tissue of the CNS.
- **Glioblastoma** – is an aggressive type of cancer that can occur in the brain or spinal cord. Glioblastoma forms from cells called astrocytes that support nerve cells. Glioblastoma can occur at any age but tends to occur more often in older adults. It can cause worsening headaches, nausea, vomiting and seizures. Also known as glioblastoma multiforme, it can be very difficult to treat, and a cure is often not possible.
- **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.
- **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. This type of brain cancer occurs most often in women ages 30 to 50.³¹
- **Mixed gliomas** – these 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.
- **Oligodendrogliomas** – these 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.

- **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.
- **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.³¹

Procedures:

During brain surgery, the patient may have chemotherapy into the area of the tumor as a wafer (implant). Or they might have a ventricular access device (an Ommaya reservoir) put in. Ventricular access devices allow the chemotherapy to go straight into the ventricles. The ventricles are the fluid filled spaces of the brain.

- **Needle biopsy** – may be used for brain tumors in hard to reach areas within the brain. The surgeon drills a small hole, called a burr hole, into the skull. A narrow thin needle is then inserted through the hole, and tissue is removed using the needle, which is frequently guided by CT scanning.
- **Gamma Knife® surgery** – is a treatment method that uses radiation and computer-guided planning to treat brain tumors, vascular malformations, and other abnormalities in the brain. Despite its name, this procedure does not involve any incisions, not even a skin incision. The Gamma knife is a treatment that delivers beams of highly focused radiation. Some 192 "beamlets" of radiation converge and are precisely focused on the targeted area of brain, specifically in the shape of the tumor or lesion, while sparing the surrounding normal tissue.

Gamma Knife surgery is also known as stereotactic radiosurgery, Gamma Knife radiosurgery and Gamma Knife radiation. The Gamma Knife may be helpful if the patient has a brain lesion or tumor that can't be reached by traditional surgery techniques or if they're unable to undergo surgery due to their condition or age. It can also be combined with traditional surgery to prevent tumor regrowth. The Gamma Knife is also used for some conditions that require urgent treatment.

Gamma Knife treatment involves several steps:

The initial steps are different if the Gamma Knife system uses an external rigid head frame or uses a frameless mask. If using a head frame:

- First, a box-shaped head frame is positioned on the patients' head. The head frame is made of aluminum and weighs less than two pounds. The head frame acts as a "frame of reference" in the planning of your treatment and is essential in keeping the target perfectly aligned during the precision treatment. The neurosurgeon positions the frame.
- Next, the patient will receive four injections of a local anesthetic, one on each side of the forehead and two in the back of the head. These are the areas where special pins are placed to fasten the head frame to the skull. The patient may feel pressure as the pins are tightened, but this usually only lasts a few minutes. After the head frame is positioned, a radiation therapist will take measurements of the head. Typically, an imaging scan, such as CT or MRI scan is performed with the head frame in place. These measurements and the scans are used for planning the treatment.

Frameless Gamma Knife systems use a thermoplastic mask that is placed over the patients' face. The mask is then secured to an existing frame on the Gamma Knife table. The head is held completely still.

These remaining steps are the same for both the frame-based and frameless systems.

- The patient may have an IV line inserted into their arm, allowing a contrast agent to be delivered for the computed tomography (CT) and/or magnetic resonance imaging (MRI) scan. These scans and dye determine the exact location, size and shape of the tumor or lesion to be treated. The scanning usually takes about 30 minutes to complete.
- The IV line can also be used to deliver a small amount of sedation to help the patient relax. Most patients are awake but under light sedation during the procedure. Under certain circumstances, general anesthesia is used.

- Based on the results of the scans and other information, the neurosurgeon, the radiation oncologist, and other team members plan the treatment on a computer. They will decide the area(s) to treat, radiation dose and how to target the lesion for best results. The patient can remain in their room with family or friends during this time. The entire procedure may take up to 12 hours at the treatment center. The treatment team will give a more accurate estimate based on each patients' unique condition.
- Next, treatment begins. The head frame or frameless mask is secured to the framework of the Gamma Knife table the patient lies on, so their head doesn't move during treatment. The Gamma Knife table slowly moves into the Gamma Knife machine that delivers the radiation. The treatment team will be immediately outside the room while the patient receives their treatment, but the patient will constantly be observed by cameras and monitored. There is a microphone near the head so they will be able to talk with the staff during treatment.
- Most treatments take 30 minutes to three hours (for the treatment itself), depending on the size, shape, and location of the lesion and number of radiation doses.
- After treatment, the table moves out of the machine and the staff enters the room. The head frame/mask and IV are removed at that time.
- The patient may wash their hair/scalp 48 hours after their surgery. This allows the pin sites to begin to heal and prevents infection from developing in the wounds.
- The patient may take non-aspirin pain medication such as ibuprofen (Advil®, Motrin®) or acetaminophen (Tylenol®) if they are having any discomfort
- They can remove the bandages from the pin sites the morning after the procedure. The sites should be cleaned twice a day with hydrogen peroxide or mild soap and water. The patient may then apply a small amount of antibiotic ointment such as Neosporin or Bacitracin to the pin sites for three to four days.

Depending on the type and size of the tumor or lesion, more than one treatment session may be needed. The neurosurgeon and/or radiation oncologist will review the treatment plan with the patient.

What is felt during the Gamma Knife procedure?

The actual Gamma Knife treatment is painless. There is no heat, noise, or discomfort during the treatment.

What happens after the Gamma Knife procedure

- After the head frame is removed, the pin sites are cleaned with hydrogen peroxide and an antibiotic ointment and bandages are applied.
- Staff will review discharge instructions with the patient and their driver. They will be observed for 30 minutes to one hour before being discharged.
- The patient must keep their head elevated on a few pillows for a week. This helps lessen swelling at the pin sites and pressure within the head.

Risks and Benefits of Gamma Knife:

While risks related to the procedure are typically low, risks and/or side effects of Gamma Knife surgery may include:¹⁸

- Swelling of the brain
- Headache
- Nausea and vomiting
- Numbness/tingling sensation on the scalp at the pin placement sites
- Hair loss (only occasionally if tumor is close to the scalp and hair follicles are irradiated)
- Seizures
- Bleeding (brain hemorrhage)
- Feeling tired

- **Functional imaging & intraoperative brain mapping** – have greatly improved the safety of brain tumor surgery. Functional magnetic resonance imaging (fMRI) uses high-speed MRI to map areas of the brain associated with vision, speech, touch, movement, and other functions, the locations of which can vary from one person to the next. The map then allows a surgeon to plan surgery precisely to avoid disrupting these important areas to optimize the patient's quality of life.

Many brain tumor operations are performed while the patient is awake but sedated. During intraoperative brain mapping, the neurosurgeon electrically stimulates the brain and the area around the tumor using small electrodes, while asking the patient to talk, count, look at pictures, and perform other basic tasks. This process helps surgeons locate the “eloquent” regions in the brain, which govern speech, the senses, and movement, and a “map” is created of the areas where preserving brain tissue is an absolute necessity. Surgeons can then avoid these sensitive tissues while removing as much of the tumor as possible. This kind of sophisticated brain mapping allows the neurosurgeon to remove tumors that are otherwise deemed inoperable, while maximizing preservation of the patient's normal function.

- **Neuroendoscopy** – some procedures are now performed using neuroendoscopy, in which the 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. Following surgery, an MRI is performed to determine the extent of tumor removal and to help plan further treatment.

A neuroendoscopy enables neurosurgeons to reach areas of the brain that are accessible with traditional surgery and/or reach a brain tumor with minimal cutting or damage to other areas of the skull.

Brain tumors that can be treated with minimally invasive brain surgery include:

- Pituitary tumors
- Tumors in the pineal region
- Rathke's cleft cysts
- Tumors in the base of the skull
- Ventricular tumors

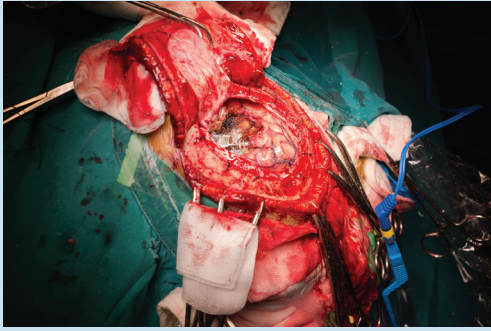
Complications associated with a neuroendoscopy include:

- Brain hemorrhage
- Severe bleeding
- Increased intracranial pressure
- Infection

- **Craniotomy** – surgical removal of a benign or malignant brain tumor. An incision is made in the scalp and the tissue is peeled back to reveal the skull. A special saw is used to cut out a plate of bone. Then the outer membrane, the **dura mater**, is cut open to expose the brain's surface. In most cases the removed piece of bone is reattached with metal screws and plates, wires, or stitches. The patient may have a drain coming out of the incision that allows excess cerebrospinal fluid (CSF) to leave the skull. Other drains may be in place to allow blood that builds up after surgery to drain from under the scalp. The drains are usually removed after a few days.

Most patients will in the hospital for about 3-4 days following a craniotomy. Complete recovery can take 4-6 weeks or longer (the incision will appear to be healed on the outside but will still be healing internally). Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds and should avoid activities that have a risk of falling, for at least 6 weeks after surgery.

- **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.
- **Functional image-guided surgery** – this procedure is carried out prior to the operation 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.
- **Intraoperative cortical stimulation (cortical mapping)** – in this approach, the surgeon electrically stimulates parts of the brain in and around the tumor during the operation and monitors the response. This can show if these areas control an important function (and therefore should be avoided).



- **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.
- **Laser surgery** – may be used with stereotactic localization to vaporize tumor cells that are inaccessible.
- **Shunt surgery** – if a tumor blocks the flow of the CSF, it can increase pressure inside the skull. This can cause symptoms like headaches, nausea, and drowsiness, and may even be life-threatening. To drain excess CSF and lower the pressure, the neurosurgeon may put in a silicone tube called a shunt (sometimes referred to as a ventriculoperitoneal or VP shunt). One end of the shunt is placed in a ventricle of the brain (an area filled with CSF) and the other end is placed in the abdomen or, less often, the heart or other areas. The tube runs under the skin of the neck and chest. The flow of CSF is controlled by a valve placed along the tubing. Shunts may be temporary or permanent. They can be placed before or after the surgery to remove the tumor. Placing a shunt normally takes about an hour. As with any operation, complications might develop, such as bleeding or infection. Strokes are possible as well. Sometimes shunts get clogged and need to be replaced.

Potential side-effects of all brain procedures:

- Blockage
- Over/under-drainage
- Infection
- Headaches
- Neck stiffness
- Stomach pain (if it drains to stomach)
- Vomiting
- Bleeding in the brain
- Damage to healthy brain tissue
- Difficulty concentrating
- Memory loss
- Weakness in arms and legs
- Difficulty walking
- Behavior changes
- Personality changes
- Problems with speech

Client should call their doctor immediately if they have:

- Swelling on around the incision
- Incision becomes red and hot or has drainage
- Difficulty breathing or chest pain
- Swelling or tenderness in legs or calves
- Fever of 100° or higher
- Double or blurred vision
- Seizure
- Vomiting or nausea
- Severe headache
- Weakness
- Confusion
- Lack of coordination
- Poor balance
- Dizzy spells
- Lack of reflexes
- Numbness in limbs

Types of treatment used:

- Radiation therapy
- Brachytherapy
- Whole brain and spinal cord radiation therapy (craniospinal radiation)
- Chemotherapy
- Interstitial chemotherapy
- Targeted therapies
- Alternating electric field therapy
- F stereotactic radiosurgery
- Proton therapy

CANCER OF THE TESTICLE

There were 74,458 new cases and 9,334 deaths worldwide in 2020.³¹ Cancer of the testicle is one of the leading malignancies among men aged 15-35 (50% of all cases), however, it is not at all restricted to that age group.³¹ One of the main risk factors for testicular cancer is a condition called cryptorchidism, or undescended testicle(s).³¹ This means that one or both testicles fail to move from the abdomen into the scrotum before birth. Males with cryptorchidism are several times more likely to get testicular cancer than those with normally descended testicles.^{31,56,88,89} The risk of testicular cancer might be a little higher for men whose testicle stayed in the abdomen as opposed to one that has descended at least partway.^{31,56,88,89} If cancer does develop, it is usually in the undescended testicle, but about 1 out of 4 cases occur in the normally descended testicle.^{31,56,88,89} Because of this, according to the American Cancer Society, some doctors conclude that cryptorchidism doesn't cause testicular cancer but that there is something else that leads to both testicular cancer and abnormal positioning of one or both testicles.^{88,89} Additional risk factors include HIV, infertility, prior history in one testicle, an abnormality of the penis and urethra known as hypospadias, and family history.^{31,56,88,89}

Testicular cancer is one of the most curable forms of cancer if treated appropriately.^{31,56,88,89} Even when the tumor has metastasized, 95% of clients can be cured.^{31,56,88,89} Symptoms of testicular cancer may be a lump in the testicle, painless enlargement of the testicle, dull ache in lower abdomen or groin, heaviness in scrotum, sudden collection of fluid in scrotum, dragging feeling in scrotum, fatigue, and tenderness or enlargement of breasts.

There are many types and classifications of testicular tumors:

- **Germ cell tumors** – more than 90% of cancers of the testicle develop in germ cells (these are the cells that produce sperm).^{31,56,88,89} There are 2 main types of germ cell tumors: seminomas and non-seminomas. They both occur about equally.^{88,89} Some cancers contain both non-seminoma and seminoma cells. These are treated as non-seminomas because they grow and spread like non-seminomas.
- **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** – more than 95% of seminomas are typical.^{31,56,88,89} These usually occur in men when they are between 25 and 45.^{31,56,88,89}
- **Spermatocytic seminoma** – this rare type of seminoma tends to occur in older men.^{31,56,88,89} The average age of men diagnosed with spermatocytic seminoma is about 65.^{31,56,88,89} Spermatocytic tumors tend to grow more slowly and are less likely to spread to other parts of the body than classical seminomas.^{31,56,88,89}

- **Non-seminomas** – usually occur in men between their late teens and early 30s.^{31,56,88,89} 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:
 - **Choriocarcinomas** – is a very rare and aggressive type of testicular cancer that occurs in adults.^{31,56,88,89} 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 nonseminoma cells in a mixed germ cell tumor.
 - **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.
 - **Yolk sac carcinomas** – these are so named because their cells look like the yolk sac of an early human embryo. Other names for this cancer include *yolk sac tumor, endodermal sinus tumor, infantile embryonal carcinoma, or orchidoblastoma*. Yolk sac carcinoma 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.
 - **Embryonal carcinomas** – this type of non-seminoma is partially present in about 40% of testicular tumors, but pure *embryonal carcinomas* occur only 3% to 4% of the time.^{31,56,88,89} 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.
- **Carcinoma in situ** – testicular germ cell cancers may begin as a non-invasive form of the disease called carcinoma in situ (CIS) 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** – 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.^{31,56,88,89} The two main types are Leydig cell tumors and Sertoli cell tumors:
 - **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%.^{31,56,88,89} They often produce androgens but sometimes produce estrogens. Most Leydig cell tumors are contained within the testicle and are cured with surgery. Although rare, when they do metastasize, Leydig cell tumors have a poor prognosis because they usually do not respond well to chemotherapy or radiation therapy.
 - **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. But if they spread, they, too, have a poor prognosis because they usually don't respond to chemotherapy and radiation therapy.

- **Secondary testicular tumors** – secondary testicular tumors start in another organ and then spread to the testicle. Lymphoma is the most common secondary testicular cancer. Testicular lymphoma is more common than primary testicular tumors in men older than 50. Their prognosis depends on the type and stage of lymphoma. The usual treatment is surgical removal, followed by radiation and/or chemotherapy. In boys with acute leukemia, the leukemia cells can sometimes form a tumor in the testicle. The prognosis for these cancers is usually poor because these cancers generally spread widely to other organs. Treatment depends on the specific type of cancer.

Procedures:

- **Laparoscopic surgery** – In some cases, the surgeon can remove lymph nodes through very small skin incisions in the abdomen by using a laparoscope and other long, thin surgical tools. A laparoscope is a narrow, lighted tube with a small camera on the end that lets doctors see inside the abdomen. The surgeon's hands are not inside the patient's body during this type of surgery.

In laparoscopic surgery, after being put to sleep, the patient is turned onto their side. Several small incisions are made on the abdomen. The laparoscope and surgical tools are put in through the incisions to remove the lymph nodes. The incisions are then closed, and the patient is woken up.

Patients recover much more quickly from this operation than the standard open procedure and are walking soon after surgery. There's usually less pain and patients are eating sooner.

Laparoscopic surgery seems to be a lot easier for the patient, but doctors aren't sure if it's as safe and effective as the standard "open" surgery in removing all of the lymph nodes that may contain cancer. Because of this uncertainty, doctors are more likely to recommend chemotherapy after laparoscopic surgery if cancer is found in the lymph nodes.

This procedure is most often used for patients with early-stage non-seminomas to see if the lymph nodes contain cancer. As with the standard open procedure, this is a complex operation that should only be done if the surgeon is very experienced.

- **Nerve-sparing retroperitoneal lymph node dissection** – a newer type of lymph node surgery called nerve-sparing retroperitoneal lymph node dissection (RPLND) is increasingly being used because it carries a lower risk of causing retrograde ejaculation and infertility.

In nerve sparing RPLND, the site of the operation is limited to a much smaller area. This means there's less chance of nerve damage occurring. The disadvantage is that the surgery is more technically demanding. Nerve-sparing RPLND is currently only available at specialist centers that employ surgeons with the required training.

- **Radical Inguinal Orchiectomy** – removes the testicle (or testicles) containing the cancer. It's called "radical" because it removes the spermatic cord along with the testicle and tumor through an incision above the pubic bone. The cord has **blood** and lymph vessels that could let the **cancer** spread to other parts of the body. In a simple orchiectomy, the doctor only removes one or both testicles. This surgery can ease symptoms, prevent problems from **prostate cancer**, and treat male **breast cancer**. An incision is made in the groin, and the testicle is moved through the opening. All stages of testicular cancer are typically treated with this type of surgery.

Most patients will be in the hospital for about a day. Full recovery can take 3-4 weeks. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period, but that is the limit for physical activity. Patients should not lift anything over 10 pounds for at least 4 weeks after surgery.

Potential side effects of Radical Inguinal Orchiectomy:

- Loss of lean muscle mass
- Limited ability to build lean muscle
- Decreased libido
- Lower extremity lymphedema
- Hot flashes
- Breast tenderness or growth
- Infertility if both testicles are removed
- Infection
- Bowel obstruction
- Scrotal hematoma
- Inguinal hernia

- **Retroperitoneal lymph node dissection** – surgical removal of the retroperitoneal lymph nodes behind the abdomen. A large incision is often made that extends from the sternum to several inches below the navel. About 5% to 10% of clients have temporary complications after surgery, such as bowel obstruction or wound infections.^{88,89} This is a difficult and long operation. A less invasive form using laparoscopic techniques (L-RPLND) exists, but it is more costly, time-consuming, and requires special equipment that not every hospital may have. There is usually less pain and clients are eating sooner as well. This procedure is most often used for clients with early stage non-seminomas to see if the lymph nodes contain cancer. Open incision RPLND (O-RPLND), has more room for complications, but is an equally effective way to remove the lymph nodes.

Most patients will be in the hospital for about 7-10 days or 2-3 days for a laparoscopic procedure, with full recovery can taking 2-3 months. Walking 4-6 times a day for the first two weeks after surgery on a level surface is strongly encouraged as prolonged sitting or lying can increase the risk of pneumonia and deep vein thrombosis. It is permissible to climb stairs. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of retroperitoneal lymph node dissection:

- Infertility
- Prolonged bowel inactivity
- Bowel obstruction
- Infection
- Damage to surrounding organs
- Lymphocele - lymphatic fluid continues to collect in the removal area

Types of treatment used:

- Chemotherapy
- Radiotherapy
- Proton Therapy
- Bone-Marrow Transplantation (BMT) or Peripheral Stem Cell Transplant (PBSCT)

CANCER OF THE SMALL INTESTINE

Small intestine cancer occurs slightly more in men than women and most often in people in their 60's -70's, according to the American Cancer Society.¹⁸³ Some studies have shown an increased link in those who drink alcohol and smoke as well as those who have diets that are high in red meat and smoked foods.^{31,183} The types of cancer found in the small intestine are adenocarcinoma, sarcoma, gastrointestinal stromal tumors, carcinoid tumors, and lymphoma. Symptoms may include pain or cramps in the middle abdomen, weight loss, lump in the abdomen, and blood in the stool.

Carcinoid tumors only make up for roughly 20% of all small-intestine tumors but are the most curable type.^{31,183} Two in five carcinoid tumors grow in the small bowel.^{31,183} One in five of these will spread, usually to the liver.^{31,183} Metastatic carcinoids that release large quantities of hormones and other substances may be accompanied by an abundance of symptoms referred to as carcinoid syndrome: flushing of the face, diarrhea, abrupt drops in blood pressure, abdominal edema, and bronchospasms. Most people who have carcinoid syndrome also have liver metastasis. Interestingly, even in clients with metastatic disease, the cancer grows very slowly.

Most small intestinal cancers (especially adenocarcinomas) develop in the duodenum.^{31,183} Cancers that develop in the duodenum are often found at the ampulla of Vater. But because this area is closely associated with the pancreas, cancers of the ampulla of Vater (also known as ampullary cancers) are treated like **pancreatic cancer**.

Adenocarcinoma starts in glandular cells in the lining of the small intestine and is the most common type of small intestine cancer. Most of these tumors occur in the part of the small intestine near the stomach. They may grow and block the intestine. Leiomyosarcoma starts in the smooth muscle cells of the small intestine. Most of these tumors occur in the part of the small intestine near the large intestine.

For people with celiac disease, eating gluten causes their body to make antibodies that attack the lining of the intestines. The damaged lining makes it hard to digest and absorb the nutrients from food, often leading to diarrhea and weight loss. People with celiac disease have an increased risk of a certain kind of lymphoma of the intestine called **enteropathy-associated T-cell lymphoma**. They may also have an increased risk of small intestine adenocarcinoma.

Survivors of colon cancer have an increased risk of getting cancer of the small intestine.^{31,183} This could be due to shared risk factors. Crohn's disease attacks the gastrointestinal (GI) tract and can affect any part of the GI tract, but it most often affects the lower part of the small intestine. People with this condition have a risk of small bowel adenocarcinoma that is much higher than normal. These cancers are most often seen in the ileum.

People with certain inherited conditions have a higher risk of small intestine adenocarcinoma.^{31,152,18} With Familial adenomatous polyposis (FAP), many polyps develop in the colon and rectum.^{31,152,18} If the colon isn't removed, one or more of these polyps will become cancerous. Polyps in the stomach and the small intestine are also part of this syndrome, and they can lead to cancers in these areas. In FAP, most small intestine cancers are found in the duodenum.

Lynch syndrome reduces the body's ability to repair damage to its DNA.^{31,152,18} This results in an increased risk for cancer of the colon and small intestine and a high risk of endometrial and ovarian cancer.^{31,152,18} People with Lynch syndrome have up to a 4% chance of developing small intestine cancer.^{31,152,18}

Peutz-Jegher's syndrome (PJS) is when polyps develop in the stomach and intestines, as well as in other areas including the nose, the airways of the lungs, and the bladder.^{31,152,18} The polyps in the stomach and intestines are a special type called *hamartomas*. They can cause problems like bleeding or blockage of the intestines. PJS can increase the risk of many types of cancer, including small intestine adenocarcinoma.^{31,152,18} This syndrome is caused by mutations in the gene STK1.^{31,152,18} People with MUTYH-associated polyposis develop colon polyps which will become cancerous if the colon is not removed.^{31,152,18} They also can get polyps in the small intestine and have an increased risk of small intestine cancer.^{31,152,18} Other cancers that can occur in people with this syndrome include cancers of the skin, ovary, and bladder. This syndrome is caused by mutations in the gene MUTYH.^{31,152,18}

Cystic fibrosis (CF) causes severe lung problems. Often, in someone with CF, the pancreas cannot make the enzymes that break food down so that it can be absorbed. People with CF have an increased risk of adenocarcinoma of the ileum.^{31,152,18} The gene that causes CF is called CFTR. A child must have 2 abnormal copies of this gene (one from each parent) to get this disease. A diet high in fiber may help lower the risk of small intestine cancer.^{31,152,175,183}

- **Local excision** – surgical removal of the cancer through an endoscope inserted down the throat
- **Segmental resection** – surgical removal of the cancerous part of the small intestine. A *duodenectomy* resects part or all the duodenum (the upper portion), a *jejunectomy*, part or all the jejunum (the middle section), and *ileectomy*, part or all the ileum (the portion that leads to the colon). Regional lymph nodes are usually removed as well. If there is enough healthy intestine left, the free ends of the intestine may be joined together. Otherwise, a permanent or temporary ileostomy is created. An ileostomy is an opening called a stoma in the abdomen. The end of the small intestine closest to the stomach is attached to the opening. This allows intestinal contents to drain into a sealed pouch on the outside of the body. If a temporary ileostomy is created, another operation will be necessary several months later to reverse it.

Most patients will in the hospital for about 5-7 days or 2-3 days for a laparoscopic procedure. Full recovery can take 4-6 weeks; no climbing and/or strenuous during that time. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for at least 4 weeks after surgery.

Potential side effects of a segmental resection:

- Excessive bleeding
- Lower extremity lymphedema
- Incisional hernia
- Narrowing of the stoma opening
- Infections at the stoma site
- Blockage of the intestine from scar tissue
- Diarrhea
- Inability to get enough nutrients and vitamins if too much intestine needed to be removed
- **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. 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. According to the American Cancer Society, when the operation is done in small hospitals or by doctors with less experience, as many as 15% of patients may die because of surgical complications.¹⁸³ In contrast, when the operation is done in cancer centers by surgeons experienced in the procedure, less than 5% of patients die as a direct result of surgery.¹⁸³

Most patients will remain in the hospital for one to two weeks with the first post-surgery night spent in the intensive care unit before being transferred to the surgical floor. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients usually remain fatigued for about two months after this operation and should not lift anything over a few pounds for at least six weeks.

Potential side effects of the Whipple procedure:

- Leaking from the various connections that the surgeon makes
- Infections
- Bleeding
- Trouble with the stomach emptying after eating
- Trouble with digestion (pancreatic enzyme may be necessary)
- Weight loss
- Change in bowel habits
- Diabetes

Types of treatment used:

- Chemotherapy
- Radiation Therapy
- Immunotherapy
- Checkpoint Inhibitors

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.^{31,182,183} There were 377,713 new cases and 177,757 deaths worldwide in 2020.^{31,182,183} 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, trouble swallowing, 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. Exposure to UV radiation from the sun or tanning beds increases the risk of lip cancer. Frequent or heavy alcohol consumption puts you at risk for cancers of the lip and oral cavity. According to the American Cancer Society, there is a 30-fold increased risk for individuals who drink and smoke.¹⁸³ HPV infection is associated with cancers of the tonsil, base of the tongue, and some other sites in the oropharynx, and is believed to be transmitted through sexual contact. The risk for cancers of the lip and oral cavity increases with age.¹⁸³ Most patients are over the age of 45 at diagnosis and is more common in men than women.^{31,182,183}

Procedures:

- **Surgical excision** – surgical removal of the cancer and some of the healthy tissue. Depending on the tumor's size and site, a more extensive operation may be required.
- **Partial glossectomy** – surgical removal of part of the tongue
- **Hemiglossectomy** – surgical removal of one side of the tongue
- **Glossectomy** – surgical removal of the entire tongue

Potential side effects of glossectomies:

- Bleeding
- Hematoma
- Infection
- Salivary fistula (hole causing saliva to leak from the mouth into the neck)
- Impaired speech
- Airway blockages
- Difficulty swallowing
- Aspiration
- Pneumonia
- Weight loss
- Difficulty chewing – often limited to liquids
- Malnourishment – may require tube feedings
- Flap or reconstruction failure

Most patients will remain in the hospital for 7-10 days with full recovery taking several months. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. No heavy lifting for at least 6 weeks after surgery. Be aware of any muscle imbalances or limitations if reconstructive flap was used.

- **Mandibulectomy** – removes all or part of the jaw bone (mandible). This operation may be needed if the tumor has grown into the jaw bone. There are two types of mandibulectomy:
 - **Marginal Mandibulectomy** – much of the jawbone is left to limit the need for reconstructive surgery. Only the area with cancer is removed.
 - **Segmental Mandibulectomy** – the entire jaw bone is removed and then reconstructed. A bone from another part of the body, (leg, back, arm or hip) is used to create

a new jaw. Skin grafts and muscle flaps may also be used. An artery, vein and some soft tissue will also be taken from another area and used for reconstruction.

Following a mandibulectomy, most patients will remain in the hospital for 10-14 days with full recovery taking several months. In some cases, a temporary or permanent feeding tube will be needed for nutrition during and after the healing process. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery. Be aware of any muscle imbalances or limitations if reconstructive flap was used.

Potential side effects of Mandibulectomy:

- Bleeding
 - Hematoma
 - Seroma (pocket of fluid)
 - Infection
 - Salivary fistula
 - Blood clot
 - Malocclusion
 - Nerve damage
 - Trismus
- **Maxillectomy** – if cancer has grown into the hard palate, all or part of the involved bone (maxilla) will need to be removed. The hole in the roof of the mouth, that is left after this operation, can be filled with a special denture called a *prosthesis*.

Most patients will remain in the hospital for a few days (with major reconstruction it may be a few weeks) with full recovery taking several months. Patients should avoid strenuous activity, bending, and lifting for the first two weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of Maxillectomy:

- Bleeding
- Infection
- Blood clots
- Enophthalmos (functional deformity in which the eye sinks down into the cheek)
- Numb skin
- Cheek numbness
- Chronic tearing

- **Laryngectomy** – surgical removal of the **larynx** and separation of the airway from the **mouth, nose** and **esophagus**. In a total laryngectomy, the entire larynx is removed (including the **vocal folds, hyoid bone, epiglottis, thyroid** and **cricoid cartilage** and a few **tracheal cartilage** rings). In a partial laryngectomy, only a portion of the larynx is removed.

Partial Laryngectomy – is the removal of part of the larynx, which helps preserve the patient's natural voice. The following are some of the different types of partial laryngectomies:

- Supraglottic laryngectomy - during this procedure, the surgeon removes the area above the vocal folds. If part of the hypopharynx is removed along with the cancer, this procedure is called a partial pharyngectomy.
- Cordectomy - removal of a vocal fold.
- Vertical hemilaryngectomy - removal of 1 side of the larynx.
- Supracricoid partial laryngectomy - removal of the vocal folds and the area surrounding them.

Most patients will remain in the hospital for a few days, the first 1-2 days may be spent in intensive care, with full recovery taking 3-4 months. Patients should avoid strenuous activity, bending, and lifting for the first two weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of Laryngectomy:

- Pharyngocutaneous fistula (an abnormal opening between the pharynx and the trachea)
- Voice loss
- Difficulty swallowing
- Malnutrition
- Breathlessness
- Fatigue
- Changes in taste, smell, and appetite
- Rupture of carotid artery
- Lymphedema
- Decreased thyroid gland function
- Esophagus or trachea damage
- Mobility limitations in the neck and shoulder area
- Difficulty eating

- **Neck dissection** – there are several types of neck dissection procedures, and they differ in how much tissue is removed from the neck. The amount of tissue removed depends on the primary cancer's size and how much it has spread to lymph nodes.

- **Modified radical neck dissection** – most lymph nodes on one side of the neck (between the jawbone and collarbone) are removed, as well as some muscle and nerve tissue. This procedure preserves structures that are usually sacrificed in the radical neck dissection such as the spinal accessory nerve, the internal jugular vein or sternocleidomastoid muscle.
- **Radical neck dissection (cervical lymphadenectomy)** – in this procedure the sternocleidomastoid muscle, omohyoid muscle, internal jugular vein, spinal accessory nerve, cervical plexus nerves, submandibular salivary gland, tail of parotid gland, and all the lymph nodes are removed. A modified radical neck dissection removes all the same lymph node groups as the radical neck dissection but spares at least one of the non-lymphatic structures removed with the radical neck dissection such as the sternocleidomastoid, spinal accessory nerve, or internal jugular vein.

Removal of one jugular vein usually causes minimal or no problems. There are many other veins in the neck and the blood can flow back through them. If a bi-lateral neck dissection is being done, the surgeon will try to save at least one jugular vein.

The spinal accessory nerve is a cranial nerve that provides motor control of the sternocleidomastoid and trapezius muscles. This can result in poor strength in head and neck movements, shoulder droop, limited shoulder range of motion, muscle wasting in the shoulder muscles, winged scapula, and weakness in shoulder flexion, abduction, and external rotation.

Removal of the sternocleidomastoid muscle causes the neck to look sunken due to its removal. The muscle also provides some coverage of the carotid artery, so this will be reduced if the muscle is resected. This can cause a problem if there is a post-operative infection, but otherwise is not that important. If both sternocleidomastoid muscles are removed, one's strength in flexing the head forward will be reduced.

Recovery time from a neck dissection alone is quite quick. If a patient has only had a neck dissection, the total hospital stay may only be 2-3 days. The recovery course will depend on the extent of additional surgery and the reconstruction performed along with the neck dissection. Some surgery might require staying in the hospital for one to two weeks. Most patients will remain in the hospital for 1 day with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for 4-6 weeks after surgery.

Potential side effects of neck dissections:

- Lymphedema in the neck and face
 - Numbness in the cheek, neck, and ear
 - Changes in speech and swallowing
 - Weakness of the lower lip
 - Neck stiffness or pain
 - Shoulder movement may be impaired
 - There may be some difficulty raising the arm over the head
 - Reduced strength in neck and head movements
 - Blood clots
 - Chyle leak, which results in fluid accumulation in the neck from disruption of the thoracic duct (this problem is more common after left sided neck dissections)
- **Tracheotomy** – is an incision (hole) made through the skin in the front of the neck and into the trachea (windpipe). It is done to help a person breathe. It may be used in different circumstances. If a lot of swelling is expected in the airway after the cancer is removed, the doctor may want to do a temporary tracheostomy (using a small plastic tube) to allow the person to breathe more easily until the swelling goes down. It stays in place for a short time and is then removed later when it is no longer needed.

If the cancer is blocking the throat and is too large to remove completely, an opening may be made to connect a lower part of the windpipe to a stoma (hole) in the front of the neck to bypass the tumor and allow the person to breathe more comfortably. This is known as a tracheotomy. A permanent tracheostomy is also needed after a total laryngectomy.

Most patients will remain in the hospital for 3-5 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of tracheotomy/tracheostomy:

- Bleeding
- Air trapped in tissue under the skin of the neck (subcutaneous emphysema)
- Buildup of air between the chest wall and lungs (pneumothorax)
- Damage to esophagus
- Injury to the nerve that moves the vocal cords
- Hematoma
- Infection at stoma site
- Lymphedema if nodes are removed

Types of treatment used:

- External beam radiation
- Intensity-modulated radiation therapy
- Hyperfractionated radiation therapy
- Hyperthermia
- Chemotherapy
- Targeted therapy
- Immunotherapy
- Brachytherapy
- Proton therapy
- Mohs micrographic surgery

CANCER OF THE THYROID

There were 586,202 new cases and 43,646 deaths worldwide in 2020.^{31,18} Thyroid cancer is the most common endocrine tumor and one of the most curable forms of cancer.^{31,18} Thyroid cancer affects three times as many women as men and is the most rapidly increasing cancer in the US and has been increasing worldwide over the past few decades, according to the American Cancer Society.¹⁸³ In the US, rates increased by 5.4% per year in men and 6.5% in women.¹⁸³ A history of radiation therapy to the head or neck during childhood has been linked to the disease.¹⁸³

Thyroid tumors may appear between 5 and 20 years after radiation treatment.¹⁸³ The most common symptom is a lump in the neck that may be detected by a physician during an exam.¹⁸³ Other symptoms may include a tight or full feeling in the neck, difficulty breathing or swallowing, hoarseness, swollen lymph nodes, and pain in the throat or neck that does not go away, goiter or thyroid nodules, a family history of thyroid cancer, and radiation exposure early in life, having certain genetic conditions such as familial medullary thyroid cancer (FMTc), multiple endocrine neoplasia type 2A syndrome (MEN2A), and multiple endocrine neoplasia type 2B syndrome (MEN2B), and being Asian all increase your risk of thyroid cancer.^{31,182,183} Sixty eight percent of thyroid cancers are diagnosed at an early stage and are extremely curable; the five-year survival rate approaches 100% for localized disease and 97% for regional disease.^{31,182,183}

There are several classifications of thyroid cancer: papillary, follicular, medullary, and anaplastic. Papillary carcinoma is slow to grow and highly treatable, even if it has already invaded the lymph nodes. More than half of the cases of papillary carcinoma will, in fact, spread to the cervical lymph nodes.^{31,182,183} Follicular carcinoma is seen more often in older men and women.^{31,182,183} It's more aggressive than papillary carcinoma, but still considered treatable in most circumstances. Medullary carcinoma is the rarest type of thyroid cancer, and it is not uncommon for it to metastasize to other organs.^{31,182,183} Because the tumor will frequently invade the cervical lymph nodes, this type of cancer usually warrants a total thyroidectomy plus extensive lymph-node dissection. One in ten cases of medullary carcinoma is hereditary.^{31,182,183} Finally, anaplastic thyroid cancer is characterized by metastasis to other organs. It usually strikes people over 60.^{31,182,183} The cells are extremely explosive in their growth and aggressive in their pattern of spread.

Procedures:

- **Lobectomy** – surgical removal of either of the thyroid's two lobes. This procedure is also called a hemithyroidectomy. Because this procedure leaves part of the thyroid behind, the patient may not need thyroid hormone for the rest of their life. This type of surgery may be used for papillary cancers smaller than 1 centimeter (about ½ inch) that have not spread.
- **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.
- **Total thyroidectomy** – surgery to remove the entire thyroid. Your parathyroid glands are located behind your thyroid, so they also carry a small risk of injury. The surgeon must carefully identify the parathyroid glands to prevent damaging them during the thyroidectomy. The parathyroid glands regulate calcium levels. If one or more of those glands are damaged, then hypoparathyroidism can result. This may eventually trigger hypocalcemia, which is a condition of abnormally low levels of blood calcium. If hypocalcemia occurs, then it can be easily treated with calcium and vitamin D supplements.

There are different surgical techniques that can be used for a thyroidectomy:

- **Standard thyroidectomy** – during a standard thyroidectomy, a surgeon makes a small incision (or cut) near the base or middle of the neck. This gives the surgeon direct access to the patient's thyroid gland for the operation. At some cancer centers, newer surgical techniques are being offered to reduce or avoid neck scarring.
- **Endoscopic thyroidectomy** – during an endoscopic thyroidectomy, the surgeon makes a single small incision. The surgery is like a standard thyroidectomy except that a scope and video monitor are used to guide the procedure rather than surgical loupe magnification, which is special eyewear.
- **Robotic thyroidectomy** – the surgeon makes an incision elsewhere, such as in an armpit, the hairline of the neck, mouth, or the chest, and then uses a robotic tool to perform the thyroidectomy. Robotic thyroidectomy is not a recommended surgery for thyroid cancer.¹⁹

If there is evidence or risk of spread of cancer to the lymph nodes in the neck, the surgeon may also perform a neck dissection. This is surgery to remove the lymph nodes in the neck. Neck dissection is also called lymphadenectomy.

Hormone Treatment

Patients who are treated with surgery usually require thyroid hormone therapy. In addition to replacing the hormone that is needed by the body, the thyroid hormone medication may slow down the growth of any remaining differentiated cancer cells. Thyroid hormone replacement is levothyroxine (Levothroid®, Levoxyl®, Synthroid®, Tirosint®, Unithroid®, and other brand names.) Levothyroxine® typically comes as a pill that should be taken daily, at the same time each day before meals, so that the body receives a consistent supply. Thyroid hormone replacement is usually prescribed by an endocrinologist, which is a doctor specializing in treating problems with hormones, glands, and the endocrine system.

Also, be sure to talk with your doctor about all other medications you take, including dietary supplements such as iron or calcium, to avoid interactions with your thyroid hormone replacement. Read more about tips to take your medication correctly. Thyroid pills may have a few side effects. Occasionally, some patients develop a rash or lose some hair during the first months of treatment.

Hyperthyroidism is a condition in which there is 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.

Hypothyroidism is a condition in where there is too little thyroid hormone. It may cause fatigue, weight gain, dry skin and hair, and a feeling of being cold.

The required amount, called a dose, of thyroid hormone is different for every patient and tumor type, and it can change as a person ages, or as a person's weight changes. The doctor will monitor your thyroid hormone levels through regular blood tests. Talk with your doctor about what signs to watch for that may mean it is time to adjust your dose of hormone supplement.

Most patients will remain in the hospital for 1 day with full recovery taking 3-4 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for at least 2 weeks after surgery.

Potential side effects of total thyroidectomy:

- Damage to the adjacent parathyroid glands (regulate blood calcium levels)
- Excessive bleeding or formation of major blood clot (hematoma) in the neck
- Wound infection
- Hypocalcemia
- Hoarseness
- Impeded speaking and breathing
- Hormonal dependence (will need to take thyroid hormone replacement)
- Weight gain
- Lethargy
- Cervical lymphedema

- **Tracheotomy** – is an incision (hole) made through the skin in the front of the neck and into the trachea (windpipe). It is done to help a person breathe. It may be used in different circumstances. If a lot of swelling is expected in the airway after the cancer is removed, the doctor may want to do a temporary tracheostomy (using a small plastic tube) to allow the person to breathe more easily until the swelling goes down. It stays in place for a short time and is then removed later when it is no longer needed.

If the cancer is blocking the throat and is too large to remove completely, an opening may be made to connect a lower part of the windpipe to a stoma (hole) in the front of the neck to bypass the tumor and allow the person to breathe more comfortably. This is also known as a tracheotomy. A permanent tracheostomy is also needed after a total laryngectomy.

Most patients will remain in the hospital for 3-5 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of tracheotomy/tracheostomy:

- Bleeding
- Subcutaneous emphysema
- Buildup of air between the chest wall and lungs (pneumothorax)
- Damage to esophagus
- Injury to the nerve that moves the vocal cords
- Hematoma
- Infection at stoma site
- Lymphedema if nodes are removed

Types of treatment used:

- External beam radiation
- Intensity modulated radiation therapy
- Radioactive iodine therapy
- Hormonal therapy
- Targeted therapy
- Chemotherapy

CANCER OF THE LARYNX

There were 184,615 new cases and 99,840 deaths worldwide in 2020^{31,183}. Fortunately, no additional treatment beyond the initial biopsy may be required for carcinoma in situ of the larynx. A laser may, however, be used to eradicate any affected areas of the organs' lining. Early-stage tumors can be treated with radiation alone or in conjunction with surgical procedures to remove part of the larynx. Laryngeal cancer is different in that a person can 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 to affect the nodes. Twenty-five to fifty percent of these clients will have node-positive disease.^{31,183} 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.^{31,147,183} Tobacco use is the most important risk factor for head and neck cancers (including cancers of the larynx and hypopharynx).^{31,147,183} The risk for these cancers is much higher in smokers than in nonsmokers.^{31,147,183} Smoke from cigarettes, pipes, and cigars all increase their chance of getting these cancers.

Moderate or heavy alcohol use increases the risk of these cancers, although not as much as smoking.^{31,51,147,183} People who smoke and drink are many times more likely to get head and neck cancer than are people who don't.^{27,28,31,51,147,183} Cancers of the larynx and hypopharynx are about 4 times more common in men than women and because they develop over many years, they are not common in young people.^{31,51,147,183} Over half of patients with these cancers are 65 or older when the cancers are first found.^{31,147,183} Cancers of the larynx and hypopharynx are more common among African Americans and whites than among Asians and Latinos.^{31,147,183}

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 cough that persists, a sore throat, or an earache. Tumors that begin in the area 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 that lasts more than three weeks should be checked by a doctor.

Procedures:

- **Endoscopic re-excision** – a second endoscopic surgical procedure to excise a wider margin of cancerous laryngeal tissue. This procedure is often performed using a laser.
- **Vocal cord stripping** – 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.
- **Corpectomy** – surgical removal of one or two of the vocal cords. This can be used to treat very small or superficial glottic (vocal cord) cancers. This procedure may be performed endoscopically, or through an incision in the neck.
- **Total Laryngectomy** – surgical removal of the **larynx** and separation of the airway from the **mouth**, **nose** and **esophagus**. In a total laryngectomy, the entire larynx is removed (including the **vocal folds**, **hyoid bone**, **epiglottis**, **thyroid** and **cricoid cartilage** and a few **tracheal cartilage** rings). In a partial laryngectomy, only a portion of the larynx is removed.

Partial Laryngectomy – is the removal of part of the larynx, which helps preserve the patient's natural voice. The following are some of the different types of partial laryngectomies:

- Supraglottic laryngectomy. During this procedure, the surgeon removes the area above the vocal folds. If part of the hypopharynx is removed along with the cancer, this procedure is called a partial pharyngectomy.
- Corpectomy. The removal of a vocal fold.
- Vertical hemilaryngectomy. The removal of 1 side of the larynx.
- Supracricoid partial laryngectomy. The removal of the vocal folds and the area surrounding them.

Laryngopharyngectomy – is the removal of the entire larynx, including the vocal folds and part or all of the pharynx. After this surgery, doctors must reconstruct the pharynx using flaps of skin from the forearm, other parts of the body, or a segment of the intestine. Like a total laryngectomy, people can no longer speak using the vocal folds after laryngopharyngectomy. They may also have difficulty swallowing. A speech pathologist can help people learn to speak and swallow afterward.

Following the procedure, the person breathes through an opening in the neck known as a **stoma**. There is no longer a connection between the trachea and the mouth and nose. These patients are termed “total neck breathers.” After a partial laryngectomy, the individual breathes mainly through the stoma, but a connection still exists between the trachea and upper airways such that patients can breathe air through the mouth and nose. They are therefore termed “partial neck breathers”. The extent of breathing through the upper airways in these individuals varies and a **tracheostomy** tube is present in many of them. Ventilation and resuscitation of total and partial neck breathers is performed through the stoma. However, for these individuals, the mouth should be kept closed and the nose should be sealed to prevent air escape during resuscitation.

Most patients will be in the intensive care unit for 2-3 days and remain in the hospital for about a week, with full recovery taking 3-4 months. Patients should avoid strenuous activity, bending, and lifting for the first 6 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for at least 6 weeks after surgery and must avoid getting water in the stoma.

Potential side effects of laryngectomy:

- Pharyngocutaneous fistula (an abnormal opening between the pharynx and the trachea)
- Voice loss
- Difficulty swallowing
- Malnutrition
- Breathlessness
- Fatigue
- Changes in taste, smell, and appetite
- Rupture of carotid artery
- Lymphedema
- Decreased thyroid gland function
- Esophagus or trachea damage
- Mobility limitations in the neck and shoulder area
- Difficulty eating
- Esophagus or trachea damage
- Mobility limitations in the neck and shoulder area
- Difficulty eating

- **Tracheostomy** – is an incision (hole) made through the skin in the front of the neck and into the trachea (windpipe). It is done to help a person breathe. It may be used in different circumstances. If a lot of swelling is expected in the airway after the cancer is removed, the doctor may want to do a temporary tracheotomy (using a small plastic tube) to allow the person to breathe more easily until the swelling goes down. It stays in place for a short time and is then removed later when it is no longer needed.

If the cancer is blocking the throat and is too large to remove completely, an opening may be made to connect a lower part of the windpipe to a stoma (hole) in the front of the neck to bypass the tumor and allow the person to breathe more comfortably. This is known as a tracheostomy. A permanent tracheostomy is also needed after a total laryngectomy.

Most patients will remain in the hospital for 3-5 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of tracheotomy/tracheostomy:

- Bleeding
 - Subcutaneous emphysema
 - Buildup of air between the chest wall and lungs
 - Damage to esophagus
 - Injury to the nerve that moves the vocal
 - Hematoma
 - Infection at stoma site
 - Lymphedema if nodes are removed
- **Total thyroidectomy** – surgery to remove the entire thyroid. The parathyroid glands are located behind your thyroid, so they also carry a small risk of injury. The surgeon must carefully identify the parathyroid glands to prevent damaging them during the thyroidectomy. The parathyroid glands regulate calcium levels. If one or more of those glands are damaged, then hypoparathyroidism can result. This may eventually trigger hypocalcemia, which is a condition of abnormally low levels of blood calcium. If hypocalcemia occurs, then it can be easily treated with calcium and vitamin D supplements.

Most patients will remain in the hospital for 1 day with full recovery taking 3-4 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for at least 2 weeks after surgery.

Potential side effects of thyroidectomy:

- Damage to the adjacent parathyroid glands (regulate blood calcium levels)
 - Excessive bleeding or formation of major blood clot (hematoma) in the neck
 - Wound infection
 - Hypocalcemia
 - Hoarseness
 - Impeded speaking and breathing
 - Hormonal dependence (will need to take thyroid hormone replacement)
 - Weight gain
 - Lethargy
 - Cervical lymphedema
- **Radical neck dissection (cervical lymphadenectomy)** – in this procedure sternocleidomastoid muscle, omohyoid muscle, internal jugular vein, spinal accessory nerve, cervical plexus nerves, submandibular salivary gland, tail of parotid gland, and all the lymph nodes are removed. A modified radical neck dissection removes all the same lymph node groups as the radical neck dissection but spares at least one of the non-lymphatic structures removed with the radical neck dissection such as the sternocleidomastoid, spinal accessory nerve, or internal jugular vein.

Removal of one jugular vein usually causes minimal or no problems. There are many other veins in the neck and the blood can flow back through them. If a bi-lateral neck dissection is being done, the surgeon will try to save at least one jugular vein.

The spinal accessory nerve is a cranial nerve that provides motor control of the sternocleidomastoid and trapezius muscles. This can result in poor strength in head and neck movements, shoulder droop, limited shoulder range of motion, muscle wasting in the shoulder muscles, winged scapula, and weakness in shoulder flexion, abduction, and external rotation.

Removal of the sternocleidomastoid muscle causes the neck to look sunken due to its removal. The muscle also provides some coverage of the carotid artery, so this will be reduced if the muscle is resected. This can cause a problem if there is a post-operative infection, but otherwise is not that important. If both sternocleidomastoid muscles are removed, one's strength in flexing the head forward will be reduced.

Recovery time from a neck dissection alone is quite quick. If a patient has only had a neck dissection, the total hospital stay may only be 2-3 days. The recovery course will depend on the extent of additional surgery and the reconstruction performed along with the neck dissection. Some surgery might require staying in the hospital for one to two weeks. Most patients will remain in the hospital for 1 day with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for 4-6 weeks after surgery.

Potential side effects of neck dissections:

- Lymphedema in the neck and face
 - Numbness in the cheek, neck, and ear
 - Changes in speech and swallowing
 - Weakness of the lower lip
 - Neck stiffness or pain
 - Shoulder movement may be impaired
 - There may be some difficulty raising the arm over the head
 - Reduced strength in neck and head movements
 - Blood clots
 - Chyle leak, which results in fluid accumulation in the neck from disruption of the thoracic duct (this problem is more common after left sided neck dissections)
- **Tracheoesophageal puncture (TEP)** – this is 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. A speech pathologist will help the patient regain good speech.

Types of treatment used:

- External beam radiation
- Three-dimensional conformal radiation therapy (3D-CRT)
- Intensity modulated radiation therapy (IMRT)
- Brachytherapy
- Monoclonal antibodies
- Chemotherapy
- Chemoradiation

CANCER OF THE PHARYNX

Cancer of the throat, or pharynx, is divided into three types based on their location: **nasopharyngeal, oropharyngeal, and hypopharyngeal**. **Nasopharyngeal** cancer is the only head and neck malignancy not associated with tobacco and alcohol use.^{31,183} There were 316,021 new cases and 166,750 deaths worldwide in 2020.^{31,183} Seventy percent of all cases are caused by the **Epstein Barr Virus**.^{31,183} Men are more than twice as likely to get throat cancer than women.^{31,183} According to the American Cancer Society, among white men and women, incidence rates are increasing for a subset of cancers in the oropharynx that are associated with HPV.¹⁸³ Death rates have been decreasing over the last three decades; 1.2% for men and 2.1% for women.^{31,183}

Tumors in the throat are much more serious than those in the larynx or oral cavity because they have a higher risk of metastasis.^{31,183} **Hypopharyngeal carcinoma** is not only the most common of the three types, it is also most likely to spread.^{31,183} There were 80,608 new cases and 34,984 deaths worldwide in 2018.^{31,183} Symptoms include a lesion in the throat or mouth that bleeds easily and does not heal, a persistent red or white patch, lump in the throat or mouth, ear pain, a mass in the neck or coughing up blood. Late symptoms include difficulty swallowing, chewing, and moving the tongue or jaw.

Most people with oral cavity and oropharyngeal cancers use tobacco and are many times more likely than non-smokers to develop these cancers.^{31,51,147,183} There were 92,887 new cases and 51,005 deaths worldwide in 201.^{8 31,183} Drinking alcohol increases the risk of developing oral cavity and oropharyngeal cancers.^{31,51,147,183} About 7 out of 10 patients with oral cancer are heavy drinkers.^{31,51,147,183} The risk of these cancers is even higher in people who both smoke and drink alcohol, with the highest risk in heavy smokers and drinkers.^{31,51,147,183} According to some studies, the risk of these cancers in heavy drinkers and smokers may be as much as 100 times more than the risk of these cancers in people who don't smoke or drink.^{27,2831,51,147,183} Several studies have found that a diet low in fruits and vegetables is linked with an increased risk of cancers of the oral cavity and oropharynx.^{27,28,147} Oral cavity and oropharyngeal cancers are more common in people who have a weak immune system. A weak immune system can be caused by certain diseases present at birth, the acquired immunodeficiency syndrome (AIDS), and certain medicines (such as immunosuppressants).^{88,160}

Types of throat cancer:

- **Nasopharyngeal carcinoma** – the nasopharynx is located behind the nasal cavity and is inaccessible through surgery. Because of this factor, radiation therapy is the standard treatment. If surgery is used at all, it may be to remove lymph nodes that have withstood radiation treatment.
- **Oropharyngeal carcinoma** – a combination of radiation and surgery are used as primary treatment for early-stage cancer of the middle throat. The oropharynx includes the base of the tongue, the soft palate and its fleshy u-shaped protuberance (uvula), and the tonsils.
- **Hypopharyngeal carcinoma** – the hypopharynx includes the pyriform sinus, the pharyngoesophageal junction (where the throat meets the esophagus), and the rear wall of the lower throat. This cancer is usually discovered at an advanced stage because of its silent nature.

Procedures:

- **Pharyngectomy** – whether a pharyngectomy is performed in total or with only partial removal of the pharynx depends on the localized amount of cancer found. The procedure may also involve removal of the larynx, in which case it is called a laryngopharyngectomy. Well-localized, early-stage tumors can be amenable to a partial pharyngectomy or a laryngopharyngectomy, but laryngopharyngectomy is more commonly performed for more advanced cancers. Reconstructive surgery is also required to rebuild the throat after a pharyngectomy to help the patient with swallowing after the operation.
- **Partial laryngopharyngectomy** – sometimes part of the voice box can be preserved in this procedure. If the entire larynx is removed, an opening can be created through the neck and into the windpipe. Patients learn to breathe through this tracheostomy and must learn new techniques for speaking.
- **Total laryngopharyngectomy** – surgical removal of the larynx (voice box) and all or part of the pharynx (throat). Neck dissection is invariably performed. After removal of the voice box and pharynx, the trachea will be sewn to the skin above your sternum, which will create a permanent breathing hole in that area. This is just like a **total laryngectomy**. However, because the pharynx is also removed, there will be no direct connection between the mouth and the esophagus. To eat again, a reconstructive procedure will be required to recreate the tube connecting the mouth to the esophagus. A new throat is reconstructed using tissue from another part of the body.

Oropharyngectomy – removes some of the oropharynx (the part of the throat behind the mouth)

Hypopharyngectomy – removes part of the hypopharynx (the lower throat)

Most patients will remain in the hospital for 3-5 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of pharyngectomy/laryngopharyngectomy:

- Lymphedema in the neck and face
 - Bleeding and hematoma
 - Infection
 - Salivary fistula
 - Seroma (collection of normal body fluid in the neck after removal of the drain)
 - Chyle fistula (lymphatic fluid is leaking from a lymph vessel to the skin surface)
 - Hypothyroidism
 - Hypocalcemia
 - Blood clots
- **Total thyroidectomy** – surgery to remove the entire thyroid. Your parathyroid glands are located behind your thyroid, so they also carry a small risk of injury. The surgeon must carefully identify the parathyroid glands to prevent damaging them during the thyroidectomy. The parathyroid glands regulate calcium levels. If one or more of those glands are damaged, then hypoparathyroidism can result. This may eventually trigger hypocalcemia, which is a condition of abnormally low levels of blood calcium. If hypocalcemia occurs, then it can be easily treated with calcium and vitamin D supplements.

Most patients will remain in the hospital for 1 day with full recovery taking 3-4 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for at least 2 weeks after surgery.

Potential side effects of thyroidectomy:

- Damage to the adjacent parathyroid glands (regulate blood calcium levels)
- Excessive bleeding or formation of major blood clot (hematoma) in the neck
- Wound infection
- Hypocalcemia
- Hoarseness
- Impeded speaking and breathing
- Hormonal dependence (will need to take thyroid hormone replacement)
- Weight gain
- Lethargy
- Cervical lymphedema

- **Radical neck dissection (cervical lymphadenectomy)** – in this procedure the sternocleidomastoid muscle, omohyoid muscle, internal jugular vein, spinal accessory nerve, cervical plexus nerves, submandibular salivary gland, tail of parotid gland, and all the lymph nodes are removed. **A modified radical neck dissection** removes all the same lymph node groups as the radical neck dissection but spares at least one of the non-lymphatic structures removed with the radical neck dissection such as the sternocleidomastoid, spinal accessory nerve, or internal jugular vein.

Removal of one jugular vein usually causes minimal or no problems. There are many other veins in the neck and the blood can flow back through them. If a bi-lateral neck dissection is being done; the surgeon will try to save at least one jugular vein.

The spinal accessory nerve is a cranial nerve that provides motor control of the sternocleidomastoid and trapezius muscles. This can result in poor strength in head and neck movements, shoulder droop, limited shoulder range of motion, muscle wasting in the shoulder muscles, winged scapula, and weakness in shoulder flexion, abduction, and external rotation.

Removal of the sternocleidomastoid muscle causes the neck to look sunken due to its removal. The muscle also provides some coverage of the carotid artery, so this will be reduced if the muscle is resected. This can cause a problem if there is a post-operative infection, but otherwise is not that important. If both sternocleidomastoid muscles are removed, one's strength in flexing the head forward will be reduced.

Recovery time from a neck dissection alone is quite quick. If a patient has only had a neck dissection, the total hospital stay may only be 2-3 days. The recovery course will depend on the extent of additional surgery and the reconstruction performed along with the neck dissection. Some surgery might require staying in the hospital for one to two weeks. Most patients will remain in the hospital for 1 day with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first 1-2 weeks after surgery, but move the neck from side to side and roll the shoulders with gentle stretches to prevent stiffness. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 10 pounds for 4-6 weeks after surgery.

Potential side effects of neck dissections:

- Lymphedema in the neck and face
- Numbness in the cheek, neck, and ear
- Changes in speech and swallowing
- Weakness of the lower lip
- Neck stiffness or pain
- Shoulder movement may be impaired
- There may be some difficulty raising the arm over the head
- Reduced strength in neck and head movements
- Blood clots
- Chyle leak, which results in fluid accumulation in the neck from disruption of the thoracic duct (this problem is more common after left sided neck dissections)

- **Tracheotomy** – is an incision (hole) made through the skin in the front of the neck and into the trachea (windpipe). It is done to help a person breathe. It may be used in different circumstances. If a lot of swelling is expected in the airway after the cancer is removed, the doctor may want to do a temporary tracheostomy (using a small plastic tube) to allow the person to breathe more easily until the swelling goes down. It stays in place for a short time and is then removed later when it is no longer needed.

If the cancer is blocking the throat and is too large to remove completely, an opening may be made to connect a lower part of the windpipe to a stoma (hole) in the front of the neck to bypass the tumor and allow the person to breathe more comfortably. This is also known as a tracheotomy. A permanent tracheostomy is also needed after a total laryngectomy.

Most patients will remain in the hospital for 3-5 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of tracheotomy/tracheostomy:

- Bleeding
- Air trapped in tissue under the skin of the neck (subcutaneous emphysema)
- Buildup of air between the chest wall and lungs (pneumothorax)
- Damage to esophagus
- Injury to the nerve that moves the vocal cords
- Hematoma
- Infection at stoma site
- Lymphedema if nodes were removed

- **Throat reconstructive surgery** – if a total or near total pharyngectomy is performed, the operation includes throat reconstruction. This can be accomplished either with a free tissue transfer or a 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). In some cases, a regional flap, such as a pectoralis major muscle/skin flap, might be used. The free flaps most used for this purpose include the radial forearm free flap and the anterolateral thigh free flap, in which the skin is turned into a tube to recreate the pharynx. In select cases, part of the small intestines (the jejunum) can be used as a free tissue transfer as well.

Most patients will remain in the hospital for 7-14 days with full recovery taking 6-8 weeks. Patients should avoid strenuous activity, bending, and lifting for the first three weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of throat reconstructive surgery:

- Infection
- Pneumothorax (collapsed lung)
- Difficulty swallowing
- Difficulty talking
- Food may get lodged in throat
- Malnourishment
- Dumping syndrome
- Muscle imbalances where flap was taken from
- **Partial glossectomy** – surgical removal of part of the tongue
- **Hemiglossectomy** – surgical removal of one side of the tongue
- **Glossectomy** – surgical removal of the entire tongue

Following a glossectomy, most patients will remain in the hospital for 7-10 days with full recovery taking several months. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. No heavy lifting for at least 6 weeks after surgery. Be aware of any muscle imbalances or limitations if reconstructive flap was used.

Potential side effects of glossectomies:

- Bleeding
 - Hematoma
 - Infection
 - Salivary fistula (hole causing saliva to leak from the mouth into the neck)
 - Impaired speech
 - Airway blockages
 - Difficulty swallowing
 - Aspiration
 - Pneumonia
 - Weight loss
 - Difficulty chewing – often limited to liquids
 - Malnourishment – may require tube feedings
 - Flap or reconstruction failure
- **Mandibulectomy** – removes all or part of the jawbone (mandible). This operation may be needed if the tumor has grown into the jawbone. There are two types of mandibulectomy:
 - **Marginal mandibulectomy** – much of the jawbone is left to limit the need for reconstructive surgery. Only the area with cancer is removed.
 - **Segmental mandibulectomy** – the entire jawbone is removed and then reconstructed. A bone from another part of the body, (leg, back, arm or hip) is used to create a new jaw. Skin grafts and muscle flaps may also be used. An artery, vein and some soft tissue will also be taken from another area and used for reconstruction.

Following a mandibulectomy, most patients will remain in the hospital for 10-14 days with full recovery taking several months. In some cases, a temporary or permanent feeding tube will be needed for nutrition during and after the healing process. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery. Be aware of any muscle imbalances or limitations if reconstructive flap was used.

Potential side effects of mandibulectomy:

- Bleeding
 - Hematoma
 - Seroma
 - Infection
 - Salivary fistula
 - Blood clot
 - Malocclusion nerve damage
 - Trismus
- **Maxillectomy** – if cancer has grown into the hard palate, all, or part of the involved bone (maxilla) will need to be removed. The hole in the roof of the mouth, that is left after this operation can be filled with a special denture called a prosthesis.

Most patients will remain in the hospital for a few days (with major reconstruction it may be a few weeks) with full recovery taking several months. Patients should avoid strenuous activity, bending, and lifting for the first two weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of maxillectomy:

- Bleeding
- Infection
- Blood clots
- Enophthalmos (functional deformity in which the eye sinks down into the cheek)
- Numb skin
- Cheek numbness
- Chronic tearing

- **Laryngectomy** – surgery to remove the voice box (larynx). For a total laryngectomy, the incision is placed in the central neck extending far to the side to perform neck dissections on both sides. This will allow exposure to remove the voice box along with the lymph nodes in the neck, if required. As part of this surgery, one or both lobes of the thyroid gland will be removed. The closure will then be performed and will include creation of a laryngostomy. A laryngostomy involves sewing the top part of the trachea directly to the skin; there is no longer a connection from the mouth/nose down into the lungs. The mouth does remain connected to your throat and esophagus down into your stomach to allow you to eat.

Some people with laryngeal or hypopharyngeal cancer may need to have a feeding tube (usually called a gastrostomy tube or G-tube), put in place before treatment. A G-tube is put through the skin and muscle of your abdomen (belly) right into your stomach. The tube is often put in place with the help of a flexible, lighted instrument (endoscope) passed down your mouth and into the stomach. This is done while you are sedated (asleep). When it's placed through an upper endoscopy, it's called a percutaneous endoscopic gastrostomy, or PEG tube. Another option is to put the tube in during an operation. Once in place, liquid nutrition and medicines can be put right into the stomach through the tube.

Often, the gastrostomy tube is only needed for a short time to help you get enough nutrition during cancer treatment. The tube is often removed once you can swallow again after treatment. It's important to keep swallowing even when you're getting most of your nutrition through a G tube. This helps keep those muscles active and gives you a better chance of going back to swallowing normally after treatment is complete.

Most patients will remain in the hospital for a few days, the first 1-2 days may be spent in intensive care, with full recovery taking 3-4 months. Patients should avoid strenuous activity, bending, and lifting for the first two weeks after surgery. Walking is essential to a smooth recovery and should be a part of each day's activities in the recovery period. Patients should not lift anything over 5 pounds for at least 6 weeks after surgery.

Potential side effects of glossectomies:

- Bleeding
- Infection
- Blood clots
- Salivary fistula
- Hypocalcemia
- Hypothyroidism (fatigue, lethargy, weight gain, and osteoporosis)
- Aspiration

Types of treatment used:

- Radiation therapy
- Proton beam radiation
- Chemotherapy
- Chemoradiation
- Immunotherapy
- Targeted therapy

CANCER OF THE ESOPHAGUS

There were 604,100 new cases and 544,076 deaths worldwide in 2020.^{31,183} Although esophageal cancer is rare, the most common kinds of the disease are squamous cell and adenocarcinoma.^{31,183} Squamous cell usually begins in the cells that form the top layer of the esophageal lining. Adenocarcinoma most often develops in people who have Barrett's esophagus, a condition in which the lining of the esophagus near the opening of the stomach changes in response to constant stomach acids (reflux).^{31,183} Men are more than three times as likely to get esophageal cancer than women and the chance of getting esophageal cancer is low at younger ages and increases with age.^{31,183} Less than 15% of cases are found in people younger than age 55.^{31,183}

People with Gastroesophageal reflux disease (GERD) have a slightly higher risk of getting adenocarcinoma of the esophagus.^{31,183} This risk seems to be higher in people who have more frequent symptoms.^{31,183} GERD can also cause Barrett's esophagus, which is linked to an even higher risk.^{31,183} If reflux of stomach acid into the lower esophagus goes on for a long time, it can damage the inner lining of the esophagus. This causes the squamous cells that normally line the esophagus to be replaced with gland cells. This condition is known as Barrett's (or Barrett) esophagus. The longer someone has reflux, the more likely it is that they will develop Barrett's esophagus.³¹ Most people with Barrett's esophagus have had symptoms of heartburn, but many have no symptoms at all.³¹ The gland cells in Barrett's esophagus can become more abnormal over time; this can result in dysplasia, a pre-cancerous condition.³¹ People with Barrett's esophagus are much more likely than people without this condition to develop adenocarcinoma of the esophagus.³¹ The risk of cancer is highest if dysplasia is present or if other people in the same family also have or have had Barrett's.³¹

The use of tobacco products is a major risk factor for esophageal cancer. The more a person uses tobacco, and the longer it is used, the higher the cancer risk.³¹ Alcohol consumption also increases the risk of esophageal cancer.^{27,30} The chance of getting esophageal cancer goes up with more consumption of alcohol.^{27,30} Alcohol affects the risk of the squamous cell type more than the risk of adenocarcinoma.^{27,30} The combination of smoking and drinking alcohol raises the risk of esophageal cancer much more than using either alone.^{27,30}

People who are overweight or obese have a higher chance of getting adenocarcinoma of the esophagus; people who are obese are more likely to have esophageal reflux.^{150,151} Certain substances in the diet may increase esophageal cancer risk.¹⁷² A diet high in processed meat may increase the chance of developing esophageal cancer.¹⁷² This may help explain the high rate of this cancer in certain parts of the world.¹⁷² A diet high in fruits and vegetables is linked to a lower risk of esophageal cancer.¹⁷² Drinking very hot liquids frequently may increase the risk for the squamous cell type of esophageal cancer.¹⁷² This might be the result of long-term damage the liquids due to the cells lining the esophagus.

People with achalasia (a condition in which the muscle at the lower end of the esophagus—the lower esophageal sphincter) does not relax properly, have a risk of esophageal cancer that is greatly increased.³¹ Food and liquid that are swallowed have trouble passing into the stomach and tend to collect in the esophagus, which becomes stretched out (dilated) over time. The cells lining the esophagus can become irritated from being exposed to foods for longer than normal amounts of time. On average, the cancers are found about 15 to 20 years after the achalasia is diagnosed.³¹ Signs of HPV infection have been found in up to one-third of esophagus cancers from patients in parts of Asia and South Africa.³¹ But signs of HPV infection have not been found in esophagus cancers from patients in the other areas, including the US.³¹

Diagnosing esophageal cancer begins with a barium swallow, followed by an esophagoscopy. Endoscopic ultrasound may be used to stage the cancerous growth and look at its depth of penetration. To locate distant metastasis, a CT scan may be used. It is not uncommon for these tests to give a false negative regarding lymph-node involvement. Surgery may be the only true indicator of the cancers' involvement. To minimize ambiguities, a thoracoscopy may be used to assess lymph nodes and take biopsies. Malnourishment is a frequent complication and can increase the risk of not surviving the operation.³¹ Symptoms of esophageal cancer include difficulty swallowing, sensations of pressure and burning or pain in the upper middle part of the chest, hoarseness, cough, fever, or choking. The sensations may come and go.

Procedures:

- **Esophagectomy** – surgical removal of all or part of the esophagus. Often a small amount of the stomach is removed as well as nearby lymph nodes. The upper part of the esophagus is then connected to the remaining part of the stomach. Part of the stomach is pulled up into the chest to become the new esophagus. If cancer is in the distal part of the esophagus (near the stomach), the surgeon will remove part of the stomach, the part of the esophagus containing the cancer, and about 3-4 inches of healthy esophagus. The stomach is then connected to what is left of the esophagus either in the neck or high in the chest. If the cancer is in the upper or middle part of the esophagus, most of the esophagus will be removed to get a “clear margin” above the cancer. The stomach will be brought up and connected to the esophagus in the neck. If the stomach can’t be used to replace the esophagus, the surgeon may use a piece of the intestine instead. Moving the intestine must be done with the utmost precision because if the vessels are damaged the blood supply will be compromised and the tissue will die.

Esophagectomy may be done using either of two main types of techniques. In the standard, open technique, the surgeon operates through one or more large incisions in the neck, chest, or abdomen. The surgical approaches include the following:

- **McKeown esophagectomy** – the incisions are made in the neck, chest, and abdomen (belly) to remove the esophagus and rebuild the gastrointestinal tract.
- **Thoracoabdominal esophagectomy** – a single incision is made from the chest to the abdomen on the left side, and an incision is made in the neck.
- **Transhiatal esophagectomy** – incisions are made in the neck and abdomen, with the intervening esophagus being dissected out bluntly (with the fingers).
- **Ivor Lewis esophagectomy** – one incision is on the right side of the chest and the other in the abdomen.
- **Minimally invasive esophagectomy** – the surgeon may choose to do a portion or all of the esophagectomy using minimally invasive techniques. A robot may be used in the chest and/or abdomen, a thoracoscope may be used in the chest, or a laparoscope may be used in the abdomen (thoracoscope and laparoscope are long, thin, flexible instruments for examining the chest and abdomen). When minimally invasive components are mixed with more traditional “open” components, the procedure is described as a “hybrid” procedure.

Regardless of the type of esophagectomy, a jejunostomy tube (feeding tube) is placed as part of the esophagectomy. This is used to provide nutrition for up to 30 days after the surgery as the patient recovers his or her swallowing function.

The patient will also have a nasogastric tube, a drain that goes in through the nose. This tube is essential for keeping the stomach decompressed to give the new connection from the esophagus to the stomach a better chance to heal.²⁰

- Depending on the location of the tumor and the surgical approach, the surgeon removes a portion of the esophagus and, an often smaller, portion of the stomach.

- The surgeon then reconnects the remaining esophagus to the stomach, which is pulled up into the chest or neck area (depending on the esophagectomy type).

- The surgeon will also remove lymph nodes so that they can be examined for cancer. Lymph nodes, a part of the body’s immune system, are small oval-shaped structures that filter extracellular fluid or lymph. Identification of cancer in the lymph nodes means the cancer has spread outside the esophagus.

Most patients will be in the intensive care unit for the first night and remain in the hospital for about a week, with full recovery taking 3-4 months. Walking is essential to a smooth recovery and should be a part of each day’s activities in the recovery period; stair climbing is another great option – stopping and resting as needed. Begin range of motion exercise on affected side (neck, arm, and shoulder) as soon as chest tube and bandages are removed. Patients should not lift anything over 10 pounds for at least 8 weeks after surgery.

Potential side effects of esophagectomy:

- Bleeding
- Infection
- Voice changes
- Nausea and vomiting
- Cough
- Leakage from the surgical connection of the esophagus to the stomach
- Hoarseness
- Acid or bile reflux
- Pneumonia
- Dysphagia
- Lymphedema

- **Surgery for palliative care** – in addition to surgery to treat the disease, surgery may be used to help patients eat and relieve symptoms caused by the cancer. They may put in a percutaneous gastrostomy or jejunostomy, also called a feeding tube, so that a person can receive nutrition directly into the stomach or intestine. This may be done before chemotherapy and radiation therapy is given to make sure that the person can eat enough food to maintain his or her weight and strength during treatment. Alternatively, the surgeon may create a bypass, or new pathway, to the stomach if a tumor blocks the esophagus but cannot be removed with surgery; this procedure is rarely used.

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 311,594 new cases and 309,006 deaths worldwide in 2020.^{31,183} Usually, leukemia involves the production of abnormal white blood cells (the cells responsible for fighting infection), however, the abnormal cells in leukemia do not function in the same way as normal white blood cells. The leukemia cells continue to grow and divide, eventually crowding out the normal blood cells. The result is that it becomes difficult for the body to fight infections, control bleeding, and transport oxygen. People often suffer excessive bleeding and bruising because their platelet levels fall dangerously low.

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 (also known as lymphoid or lymphoblastic leukemias) start in cells that become lymphocytes. People with leukemia have many treatment options depending on whether they have acute or chronic leukemia, their age, general health, and whether the leukemia cells were found in the cerebrospinal fluid. People with acute leukemia need to be treated immediately.

The goal of treatment is to achieve a remission: destroying signs of leukemia in the body and becoming symptom free. Additional therapy may be needed to prevent relapse. This is referred to as consolidation or maintenance therapy. Many people with acute leukemia can be cured. Clients with chronic leukemia who are symptom-free may not need treatment immediately. Their doctor will carefully watch their health (watchful waiting) so that treatment can begin when symptoms arise. Although watchful waiting helps patients to avoid the undesirable side-effects of treatment, some people will choose to treat the leukemia right away, avoiding the risk of the leukemia getting worse before treatment is started. When treatment is needed, it often can control the disease and its symptoms. While people may receive maintenance therapy to keep the cancer in remission, chronic leukemia is seldom cured with chemotherapy.^{74,76,88} Stem cell transplants will offer the best hope for a cure.^{74,76,88}

Supportive care will be needed to prevent and/or treat infections, control pain and symptoms, and to relieve the side-effects of treatment. Because people with leukemia get infections, they may be given antibiotics and other drugs. Vaccines may be given against the flu and pneumonia. Anemia and bleeding are very common in people with leukemia. Blood transfusions of red blood cells and platelets may be needed to treat anemia and reduce the risk of serious bleeding. Leukemia along with chemotherapy can make the mouth sensitive, easily infected, and likely to bleed. This can lead to problems with malnutrition due to the inability for some people to consume certain foods.

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 alteration 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.

Risk factors associated with ALL include:

- *Previous exposure to chemotherapy and radiation therapy*
- *Genetic disorders* – down syndrome, neurofibromatosis, Klinefelter syndrome, Fanconi anemia, Schwachman-Diamond syndrome, Bloom syndrome and ataxia telangiectasia have been associated with an increased risk of developing ALL
- *Age* – children, adolescents or adults older than 70 years are at greater risk of developing ALL
- *Sex* – males are more likely to develop ALL than females
- *Race/ethnicity* – in the United States, ALL is more common in Hispanics and whites

Tumor Lysis Syndrome (TLS) – is characterized by metabolic abnormalities caused by the sudden release of the cellular contents of dying cells into the bloodstream, which is induced by chemotherapy. If untreated, TLS can lead to heart arrhythmias, seizures, loss of muscle control, acute kidney failure and even death. Patients with leukemia are constantly monitored for the development of TLS and are given drugs, such as Zyloprim® (allopurinol) or Elitek® (rasburicase), to prevent or lessen the effects of this condition.

Tyrosine Kinase Inhibitors – Tyrosine kinases are enzymes that are a part of many cell functions including cell signaling, growth and division. These enzymes may become too active in patients with an ALL subtype called Philadelphia chromosome-positive ALL (Ph+ ALL).

TKIs work to block these overactive enzymes and may stop cancer cells from growing. TKIs are pills taken by mouth. They are generally not used alone to treat ALL. Instead, they are added to other medications, such as a combination chemotherapy regimen. TKIs used in the treatment of Ph+ ALL include:

- Gleevec® (Imatinib)
- Sprycel® (Dasatinib)
- Iclusig® (Ponatinib)
- Bosulif® (Bosutinib)
- Tasigna® (Nilotinib)

Common side effects of TKIs include low blood counts, abnormal bleeding, pain, nausea and vomiting, diarrhea, fatigue, rashes, headaches, and pain in muscles, bones, and joints. TKIs may also cause fluid to collect under the eyes, and in the hands, feet, or lungs. Uncommon but serious side effects include a change in the rhythm of the heart, inflammation of the pancreas, blood vessel narrowing or blood clot formation.

Another 10 to 30 percent of adults who have ALL have a subtype known as “Philadelphia chromosome-like ALL” (Ph-like ALL). Unlike those with Ph+ ALL, who share a similar genetic mutation, patients with Ph-like ALL have a highly diverse range of genetic mutations that activate tyrosine kinase signaling. Researchers are working to understand better ways to identify these genetic mutations to determine whether specific TKIs may be effective.

Types of treatment used:

- Chemotherapy
- Stem cell transplant
- CAR T Cell therapy
- Targeted therapy
- Growth factors
- Steroids
- Bone marrow transplant
- Radiotherapy
- Immunotherapy

- **Acute myelogenous leukemia (AML)** – affects a group of white blood cells called the myeloid cells, which normally develop into the various types of mature blood cells, such as red blood cells, white blood cells and platelets. AML is also referred to as acute myeloid leukemia, acute myeloblastic leukemia, acute granulocytic leukemia and acute nonlymphocytic leukemia. Acute myelogenous leukemia is caused by damage to the DNA of developing cells in the bone marrow that causes the bone marrow to produce immature cells that develop into leukemic white blood cells called myeloblasts. These abnormal cells are unable to function properly, and eventually build up and crowd out healthy cells. In most cases, it's not clear what causes the DNA mutations that lead to leukemia. Symptoms may include bleeding from the gums, bone pain, fever, frequent infections, easy bruising, frequent nosebleeds, pale skin, shortness of breath, lethargy, fatigue and shortness of breath.

Risk factors include previous cancer treatment, gender (men are more likely to have it), increasing age (more common over 65 years old), exposure to certain chemicals such as benzene, smoking, other blood disorders, and exposure to radiation.^{74,76,88}

Types of treatment used:

- Chemotherapy
- Stem cell transplant
- External beam radiation
- Targeted therapy

- **Acute promyelocytic leukemia (APL)** – most APL cells have a specific chromosome abnormality involving a balanced translocation (swapping) between chromosomes 15 and 17 t(15;17), resulting in the abnormal fusion gene PML/RAR α . This abnormality is a distinguishing feature of APL that causes the symptoms of the disease; it is also a key target of treatment. Among adults over age 20, APL represents approximately 7 percent of AML cases. There are approximately 1,100 new cases of APL each year in the United States. According to data from the National Cancer Institute (NCI) SEER (Surveillance, Epidemiology, and End Results Program) registry, for the period from 2013 to 2017, the age-adjusted annual incidence of newly diagnosed cases was 0.34 per 100,000 persons— about 1 case per 294,000 persons. During that period, the median age of APL diagnosis was 51 years. The median age of AML diagnosis is 68 years.

Symptoms include small red dots under the skin (petechiae), nosebleeds, bruising easily, bleeding gums, excessive menstrual bleeding, bloody urine, fever, fatigue, loss of appetite, frequent infections, and pallor. Risk factors include the following genetic mutations: Fanconi anemia, Bloom syndrome, Ataxia-telangiectasia, Diamond-Blackfan anemia, Shwachman-Diamond syndrome, Li-Fraumeni syndrome,

Neurofibromatosis type 1, and Kostmann syndrome. Other risk factors include Myelodysplastic Syndrome, exposure to radiation, certain chemotherapy drugs, increasing age, gender (men are more likely to have it), smoking, exposure to certain chemicals such as benzene and formaldehyde, and family history.

Associated Conditions

- **Differentiation Syndrome** – treatment for APL is often associated with a variety of symptoms and abnormal conditions, including fluid retention, labored breathing, fever, fluid accumulation around the heart or lungs, and episodes of low blood pressure. This group of symptoms is known as “differentiation syndrome.” Patients should be closely monitored for the development of these symptoms because differentiation syndrome, along with hemorrhage (bleeding), are the leading causes of death during induction therapy. Differentiation syndrome is often caused by all-trans-retinoic acid (ATRA) or arsenic trioxide (ATO) treatment. It occurs in approximately 15 to 25 percent of patients during their first treatment. Not everyone gets this syndrome. Patients with a white blood count higher than 10,000/microliter are at a higher risk for this condition. Early recognition and the prompt start of corticosteroid therapy with dexamethasone or prednisone are essential to manage this potential complication.
- **Central Nervous System (CNS) APL** – a small number of patients with APL develop disease in their cerebrospinal fluid, the watery fluid that bathes the brain and the spinal cord. Symptoms of CNS APL are headaches and various neurologic manifestations, such as confusion and visual changes. CNS APL is most often diagnosed in patients thought to be in remission. It is associated with patients who have a high white blood cell count (greater than 10,000/microliter) at diagnosis and/or those who have had a previous CNS hemorrhage, because the risk for CNS relapse is higher in these patients. This type of APL is treated with “intrathecal therapy,” which involves spinal taps and chemotherapy injections into the spinal fluid.
- **Pseudotumor cerebri** – this disorder, also known as intracranial hypertension, is related to high pressure in the brain that causes signs and symptoms of a brain tumor – hence the term “pseudo” (or false) tumor. It happens when the fluid that surrounds the spinal cord and the brain—called cerebrospinal fluid—accumulates abnormally in the brain, causing pressure and pain. Pseudotumor cerebri can be a rare side effect of ATRA therapy and is most often observed in children and adolescents. The main symptom of this disorder is headache. Pseudotumor cerebri can be treated with the use of painkillers, glaucoma drugs that might reduce

production of cerebrospinal fluid, steroids to reduce inflammation, and/or diuretic medication to reduce fluid buildup. Sometimes the temporary discontinuation of ATRA is necessary.

- **High White Blood Cell (WBC) Count** – elevated WBC counts, also known as “hyperleukocytosis,” is a frequent side effect that occurs in APL patients receiving ATO and/or ATRA therapy. A WBC count higher than 10,000/microliter is considered elevated. This side effect is generally managed with medications such as hydroxyurea, Mylotarg® (gemtuzumab ozogamicin) and anthracyclines (idarubicin and daunorubicin). Changes in Liver Function. Liver enzymes can become elevated because of therapy with ATO, ATRA and/or gemtuzumab ozogamicin. Liver function should be routinely monitored during APL treatment. If needed, therapy can be temporarily discontinued until liver function returns to normal. QT Interval Prolongation. The use of arsenic trioxide (ATO) can affect electrolyte levels. Electrolytes are essential minerals in the blood such as potassium, magnesium, and calcium. Electrolyte imbalance can cause a heart rhythm disorder known as “QT interval prolongation.” This disorder causes a fast heartbeat that may lead to sudden fainting or seizures. Electrolytes should be monitored before and during APL treatment to ensure that they stay within a normal reference range. The doctors on your treatment team may order routine blood work and electrocardiograms to monitor any negative effects of ATO or other drugs. Bleeding. The ability to form blood clots (a process called “coagulation”) is impaired in APL patients because they have decreased numbers of platelets and clotting factors. This condition, also known as “coagulopathy,” can cause a tendency toward prolonged or excessive bleeding that may occur spontaneously, after an injury, or during medical or dental procedures. It is important to screen for this problem with specific blood tests as part of the initial workup of newly diagnosed patients as well as before any invasive procedure. When coagulopathy symptoms are present, patients are supported with transfusion therapy that contains platelets or fresh frozen plasma. Plasma is the liquid part of the blood that carries the blood cells. The proteins that form blood clots are found in the plasma. Plasma can be frozen and preserved after blood donation to help prevent and control bleeding disorders, which frequently occur in APL. Other side effects caused by APL treatment include nausea, vomiting, electrolyte imbalance, peripheral neuropathy, and veno-occlusive disease (VOD).

Types of treatment used:

- Chemotherapy
- Targeted therapy
- External beam radiation
- Stem cell transplant
- (ATRA) all-trans-retinoic acid
- (ATO) Arsenic trioxide
- Trioxide (Trisenox®)

- **Chronic lymphocytic leukemia (CLL)** – affects a group of white blood cells called lymphocytes, which help the body to fight infection. CLL most commonly affects older adults and is caused by damage to the DNA in blood-producing cells.^{31,74,76,88} This mutation causes the blood cells to produce abnormal, ineffective lymphocytes that continue to live and multiply, long after healthy lymphocytes would die. The abnormal lymphocytes accumulate in the blood and certain organs, where they crowd healthy cells out of the bone marrow and interfere with normal blood cell production. Symptoms include enlarged, but painless, lymph nodes, fatigue, fever, pain in the upper left portion of the abdomen (may be caused by an enlarged spleen), night sweats, weight loss, and frequent infections. Risk factors include previous cancer treatment, race (whites are more likely to develop chronic lymphocytic leukemia than are people of other races), increasing age (more common over 70 years old), exposure to certain chemicals such as herbicide, insecticide, and Agent Orange, and a family history of blood and bone marrow cancers.^{31,74,76,88}

Associated Conditions

- **Richter Transformation** – in about 2 to 10 percent of people with CLL, the disease transforms into something more complex. Of this small group, 95 percent may develop diffuse large-B cell lymphoma (DLBCL), and the other 5 percent may develop Hodgkin lymphoma. This is known as “Richter transformation” or “Richter’s syndrome.” This syndrome is much more common in patients with high-risk factors such as: advanced Rai stage; del(17p), trisomy 12, TP53 or NOTCH1 mutations; and IGHV-unmutated CLL.

Patients may have significantly enlarged lymph nodes and may experience fevers and weight loss. Lymphocyte masses may also develop in parts of the body other than the lymph nodes.

Patients with Richter transformation whose CLL has transformed into DLBCL are treated with regimens designed for DLBCL. Allogeneic stem cell transplantation can also be considered following a response to initial therapy.

Standard Hodgkin lymphoma therapy is used for patients with Richter transformation whose CLL has transformed to Hodgkin lymphoma. With aggressive therapy, these patients tend to do better and may be cured of this condition (although not the underlying CLL).

These patients should also consider a clinical trial as a treatment option. Recently, some treatment responses have been reported with the use of checkpoint inhibitors and CAR T-cell therapy.

- **Tumor Lysis Syndrome (TLS)** – is a potentially life-threatening condition that occurs when large amounts of tumor cells are killed at the same time by the cancer therapy, releasing their content into the bloodstream. Patients with bulky lymph nodes are considered at high risk for developing TLS, which is best managed if anticipated and treatment is started before chemotherapy. Treatment for TLS includes increased hydration, monitoring and treatment of electrolyte imbalances and abnormal uric acid levels, and therapy with the drug Elitek® (rasburicase) as needed.
- **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.
- **Autoimmune Cytopenias** – the most frequent autoimmune cytopenias in CLL patients are as follows. Bone marrow tests are used to confirm the presence of these conditions.
 - Autoimmune hemolytic anemia (AIHA)
 - Immunemediated thrombocytopenia (also known as “immune thrombocytopenic purpura” [ITP])
 - Pure red blood cell aplasia (PRCA)

AIHA is the most common form of autoimmune cytopenia. Patients who have AIHA produce antibodies that work against their own cells. These “autoantibodies” are usually directed against the patient’s red blood cells and causes them to be removed rapidly from the blood. The loss of these red blood cells can worsen the effects of already low red blood cell counts. The direct antiglobulin test (DAT, also known as the “direct Coombs test”) is used to identify the autoantibodies; however, most patients with AIHA have a negative DAT test result. In these cases, additional serum markers, such as low haptoglobin (a blood protein) and elevated reticulocyte (immature red blood cell) levels are required to make the diagnosis. Patients with advanced disease; high-risk factors, such as unmutated IGHV gene status; increased serum beta-2 microglobulin levels; and high expression of ZAP-70 are also more likely to develop AIHA. Less often, the antibody works against the platelets. This condition, called “immune thrombocytopenic purpura” (ITP), results in significantly decreased platelet counts.

The drugs prednisone, Rituxan® (rituximab) and cyclosporine are sometimes used to treat AIHA and ITP. Splenectomy should be considered in cases where the patient does not respond to steroid therapy. The drugs Nplate® (romiplostim) and Promacta® (eltrombopag) are both FDA approved for the treatment of thrombocytopenia in patients with ITP that is resistant to other treatments.

Types of treatment used:

- Targeted therapy
- Radiation therapy
- Stem cell transplant
- Immunotherapy
- Monoclonal antibodies
- Chemotherapy

- **Chronic myelogenous leukemia (CML)** – is an uncommon type of cancer of the blood cells. CML can also be called chronic myeloid leukemia and chronic granulocytic leukemia. CML typically affects older adults and rarely occurs in children, though it can occur at any age.^{74,7} In CML, the tyrosine kinase caused by the BCR-ABL gene causes uncontrolled growth of white blood cells.^{31,74,76,88} Most or all these cells contain the abnormal Philadelphia chromosome.^{31,74,76,88} The diseased white blood cells build up in massive numbers and crowd out healthy blood cells and damage the bone marrow. Symptoms include fatigue, excess bleeding, bone, or joint pain, feeling of fullness from enlarged spleen, and frequent infections. Risk factors include increasing age, being male, and radiation exposure.^{31,74,76,88}

Risk Factors for CML – for most people who have chronic myeloid leukemia (CML), there are no obvious reasons why they develop the disease. No one is born with CML. It happens when there is an injury to the DNA of a single bone marrow cell. Risk factors include increasing age, gender (men are more likely to have it), radiation exposure.

Types of treatment used:

- Stem cell transplant
- Chemotherapy
- Leukapheresis
- Tyrosine Kinase Inhibitors
- Immunotherapy
- Monoclonal Antibodies

- **Hairy cell leukemia** – is a rare, slow-growing cancer of the blood in which the bone marrow makes too many B cells.^{31,74,76,88} These excess B cells are abnormal and look "hairy" under a microscope. As the number of leukemia cells increases, fewer healthy white blood cells, red blood cells and platelets are produced. Hairy cell leukemia affects more men than women, and it occurs most commonly in middle-aged or older adults.^{31,74,76,88} Hairy cell leukemia is considered a chronic disease because it may never completely disappear, although treatment can lead to a remission for years.^{31,74,76,88} Hairy cell leukemia progresses very slowly and sometimes remains stable for many years.^{31,74,76,88} There is an increased risk for non-Hodgkin's lymphoma in patients with hairy cell leukemia.^{74,76} Symptoms include a feeling of fullness in the abdomen, fatigue, easy bruising, frequent infections, weakness, and weight loss. Risk factors include exposure to radiation and exposure to agricultural and industrial chemicals.

Types of treatment used:

- Chemotherapy
- Monoclonal antibodies
- Stem cell transplant
- Splenectomy

- **Chronic myelomonocytic leukemia (CMML)** – starts in blood-forming cells in the bone marrow and invades the blood.^{31,74,76,88} People with CMML may have shortages of some blood cells, but a main problem is too many monocytes (at least 1,000 per mm³).^{31,74,76,88} Often, the monocyte count is much higher, causing their total white blood cell count to become very high as well.
 - In a healthy individual there are some abnormal cells (blasts), in the bone marrow. The number of blasts in CMML is below 20%^{74,76,88}
 - Many people with CMML have an enlarged spleen
 - About 15% to 30% of people with CMML go on to develop AML^{74,76,88}

Since CMML has features of both a myelodysplastic syndrome and myeloproliferative neoplasm, experts created a new category for it: myelodysplastic / myeloproliferative neoplasm; this basically means abnormal looking excessive growth of the bone marrow.^{74,76} Symptoms include fatigue, shortness of breath, pale skin, severe and frequent infections, easy bruising and bleeding, weight loss, fever, and loss of appetite. Risk factors include the risk of CMML increases with age.^{31,74,76,88} This disease is rare in those younger than 40, with most cases found in people 60 and older.^{74,76,88} CMML is about twice as common in men as in women.^{31,74,76,88} Prior treatment with chemotherapy seems to increase the risk of CMML.^{31,74,76,88}

Types of treatment used:

- Chemotherapy
- Stem cell transplant

- **Juvenile myelomonocytic leukemia (JMML)** – is a rare childhood cancer that usually happens in children younger than 4 years old; with the average age being two years old.^{16,17} In JMML, too many myelocytes and monocytes (two types of WBCs) are produced from immature blood stem cells (blasts).^{16,17} These myelocytes, monocytes, and blasts overwhelm the normal cells in the bone marrow and other organs, causing the symptoms of JMML. The cause of JMML is unknown, but doctors do know that certain medical conditions, such as neurofibromatosis type 1 and Noonan syndrome, can make a child more likely to develop it.^{16,17} Symptoms include fatigue, weakness, swollen lymph nodes, recurrent infections, fever, easy bruising, bone and joint pain, abdominal pain (caused by abnormal blood cells building up in organs like the kidneys, liver, and spleen), swelling of the spleen and abdomen.

Types of treatment used:

- Chemotherapy
- Stem cell transplant

- **Large granular lymphocytic (LGL) leukemia** – is a type of chronic leukemia affecting lymphocytes.^{74,76,88} LGL leukemia is characterized by enlarged lymphocytes that contain granules that can be seen when the blood is examined under the microscope. There are two types of LGL leukemia: T-cell (T-LGL) and natural killer cell (NK-LGL). Each type may be chronic or aggressive. The frequency of T-cell and NK-cell LGL leukemia ranges from 2 to 5 percent of chronic lymphoproliferative diseases. LGL leukemia affects both men and women, and the median age at diagnosis is 60 years.^{31,74,76,88} Less than 25% of patients are younger than 50 years.^{31,74,76,88} Symptoms include low blood cell counts, recurrent infections, fever, night sweats, weight loss, enlarged spleen, enlarged liver, and swollen lymph nodes. Autoimmune diseases, such as rheumatoid arthritis, are diagnosed before the onset of LGL leukemia in about 20 percent of cases.⁸⁸

Types of treatment used:

- Methotrexate
- Cyclosporine
- Cyclophosphamide
- Chemotherapy
- Stem cell transplant
- Targeted Therapy
- Purine Analogs
- Splenectomy

- **Blastic plasmacytoid dendritic cell neoplasm (BPDCN)** – is categorized by the World Health Organization (4th edition, 2008) under acute myeloid leukemia (AML).³¹ It was previously known as natural killer (NK) cell leukemia/lymphoma.³¹ Most often, BPDCN presents with features of both lymphoma and leukemia. There is very little data available about BPDCN and there is no established treatment.³¹ The average age at diagnosis is 60 to 70 years.³¹ There are more men than women who are diagnosed with BPDCN.^{31,88} It is difficult to diagnosis and, therefore, under-reported. In 80% of all cases, the skin is the most frequently involved site however, BPDCN usually progresses with bone marrow involvement and a decrease in red blood cell, white blood cell and platelet counts.^{31,88} The lymph nodes and spleen may also be involved. Rashes without symptoms can also occur. Common misdiagnoses for BPDCN include non-Hodgkin lymphoma, AML, leukemia cutis (a nonspecific term used for skin manifestation of any type of leukemia), melanoma, and lupus.³¹

Types of treatment used:

- Tagraxofusp-erzs (Elzonris™)
- Chemotherapy
- Stem cell transplant

- **B-cell prolymphocytic leukemia (B-PLL)** – is a very rare and typically aggressive malignancy characterized by uncontrolled growth of B-cells (type of white blood cell that is part of the immune system).^{31,88} B-PLL usually affects older adults with a median age at diagnosis of 69 years, and it is slightly more common in men than women.³¹ Most of the time, B-PLL occurs as a transformation or evolution of a “more slow-growing” B-cell cancer, such as CLL. It is seldom a primary disorder.³¹ B-PLL is extremely rare, and accurately diagnosing it can be difficult as B-PLL has similar clinical presentation to other mature B-cell malignancies including CLL, mantle cell lymphoma, and splenic marginal zone lymphoma.³¹ B-PLL is diagnosed when more than 55 percent of the lymphocytes in the peripheral blood are prolymphocytes, or when a lymph node or bone marrow sample shows that most of lymphocytes are prolymphocytes.³¹

The genetic features causing B-PLL are largely unknown.³¹ Abnormalities of the TP53 gene (deletion and/or mutation) are seen in about 50 percent of cases and abnormalities of MYC gene are seen in about 50 percent of cases.^{74,123} Some patients have abnormalities in both genes.^{74,123} Symptoms include high lymphocyte count, low blood cell counts, enlarged spleen, fevers, night sweats, and weight loss. Risk factors include smoking, exposure to certain chemicals, age (more common in older people, gender (affects slightly more males than females), and previous diagnoses with CLL.^{31,88}

Types of treatment used:

- Chemo-immunotherapy
- Monoclonal antibodies
- Stem cell transplant
- Targeted Therapy

- **T-cell prolymphocytic leukemia (T-PLL)** – is an extremely rare and typically aggressive malignancy (cancer) that is characterized by the out-of-control growth of mature T-cells (T-lymphocytes). T-cells are a type of white blood cell that protects the body from infections. T-PLL affects older adults with a median age at diagnosis of 61 years, and it is more common in men than in women.

Abnormal changes (mutations) in the genes of a T-cell can cause a normal, healthy T-cell to become a cancer cell. These genetic errors in the mutated T-cell tell the cell to keep growing and dividing when a healthy cell would typically stop dividing and eventually die. Every cell that arises from the initial leukemia cell also has the same mutated DNA. As a result, over time the number of leukemia cells multiply and can travel in the blood to other sites including the bone marrow, spleen, liver, lymph nodes and sometimes skin.

Chromosomal abnormalities are very common in patients with T-PLL. The most common chromosomal abnormalities are inversions or translocations involving chromosome 14 that result in mutations (changes in DNA) to the proto-oncogene TCL-1. Proto-oncogenes are genes involved in normal cell growth. When mutations occur to proto-oncogenes, these cells grow out of control which can lead to cancer. Less frequently, a translocation between chromosomes X and 14 can result in mutations to proto-oncogene MTCP-1. Also frequently detected in patients with T-PLL are abnormalities in chromosome 8, primarily trisomy 8q which is an extra copy of genetic material on the long arm (q) of chromosome 8.

Deletions or mutations to the tumor suppressor gene ATM have also been observed in patients with T-PLL. Tumor suppressor genes are a class of genes that help control cell growth. Mutations in tumor suppressor genes can cause uncontrolled growth of cells which can lead to cancer as well. Recently, DNA sequencing has found several gene mutations, particularly in the JAK-STAT pathway that may also contribute to the development of T-PLL. Janus kinases, or JAKs, are proteins that send signals which regulate the growth and production of certain types of white blood cells. When JAKs send too many signals, they cause the body to make the wrong number of blood cells. This is called overactive JAK signaling.

Types of treatment used:

- Campath® (Intravenous alemtuzumab)
- Nipent® (Intravenous alemtuzumab plus pentostatin)
- FMC[Fludara® (fludarabine) Novantrone® (mitoxantrone), Cytoxan® (cyclophosphamide), followed by intravenous alemtuzumab
- Arranon® (Nelarabine) can sometimes be used to treat T-PLL, though it is not approved by the Food and Drug Administration for T-PLL
- 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 (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 immune system 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 “war” begins involving the activation and recruitment of more and more cells, the production of antibodies and cytokines, and the recruitment of other immunological cells such as macrophages. The major sites of lymphoid tissue are:

1. **Bone marrow**
2. **Lymph vessels**
3. **Lymph nodes**
4. **Digestive tract**
5. **Thymus**
6. **Spleen**
7. **Adenoids and tonsils**

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 the various parts of the body in a process called metastasis. The intervening lymph nodes can trap the cancer cells; If they are not successful in destroying the cancer cells the nodes may become sites of secondary tumors. Lymphoma, on the other hand, is considered a primary cancer. People with lymphoma become increasingly vulnerable to infection. There were 627,439 new cases and 283,169 deaths worldwide in 2020.³¹ Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL) are the two main types of lymphoma. About 90 percent of people with lymphoma have non-Hodgkin lymphoma.³¹ The risk of developing NHL increases with age whereas the risk of HL is greatest during adolescence and early adulthood.³¹ Most risk factors are associated with an altered immune system.³¹

Types of Lymphoma:

- **Non-Hodgkin (NHL)** – is most common in middle aged and elderly people and forms in tissue other than the nodes and is grouped according to how aggressively it spreads³¹⁹. Compared to Hodgkin, these malignancies tend to advance rapidly and follow a less predictable course³¹⁹. Cancers are classified as low grade (indolent) or high grade (aggressive). Contiguous lymphomas are those in which the lymph nodes containing cancer are next to each other. Non-contiguous lymphomas are those in which the lymph nodes containing cancer are not next to each other but are on the same side of the diaphragm.

How Does NHL Develop?

A cell mutates in a lymph node or in another lymphatic structure. It can start in one of three major types of lymphocytes:³¹⁵

- **B lymphocytes (B cells)** – which produce antibodies to help combat infections³¹⁵
- **T lymphocytes (T cells)** – which have several functions, including helping B lymphocytes make antibodies³¹⁵
- **Natural killer (NK) cells** – which attack virus-infected cells or tumor cells³¹⁵

About 85-90 percent of NHL cases start in the B cells.³¹⁵

The abnormal lymphocyte grows out of control and produces more abnormal cells like it.

- These abnormal lymphocytes accumulate and form tumors. If NHL isn't treated, the cancerous cells crowd out normal white cells, and the immune system can't effectively guard the body against infection.³¹⁵
- NHL that develops in or spreads to other areas of the body where lymphoid tissue is found, such as the spleen, digestive tract, and bone marrow, is called primary extranodal lymphoma³¹⁵
- NHL is classified into more than 60 different subtypes. These subtypes are broken into categories that describe the speed at which the disease is progressing:³¹⁵
 - Aggressive (fast-growing) NHL
 - Indolent (slow-growing) NHL
- **Aggressive lymphomas** are fast-moving and account for about 60 percent of all NHL cases³¹⁵
- **Indolent lymphomas** grow more slowly and have fewer signs and symptoms when first diagnosed.³¹⁵ Slow-growing or indolent subtypes represent about 40 percent of all NHL.

Symptoms of Non-Hodgkin include painless swelling in the neck, armpit, or groin, fevers, night sweats, fatigue, weight loss, itching and reddened patches on the skin, nausea, vomiting, and abdominal pain. “B symptoms” refer 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.

Risk factors include age (most cases are in people 60 and older), gender (overall more men than women will get it, but certain types of NHL are more common in women), race (in the U.S., whites are more likely to get it), having a first-degree family relative who has it, benzene and certain herbicides and insecticides, certain chemotherapy drugs, certain drugs to treat rheumatoid arthritis, exposure to radiation, some autoimmune diseases such as rheumatoid arthritis, systemic lupus erythematosus (SLE or lupus), Sjogren disease, celiac disease, infection with human T-cell lymphotropic virus (HTLV-1), infection with the bacterium *Campylobacter jejuni*, long-term infection with the hepatitis C virus, infection with the Epstein-Barr virus, Human herpes virus 8 (HHV-8), *Helicobacter pylori*, *Chlamydia psittaci*, being overweight and obese, women with textured breast implants, and people with a weakened immune system (post-transplant, HIV, and auto-immune disease).^{31,149,160}

Types of treatment used:

- Chemotherapy
- Radiation therapy
- Stem cell transplant
- Targeted therapy
- Immunotherapy
- Monoclonal antibodies
- Immunomodulating drugs
- Chimeric antigen receptor (CAR) T-cell therapy
- Lymphoma vaccines

- **Hodgkin (HL)** – is one of the most curable forms of cancer.³¹⁹ It is easily distinguishable from non-Hodgkin under the microscope by the presence of unique large cells called Reed Sternberg cells. The disease is very treatable because it generally travels very slowly and predictably down the body from the nodes in the neck to the chest, then down to the abdomen and pelvis. Because it advances slowly, three in four clients can be cured.³¹⁹ Once the diagnosis is confirmed, doctors need to “stage” the disease. This will help determine the extent of the disease as well as treatment options.

One of the important features of HL is a compromised immune-system that can increase the risk of infection in patients.³¹⁶ One viral disease that occurs frequently in patients with HL is Herpes zoster (shingles).³¹⁶ By weakening immune-system function, both chemotherapy and radiation can make patients more susceptible to infections.³¹⁶

HL patients are advised to get certain vaccinations once they have finished their treatment, including vaccinations for pneumococcal pneumonia and influenza.³¹⁶ Two types of pneumococcal vaccines are available for adults: a pneumococcal polysaccharide vaccine (PPSV23) and a pneumococcal conjugate vaccine (PCV13).³¹⁶ Immunizations using “live” vaccines, such as the herpes zoster or shingles vaccine, should not be administered.³¹⁶ Patients who have HL can receive the shingles vaccine Shingrix® because it is an “inactivated” rather than a “live” vaccine.³¹⁶

The initial symptoms of Hodgkin lymphoma are painless swelling in the neck, upper chest, underarm, or groin (caused by enlarged lymph glands), cough and shortness of breath, fatigue, and itchy skin. “B symptoms” refer 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. Risk factors include Epstein-Barr virus, age (most likely in a person's 20s or after 55), gender (more common in men than women), family history (brothers and sisters of young people with this disease have a higher risk for HL; the risk is very high for an identical twin of a person with HL), and people with a weakened immune system (post-transplant, HIV, and auto-immune disease).^{319,149,160}

Types of treatment used:

- Chemotherapy
- Radiation therapy
- Immunotherapy
- Stem cell transplant
- Monoclonal antibodies

In the case of children's HL, if the child is past puberty and muscles and bones are fully developed, treatment is usually the same as that given to adults. But if the child has not reached his or her full body size, chemotherapy (chemo) will likely be favored over radiation therapy. This is because radiation can affect bone and muscle growth and keep children from reaching their normal size.

- **Lymphoplasmacytic Lymphoma and Waldenström Macroglobulinemia** – are both slow-growing sub-types of Hodgkin lymphoma that originate in a B-lymphocyte precursor.³¹⁵ In lymphoplasmacytic lymphoma, the lymph nodes are more involved than they are in Waldenström macroglobulinemia, however, both disorders present with cancerous lymphoplasmacytic cells in the bone marrow and spleen.

Patients may experience thickening of the blood, inadequate blood flow, and symptoms and signs of limited blood flow.³¹⁵ Symptoms such as headache, visual blurring, mental confusion are referred to as “hyperviscosity syndrome” and may require urgent intervention.³¹⁵ Hyperviscosity syndrome can be treated by plasmapheresis (a process in which plasma is separated from whole blood and the rest is returned to the patient).³¹⁵ This process may reverse the acute symptoms, but in order to achieve long-term control, a reduction in the mass of lymphoma cells that make the protein must be achieved.³¹⁵ Progressive disease may also involve the lungs, the gastrointestinal tract and other organs.³¹⁵

- **Marginal Zone Lymphoma (MZL)** – this indolent B-cell lymphoma subtype may be within, or outside of, the lymph nodes.²⁷ It begins in B lymphocytes in a part of the lymph tissue called the “marginal zone” and tends to remain localized.²⁷

There are several subtypes of MZL, each categorized by the type of tissue where the lymphoma forms.²⁷

- **Gastric mucosa-associated lymphoid tissue (MALT) lymphoma** – usually develops in the stomach.²⁷ Patients with MALT lymphoma may have a history of an autoimmune disease such as Hashimoto thyroiditis or Sjögren syndrome.²⁷ A higher incidence of MALT lymphoma involving the stomach is seen in patients who have been infected with the bacterium *H. pylori*.²⁷ Treatment may include strong combinations of antibiotics to eradicate the *H. pylori* infection and cause the lymphoma to regress.²⁷ If remission is not achieved following antibiotic treatment, radiotherapy is often the next option.²⁷
- **Monocytoid B-cell lymphoma also known as “nodal marginal zone B-cell lymphoma” (nodal MZL)** – is found in the spleen and blood.²⁷
- **Splenic marginal zone lymphoma (SMZL)** – begins in the spleen and may spread to the peripheral blood and bone marrow.²⁷ Usually the first sign of SMZL is an enlarged spleen.²⁷ SMZL has been associated with hepatitis C infection and may be treated with interferon to achieve remission.²⁷ For symptomatic patients who are hepatitis-C negative.

For relapsed or refractory cases, treatment may include:

- Lenalidomide (Revlimid®), given by mouth, is indicated in combination with a rituximab product for MZL patients who have been previously treated.

Treatments may include:

- Removal of the spleen
- Single-agent chemotherapy
- Combination chemotherapy plus Rituxan®(rituximab)
 - R-CVP (rituximab, cyclophosphamide, vincristine and prednisone)
 - R-CHOP [Rituxan® (rituximabplus), Cytoxan® (cyclophosphamide), doxorubicin® (hydroxydoxorubicin), Oncovin® [vincristine], and prednisone]
 - BR [Bendeka® (bendamustine hydrochloride) and Rituxan®(rituximab)]

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 higher the chances that MGUS will progress to multiple myeloma or lymphoma. There were 176,404 new cases and 117,077 deaths worldwide in 2020.^{31,183}

Multiple myeloma causes plasma cells to reproduce uncontrollably, accumulate in the bone marrow, and crowd-out the healthy cells. Not only will there be too many plasma cells in the marrow, but also an abundance of the unique antibody they produce. It is referred to as the M protein. Presence of the M protein in the blood or urine is how multiple myeloma is diagnosed. Typically, multiple myeloma cells collect in the marrow and the outermost layer of the bones, creating multiple tumors. The myeloma cells also react with the cells that help keep the bones strong.

There are 2 major kinds of bone cells that normally work together to keep bones healthy and strong. The cells that lay down new bone are called *osteoblasts*. The cells that break down old bone are called *osteoclasts*. Myeloma cells make a substance that tells the osteoclasts to speed up the dissolving of bone. Since the osteoblasts do not get a signal to put down new bone, old bone is broken down without new bone to replace it. This makes the bones weak, and they break easily. Therefore, fractured bones are a major problem in people with myeloma. There is a rare, related cancer, called *plasmacytoma*, in which the malignant cells accumulate in one bone to form a single mass. This is another type of abnormal plasma cell growth. Rather than multiple tumors in different locations as in multiple myeloma, there is only one tumor; it is called solitary plasmacytomas.

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. Sometimes surgery may be used for a single extramedullary plasmacytoma. If no other plasmacytomas are found later, the patient's prognosis is usually very good³¹. However, since many people with a solitary plasmacytoma will develop multiple myeloma, these people are watched closely for signs of this disease.

If a patient has smoldering multiple myeloma or precancerous monoclonal gammopathy of undetermined significance (MGUS), the hematologist may recommend no treatment. In the case of MGUS, they will be monitored closely for signs of progression to myeloma. Clients 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. This will be determined by the patient's age and general health. For those who do not qualify for a transplant, they will be given combination chemotherapy.

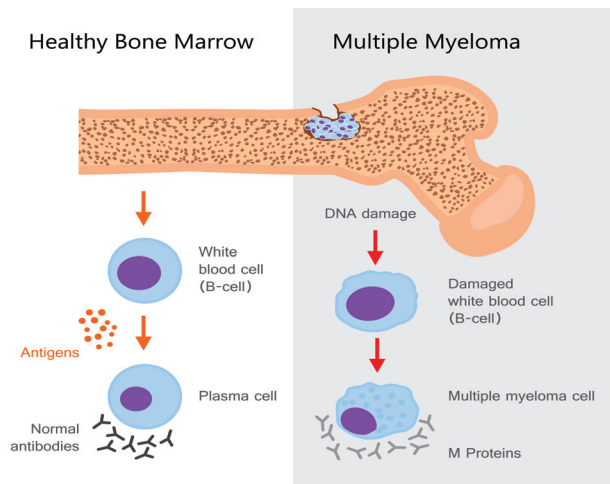
Eighty percent of myeloma cases occur after age 65 and rarely occurs in people under age 50.³¹ Black people are twice as likely to develop it than white people, and the risk is slightly higher in men than women.³¹ Someone who has a sibling or parent with myeloma is 4 times more likely to get it than would be expected; most patients have no affected relatives, so this accounts for only a small number of cases.³¹

Myeloma may show abnormalities in their chromosomes. Although normal human cells contain 46 chromosomes, some cancer cells may have extra chromosomes (aduplication) or have all or part of a chromosome missing (deletion).³¹ One common finding in myeloma cells is that parts of chromosome number 13 are missing.³¹ These deletions appear to make the myeloma more aggressive and resistant to treatment.³¹ In about half of all people with myeloma, part of one chromosome has switched with part of another chromosome in the myeloma cells.³¹ This is called a translocation. When this occurs in a crucial area next to an oncogene, it can turn the oncogene on. According to the American Cancer Society and the World Health Organization, researchers have found that patients with plasma cell tumors have important abnormalities in other bone marrow cells and that these abnormalities may also cause excess plasma cell growth.^{31,183} Certain cells in the bone marrow called dendritic cells, release a hormone called interleukin-6 (IL-6) which stimulates normal plasma cells to grow. Excessive production of IL-6 by these cells appears to be an important factor in development of plasma cell tumors.³¹

Symptoms include bone pain – often in the spine or chest, broken bones, weakness, fatigue, weight loss, nausea, vomiting, constipation, loss of appetite, excessive thirst, mental foggy or confusion, problems with urination, repeated infections and weakness or numbness in the legs. Surgery is sometimes used to remove single plasmacytomas, however, it's 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 to attach metal rods or plates can help support weakened bones and may be needed to prevent or treat fractures. Procedures have been investigated in recent years to relieve pain, restore lost height due to a collapsing vertebra, and strengthen the spine.³¹ One procedure known as kyphoplasty requires the surgeon to inflate a balloon between vertebrae to clear the space and then remove the balloon and inject a bone cement to stabilize the spine. Another procedure is vertebroplasty, which involves injecting bone cement to stabilize fractures in the spine.

Complications:

1. Multiple myelomas' main effect is on the bones, especially the spine and rib cage.³¹ As the cancer cells grow, they stimulate the activities of other cells to eat away at the bone. Skeletal x-rays of clients often display gaping black holes called *lytic lesions*. These holes leave the bones weak and prone to fracture. The first indicators of the disease are often bone pain in the back or ribs, and broken bones. Although multiple myeloma attacks bone, it is not bone cancer because it originates in the plasma cells.
2. Because multiple myeloma erodes the bone, calcium is released into the blood and builds up in large amounts causing symptoms of *hypercalcemia*; nausea, fatigue, and thirst. It is important to try and prevent fractures through weight bearing exercise. A cane or walker can be used to provide a wider base of support. Drinking plenty of fluids is also important, since it helps the kidneys to get rid of excess calcium in the blood and prevents problems that occur when calcium collects in the kidneys. *Bisphosphonates* help reduce destruction of bone by reducing the calcium levels in the blood and stabilizing the bones; they can also help relieve bone pain. Two bisphosphonates are approved for this purpose: Zometa® (zoledronate) and pamidronate (Aredia®). Another nonbisphosphonate, medicine is also approved: Xgeva® (denosumab).
3. As malignant plasma cells invade the marrow, white cells, red cells, and platelets are crowded out and can't produce their usual cells. A deficiency in red blood cells brings on symptoms of anemia; fatigue, shortness of breath, and lethargy. Too few platelets in the bloodstream are known as thrombocytopenia and can lead to excessive bleeding and bruising. Procrit® and Aranesp® (erythropoietin) can be given to help boost red blood cells for patients with *anemia*; for more severe anemia, they may need a transfusion.
4. In multiple myeloma, the myeloma cells crowd out the normal plasma cells, so that the antibodies to fight the infection aren't made. Infections associated with multiple myeloma include *pneumococcal pneumonia, streptococcus, staphylococcus, and shingles (herpes zoster)*. In order to prevent infections, clients should not get any vaccines or inoculations with live materials. Clients should consume plenty of fluids as well as a diet high in calories and proteins and should get plenty of rest. They may also need antibiotics to fight an infection or Neupogen®(filgrastim), to boost their white blood cell count.



5. In three out of four patients, a substance called **Bence-Jones** proteins are produced by the plasma cells, clogging the narrow tubules of the kidneys, and damaging the organs.^{31,183} They sometimes have impaired renal function and must go on kidney dialysis while they're being treated for the cancer.^{31,183} The kidney damage may be permanent, but is often reversible with treatment, sustaining minimal damage.^{31,183}
6. Orthopedic surgery may be used to place metal rods or plates to repair or strengthen bones damaged by myeloma. If vertebrae in the spine are damaged, they may press on the spinal cord or the nerves that branch from the spinal cord to the rest of the body. In this case, emergency surgery may be required to take off the pressure. **Kyphoplasty** is a procedure to inject special cement into a damaged vertebra to stop pain caused by a spinal fracture and stabilize the bone.
7. **Spinal cord compression is one of the most severe adverse effects of multiple myeloma.** Reports indicate that as many as 20% of patients develop spinal cord compression at some point during their disease.^{31,183} Symptoms typically include back pain, weakness or paralysis in the legs, and numbness in the lower extremities. However, depending on the level of involvement, patients may present with upper extremity symptoms. The dysfunction may be reversible, depending on the duration of the cord compression; however, once established, the dysfunction is only rarely fully reversed.^{31,183}

8. **Kidney Dialysis** – in **hemodialysis**, a machine called a **dialyzer** carries out the task of filtering blood three times a week. In **peritoneal dialysis**, the function is performed several times a day, but inside the person's body.

9. **Plasmapheresis** – clients are connected to a machine like a **dialyzer**, filtering out the excess myeloma antibodies. Plasmapheresis thins the blood and eases the workload of the kidneys and heart.

Types of treatment used:

- External beam radiation
- Chemotherapy
- Stem cell transplant
- Immunotherapy
- Targeted therapy

BONE AND SOFT TISSUE CANCER

Bone and soft tissue sarcomas are cancers of the structural and connective tissues of the body.^{31,183} They include bone, cartilage, nerves, fibrous connective tissue, fat, muscle, and blood vessels.^{31,183} They can also be found in the trunk, head and neck area, internal organs, and the area behind the abdominal cavity (retroperitoneum).^{31,183} Primary bone cancers (those that begin in the bone) are extremely rare.^{31,183} By contrast, many cancers that begin in other areas of the body – such as breast, prostate, or lung – may spread to the bone and cause secondary tumors there.^{31,183} Symptoms of bone cancer include pain, fever, swelling or mass, stiffness or tenderness in the affected area, loss of bladder or bowel function (if cancer is in pelvic bones or base of spine), and bone fractures. Risk factors include having lymphedema in the arms or legs for a long time, being exposed to certain chemicals, such as Thorotrast (thorium dioxide), vinyl chloride, or arsenic and being infected with HIV and human herpesvirus 8 (these viruses have been linked to Kaposi sarcoma), advanced age, and inherited syndromes:³¹

- Li-Fraumeni syndrome (TP53 mutation)
- von Recklinghausen disease (neurofibromatosis type 1; NF1 mutation)
- Gardner syndrome (APC mutation)
- Nevoid basal cell carcinoma syndrome (Gorlin syndrome; PTCH1 mutation)
- Tuberous sclerosis (Bourneville disease; TSC1 or TSC2 mutation)
- Werner syndrome (adult progeria; WRN mutation)

Types of bone cancer:

- **Adamantinoma** – is a rare bone cancer that almost always occurs in the bones of the lower leg. Adamantinomas account for less than one percent of all bone sarcomas.
- **Chondrosarcoma** – is a rare tumor that grows in the cartilage.^{31,183} 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.^{31,183} It can remain slow growing, but when they become aggressive, can metastasize to the lungs and heart.^{31,183}
- **Chordoma** – affects bones in the spine and the base of the skull. This type of bone cancer occurs most frequently in adults 30 or older, particularly men. It tends to be a slow growing tumor with a low risk of spreading to distant sites, but it may return at the original site if not removed completely during surgery. Chordoma may also eventually spread to the lungs, liver, or lymph nodes.
- **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.^{31,183} It typically affects the same age group as osteosarcoma; 10-25 years of age. It may involve any part of the bony skeleton and may extend into the soft tissue around the bones.^{31,183} When the tumor is found outside the bones, it is known as “soft tissue” or extra-osseous Ewing's sarcoma.^{31,183} For many years Ewing's sarcoma was considered fatal, but with present treatment methods it is highly treatable and, in many cases curable.^{31,183} The most curable cases are those found in the lower jaw, skull, face, scapula, vertebra, or clavicle, and those below the elbow or knee.^{31,183}
- **Fibrosarcoma** – this is a very rare form of bone cancer which may occur at any age but is rare in children.^{31,183} Fibrosarcomas may develop in persons who have had radiation or at the site of a past bone fracture.^{31,183} It is also felt that Paget's Disease (parts of the skeleton become overactive and dismantle simultaneously, then rebuild themselves at an abnormally fast rate) may be a predisposing factor in the development of fibrosarcoma.^{31,183}

- **Giant cell tumor** – begins in connective tissue of bone marrow. It may weaken the knees or vertebra and cause bone fractures.^{31,183} Malignant giant cell tumors typically affect ages 40-55.^{31,183}
- **Multiple exostoses (sometimes called multiple osteochondromas) syndrome** – is an inherited condition that causes many bumps on a person's bones.^{146,152} 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.^{146,152} Patients with this condition have an increased risk of chondrosarcoma.^{146,152} 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.^{146,152} They have an increased risk of developing chondrosarcomas.^{146,152}
- **Osteosarcoma** – is the most common type of bone cancer.^{31,183} 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 it has a high tendency to spread to distant areas of the body, particularly the lungs. Children with certain rare inherited syndromes have an increased risk of developing osteosarcoma.^{31,183,146,152} Li-Fraumeni syndrome makes people much more likely to develop several types of cancer, including breast cancer, brain cancer, osteosarcoma, and other types of sarcoma.^{31,183,146,152} Another syndrome that includes bone cancer is the Rothmund-Thomson syndrome.^{146,152} Children with this syndrome are short, have skeletal problems, and rashes; they also are more likely to develop osteosarcoma.^{146,152} This syndrome is caused by abnormal changes in the gene REQL4.^{31,183,146,152} Retinoblastoma is a rare eye cancer of children that can be hereditary.^{146,152} The inherited form of retinoblastoma is caused by a mutation of the RB1 gene.^{146,152} Those with this mutation also have an increased risk of developing bone or soft tissue sarcomas.^{146,152}

- **Skip metastasis** – is a tumor nodule located in the same bone as the main tumor, but not in continuity with the tumor. It is usually located in the joint adjacent to the main tumor and is most often a high-grade sarcoma.^{31,183}

Surgery is the primary treatment for most bone cancers and may be needed to obtain a biopsy of the cancer^{31,183}. The main goal of surgery is to remove all the cancer. If even a few cancer cells are left behind, they can grow and multiply to make a new tumor. To minimize the risk of this happening, surgeons remove the tumor plus some of the normal tissue that surrounds it. This is known as wide excision. If cancer cells are present at the edges of the tissue, when looked at under the microscope, the margins are “positive.” Positive margins can mean that some cancer cells were left behind. When no cancer is seen at the edges of the tissue, the margins are said to be “negative,” “clean,” or “clear.” A wide excision with clean margins minimizes the risk that the cancer will grow back where it started.

Soft tissue cancers are also uncommon.^{31,183} Symptoms of soft tissue sarcomas include enlarging, non-tender swelling or mass and pressure against nearby nerves and muscles. Risk factors include family (other people in family have had sarcoma), exposure to chlorophenols in wood preservatives, vinyl chloride (a chemical used in making plastics), arsenic, dioxin, and to herbicides that contain phenoxyacetic acid at high doses, having a bone disorder called Paget's disease, damage to the lymphatic system, genetics (*Von Recklinghausen disease, Li-Fraumeni syndrome, Gardner syndrome, Inherited retinoblastoma, Werner syndrome, Gorlin syndrome, Bourneville disease*), or exposure to radiation from another cancer^{31,146,152,183}. Sarcoma can start in any part of the body, such as the bone or soft tissue.

- 50% begin in an arm or leg^{31,183}
- 40% start in the torso or abdomen^{31,183}
- 10% occur in the head or neck^{31,183}

Both children and adults can develop a sarcoma.^{31,183} It is rare in adults, accounting for only 1% of all adult cancers.^{31,183} Sarcomas are more common in children accounting for 15% of all childhood cancers.^{31,183} Soft-tissue sarcoma is a group of cancers that begin in the connective tissues that support and connect the body, including:

- Blood and lymph vessels
- Fat cells
- Joint tissue
- Muscle tissue
- Peripheral nerve tissue
- Fibrous tissue

Because there are at least 50 different types of STS, it is more accurate to describe them as a family of related diseases, rather than as a single disease.^{31,183} Specific types of sarcomas are often named according to the normal tissue cells they most closely resemble. Most other types of cancer are usually named for the part of the body where the cancer began.

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 and 60, but can occur in people of any age, even in infants.^{31,183}
- **Alveolar Soft-part Sarcoma** – is a rare cancer that mostly affects young adults.^{31,183} These tumors most commonly occur in legs.
- **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^{31,183}. Angiosarcomas are sometimes seen in the breast after radiation therapy and in limbs with lymphedema^{31,183}.
- **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.^{31,183}
- **Dermatofibrosarcoma Protuberans** – is a very rare type of skin cancer that begins in connective tissue cells in the middle 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 skin 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.^{31,183}
- **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^{31,183}. It is also sometimes called an *Evans' tumor*.
- **Gastrointestinal Stromal Tumor (GIST)** – is a type of sarcoma that develops in the digestive tract.

- **Kaposi Sarcoma** – is a type of sarcoma that develops from the cells lining lymph or blood vessels.
- **Leiomyosarcoma** - is a rare type of cancer that affects smooth muscle tissue. These tumors are most common in the abdomen, but can occur anywhere in the body, including the uterus, blood vessels (including the inferior vena cava and the pulmonary artery), and skin. Abdominal leiomyosarcoma tumors can measure over 4 inches (10 centimeters) across and may be accompanied by pain, weight loss, nausea or vomiting.
- **Liposarcomas (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^{31,183}.
- **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** (includes neurofibrosarcomas, neurogenic sarcomas, and malignant schwannomas) – 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 (specifically skeletal muscle tissue or sometimes hollow organs such as the bladder or uterus). It can occur at any age but is the most common type of soft tissue sarcoma seen in children. Although RMS 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 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^{31,183}. Although it mostly tends to grow locally, it can spread to distant sites^{31,183}.

Procedures:

- **Amputation** – surgery to remove part or all of a limb or appendage, such as an arm or leg. Amputation is rarely used to treat soft tissue sarcoma of the arm or leg.
- **Conservative Surgical Excision** – surgery to remove the cancer and a margin of normal tissue less than 2 centimeters in all directions, from the tumor site.
- **Curettage** – the doctor scoops out the tumor from the bone without removing a section of the bone. This leaves a hole in the bone and in some cases, after most of the tumor has been removed, the surgeon will treat the nearby bone tissue to kill any remaining tumor cells. This can be done with cryosurgery or by using bone cement.
- **Limb-sparing Surgery (limb salvage)** – 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 (endoprosthesis). 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. Before taking this approach, the doctor must be confident that this will control the cancer at least as well as amputation and that the preserved limb will be functional. When used in growing children, some prostheses can be made longer without any extra surgery as the child grows. Further surgery could be needed if the bone graft becomes infected, loose, or broken. Limb-sparing surgery patients may need more surgery during the following 5 years, and some may eventually need an amputation. Rehabilitation is much more difficult after limb-salvage surgery than it is after complete amputation. It will usually be at least a year for patients to learn to walk again after limb-salvage of a leg.^{15,75}

- **Lymph Node Dissection** – removal of lymph node(s).
- **Mohs Micrographic Surgery** – a surgical procedure in which individual layers of tissues are removed and examined one at a time under a microscope to look for signs of cancer. This is done until all cancerous tissue is removed.
- **Surgical Excision** – surgical removal of the primary or secondary tumor; with or without a margin of normal tissue.
- **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. For tumors of the head, neck, abdomen, and trunk, as little normal tissue as possible is removed. Most people will be able to have the surgical wound drawn together with stitches. When large cancers are removed, the wound may be too big to close with stitches. The surgeon may cover it using some skin from another part of the body.
- **Amputation** – surgery to remove the cancerous part of the body.



Reconstructive Surgery:

Several procedures are available depending on the patients' functional needs.^{15,75} For the large bones of the arm and leg, reconstruction is done at the same time as surgery to remove the cancer.

Types of Reconstruction:

1. **Bone Graft** – is a piece of bone taken from another part of the patient's body (autologous), or from a genetically compatible donor (allogeneic) to rebuild the area that has had bone removed. When an allograft is used, there is a higher chance that the bone graft won't attach properly (non-union) or will become infected. However, the advantage of allografts is that they become stronger and are less likely to require additional surgery over time.^{15,75} The patient can be physically active after an allograft on the leg or arm but will need to avoid activity such as contact sports or those with a high risk of falling. The bone graft will be fragile and can easily break if it is hit or stressed repetitively or with force.
2. **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. Although there have been significant improvements in the materials used for implants and component designs, serious complications such as prosthetic fracture, infection, and mechanical aseptic loosening limit the life span of these prostheses.³⁰⁰ It has been reported that the revision risk for endoprostheses in the knee joint was 17% at 5 years, 33% at 10 years and even more than 50% in 20 years.³⁰⁰

3. **Fusion (arthrodesis)** – may be used when a tumor is in or near the knee or shoulder joint. The entire joint is removed and replaced with a metal implant, such as a rod or plate. It is positioned between the 2 remaining bone ends to join them together without an actual joint. After a fusion the joint will have little to no mobility and make it difficult to perform activities that require running and jumping.^{15,75}
4. **Rotationplasty** – may be used when a bone tumor is removed from the lower thigh or upper leg in a wide resection. In rotationplasty, the leg is turned so that the foot faces backward. The lower part of the leg is joined to the upper part with a metal plate, and screw or a rod. The rotated ankle joint acts as a new knee joint and a prosthesis is attached to the reconstructed limb to make the limbs the same length.
5. **Tissue regeneration** – is a rapidly evolving field that uses combinations of a patient's own cells, synthetic matrix materials and purified protein growth factors to induce the regeneration of the patient's own tissue^{15,75}. Additionally, bone can be transported and made to grow a millimeter per day (one inch per month) using the Ilizarov or spatial frame technique.^{15,75}

Following limb sparing surgery or amputation, most patients will remain in the hospital for 5-10 days with full recovery taking 6-8 weeks (depending on the extent of the procedure, patient's general health, and whether immediate reconstruction is performed). Physical therapy will usually start within 10-14 days. The amount of bone removed, and the type of reconstruction performed dictate how soon and how much the patient can exercise, but most patients begin muscle-strengthening, continuous passive motion (CPM), and ROM exercises the day after the operation and continue them for the next 12 months.

Patients should not do active elbow or shoulder exercises for 2-8 weeks after having surgery involving the humerus. Rehabilitation following lower-extremity limb salvage focuses on strengthening quadriceps, maintaining muscle tone, and gradually increasing weight-bearing so that the patient can stand on the affected limb within three months of the operation. A patient who has had lower-extremity surgery may have to learn a new way of walking (gait retraining) or wear a lift in one shoe.

Once the patient has been cleared to exercise, you will want to focus on activities that help to improve motor skills, restore the ability to perform activities of daily living, and promote independence. There are no limitations on the unaffected body parts (except for pre-existing orthopedic issues), but you will want to make sure to maintain, or work toward muscle balance. Do not train unilaterally with resistance. You can, however, use movement for maintenance of motor control on unaffected side. Have the patient speak to their doctor about limitations on exercise intensity i.e.; running, jumping, and heavy lifting.

Potential side effects of amputation/reconstruction:

- Infection
- Heart attack
- DVT (deep vein thrombosis)
- Necrosis
- Severe blood loss
- Anemia
- Pain (including Phantom pain)
- Need for prostheses
- Loosening, shifting, or breakage of implants
- Pneumonia
- Edema
- Depression, anxiety, denial, anger, grief, and feeling suicidal

Types of treatment used:

- External beam radiation
- Intensity modulated radiation therapy (IMRT)
- 3D conformal radiation therapy
- Proton therapy
- Chemotherapy
- Brachytherapy
- Targeted therapy
- Immunotherapy
- Monoclonal antibodies
- Hyperthermia
- Cryosurgery
- Bone cement
- Isolated limb perfusion (embolization)

SKIN CANCER

The skin is the body's largest organ. It protects against heat, sunlight, injury, and infection. Skin also helps control body temperature and stores water, fat, and vitamin D. The skin has several layers, but the two main layers are the epidermis (upper or outer layer) and the dermis (lower or inner layer). Skin cancer begins in the epidermis, which is made up of 3 kinds of cells^{31,183}

- **Squamous cells** – thin, flat cells that form the top layer of the epidermis
- **Basal cells** – round cells under the squamous cells
- **Melanocytes** – found in the lower part of the epidermis

Skin cancer is the most common type of cancer. Skin cancer can occur anywhere on the body, but it is most common in skin that has been exposed to sunlight; such as the face, neck, hands, and arms.^{31,183} There are several types of cancer that start in the skin. The most common types are basal cell carcinoma and squamous cell carcinoma; which are non-melanoma skin cancers.^{31,183} Basal cell carcinoma grows slowly and rarely spreads, but it can damage nearby tissue. Basal cell cancer usually appears as a pink or white pearly bump or as an irritated patch. The skin may bleed and crust over in a repeating cycle. Squamous cell carcinoma is less common than basal cell; but it can be more dangerous because it grows more quickly and may spread.^{31,183} Squamous cell cancer may appear as a raised pink bump or scaly patch with an open sore in the center. Neither basal or squamous cell cancers are likely to become life-threatening.^{31,183} There were 1,198,073 new cases of non-melanoma skin cancer and 63,731 deaths worldwide in 2020.^{31,183} Actinic keratosis is a skin condition that sometimes develops into squamous cell carcinoma.

The greatest increase has been in melanoma (although it only accounts for 2% of all skin cancers); the most serious and most deadly type of skin cancer.^{31,183} There were 324,635 new cases of melanoma and 57,043 deaths worldwide in 2020.^{31,183} Melanoma develops in the cells that produce melanin – the pigment that gives your skin its color. It can also form in your eye, and in rare cases, in internal organs such as your intestine. Although they make up a small percentage of all skin cancers, melanomas cause the greatest number of deaths; it's because they are more likely than other skin cancers to spread to different parts of the body.^{31,183} Incidence rates are higher in women than in men below age 45, but by the age of 60, rates in men more than double those in women, and by the age of eighty they almost triple, according to the American Cancer Society.^{31,183}

Changes in the size, shape, or color of a mole, the appearance of a new growth on the skin, or a sore that doesn't heal are all warning signs of melanoma. If these changes do not go away within a month's time, they should be evaluated by a doctor.^{31,183} Major risk factors for melanoma include a personal or family history as well as the presence of atypical, large, or numerous (more than 50) moles.^{31,183}

Risk factors for all types of skin cancer include sun burning easily, fair skin, and blonde or red hair, a history of tanning bed usage, excessive sun exposure, sun burns, history of skin cancer, past treatment with radiation, being exposed to arsenic, and a suppressed immune system. Wearing protective clothing, glasses, and sun block, as well as avoiding the sun between 10-2, and seeking shade may all prove invaluable in preventing skin cancer.

Several hereditary syndromes are associated with the development of skin cancer:

- **Basal cell carcinoma** – Basal cell nevus syndrome (BCNS, caused by pathogenic variants in PTCH1 and PTCH2) is associated with increased BCC risk³⁴
- **Squamous cell carcinoma** – syndromes such as oculocutaneous albinism, epidermolysis bullosa, and Fanconi anemia are associated with increased SCC risk³⁴
- **Melanoma** – CDKN2A is a major germline tumor suppressor gene that is associated with increased melanoma risk.³⁴ Pathogenic variants in CDKN2A may account for 35% to 40% of all familial melanomas. Germline pathogenic variants in several other genes (i.e., CDK4, MITF, and BAP1) are also associated with increased melanoma risk.³⁴ An autosomal recessive disease, called xeroderma pigmentosum (XP), is associated with increased BCC, SCC, and melanoma risks.³⁴

Melanoma of the Eye (Ocular Melanoma) – the eye is the second most common site in the body for melanomas after skin.^{31,183} However, with only 2,500 cases a year, ocular melanomas are relatively rare and require special techniques for diagnosis and treatment.^{31,183} Like melanoma of the skin, ocular melanoma often begins with the emergence of a cluster of melanocytes called a nevus (mole). More than 10 percent of the population will develop a nevus in the eye during their lifetime.^{31,183} Nearly one in 5,000 of these will become cancerous.^{31,183}

Most ocular melanomas occur in the part of the eye known as the uveal tract, the vascular layer that includes the iris (the pigmented cells surrounding the pupil), ciliary body (the ring-shaped muscle that changes the size of the pupil and the shape of the lens when the eye focuses), and choroid (the pigmented layer under the retina). Choroidal melanoma is the most common type of ocular melanoma.^{31,183} Melanoma also may occur in the eyelid, the conjunctiva (the filmy white covering of the eye), and the optic nerve. Most people with ocular melanoma experience no symptoms until the tumor has become large enough to interfere with vision.^{31,183} Untreated, however, ocular melanoma may spread through the bloodstream to other organs. Melanomas of the iris often respond better to treatment than those of the ciliary body.^{31,183}

Procedures:

- **Cryoablation** – a procedure in which tissue is frozen to destroy abnormal cells. Liquid nitrogen or liquid carbon dioxide is used to freeze the tissue.
- **Dermabrasion** – removal of the top layer of skin using a rotating wheel or small particles to rub away.
- **Electrodessication and curettage** – the tumor is cut from the skin with a curette (a sharp, spoon-shaped tool). A needle-shaped electrode is then used to treat the area with an electric current that stops the bleeding and destroys cancer cells that remain around the edge of the wound. The process may be repeated one to three times during the surgery to remove all the cancer.
- **Laser surgery** – a surgical procedure that uses a laser beam (a narrow beam of intense light) as a knife to make bloodless cuts in tissue or to remove a surface lesion such as a tumor.
- **Mohs Micrographic surgery** – a surgical procedure in which individual layers of tissues are removed and examined one at a time under a microscope to look for signs of cancer. This is done until all cancerous tissue is removed.
- **Punch biopsy** – a special instrument called a punch is used to remove a circle of tissue from the abnormal-looking growth.

- **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.
- **Shave biopsy** – a sterile razor blade is used to “shave-off” the abnormal-looking growth.
- **Surgical excision** – surgical removal of the primary or secondary tumor; with or without a margin of normal tissue.
- **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. For tumors of the head, neck, abdomen, and trunk, as little normal tissue as possible is removed. Most people will be able to have the surgical wound drawn together with stitches. When large cancers are removed, the wound may be too big to close with stitches. The surgeon may cover it using some skin from another part of the body.

Simple excision, Mohs micrographic surgery, curettage and electrodessication, and cryosurgery are used to treat basal cell carcinoma and squamous cell carcinoma of the skin. Laser surgery is rarely used to treat basal cell carcinoma. Simple excision, shave excision, curettage and desiccation, dermabrasion, and laser surgery are used to treat actinic keratosis.

Types of treatment used:

- External beam radiation
- Chemotherapy
- Topical chemotherapy
- Chemical peel
- Immunotherapy
- Photodynamic therapy
- Cryosurgery
- Targeted therapy
- Vaccine therapy (melanoma)
- Immune checkpoint inhibitors (melanoma)



CHAPTER FIVE

CHILDHOOD CANCER

OBJECTIVE: to understand the different types of childhood cancer and their treatments/side-effects and to create a safe exercise environment that provides a sense of “normalcy” for the patient.

- What is a central line and what precautions are necessary?
- What restrictions are there for team sports?
- What are the psychological and physiological aspects of recovery?
- What are the long-term side-effects of chemotherapy and radiation and how will it affect the patient throughout their lifetime?

GOAL: to create a safe exercise environment that helps a child to feel “normal” as well as to help prevent/minimize some of the long-term side-effects of treatment.

The term “childhood cancer” is most used to designate cancer that arises in children from 0-14 years however, the definition of childhood cancer sometimes includes adolescents between 15–19 years old. Childhood cancers are rare, representing between 0.5% and 4.6%* of all cancers. The overall incidence rates of childhood cancer vary between 50 and 200 per million children across the world.^{31,183}

According to the World Health Organization, cancer is a leading cause of death for children with 300,000 new cases and 80,000 deaths each year among children aged 0-19 years.^{31,183} Children with cancer in low- and middle-income countries are four times more likely to die of the disease than children in high-income countries.^{17,31,183} This is because their illnesses are not diagnosed, they are often forced to abandon treatment due to high costs, and the health professionals entrusted with their care lack specialized training.^{17,31,183}

The types of cancer differ between children and adults. According to the American Childhood Cancer Organization, nearly half of childhood cancers worldwide are cancers of the blood (leukemia and lymphoma), but leukemia, the most common form of childhood cancer, is rarely diagnosed in sub-Saharan Africa.^{17,183} There is a surprising correlation between some forms of childhood cancers and infectious diseases.^{17,183} Burkitt lymphoma is one of the rarest forms of childhood cancer but occurs with the highest frequency in equatorial Africa where exposure to Epstein-Barr virus and malaria are also prevalent.^{17,183} Kaposi sarcoma, another rare form of cancer, has a higher rate of diagnosis in countries with a high prevalence of HIV infection.¹⁷⁹

The predominant types of pediatric cancers (ages 0-19) are leukemia (26%), cancers of the brain and central nervous system (18%), and lymphoma (14%).^{17,183} The cancers that arise from embryonic cells and arise in developing tissues, are rarely seen in adults.^{17,183} These include neuroblastoma, Wilms tumor, medulloblastomas (brain), rhabdomyosarcomas (muscles), and retinoblastoma (eyes).^{17,183} While studies are constantly underway to investigate possible causes of childhood cancer, only a relatively small proportion have known of preventable causes.^{17,183} Parents should make sure that their children have regular check-ups with their pediatrician and pay attention to any unusual symptoms (unexplained paleness, lack of energy, bruising, persistent localized pain, limping, prolonged fever or illness, frequent headaches, vomiting, sudden vision changes, and rapid weight loss.)

The Centers for Disease Control and Prevention (CDC) recommends that the HPV vaccine (Gardasil 9) be given to girls and boys between ages 11 and 12; it can be given as early as age 9.³⁶ It's ideal to receive the vaccine having sexual contact and being exposed to HPV.³⁶ Cervical, vulvar, vaginal, penile, anal, mouth, and throat cancer are all linked to HPV.³⁶

Do you remember when you were a child, playing hide-and-go-seek, tag, dodge ball, jump rope, riding a bike, playing catch, roller skating, ice skating, school recess, and structured sports? They were a normal part of our everyday lives; perhaps something we took for granted. Although we may not have been aware of, or even cared at the time, sport and exercise are important because:

1. They can maintain and/or increase our level of fitness
2. They help us maintain a healthy weight
3. They improve our self-confidence and sense of well-being
4. When we play team sports, we have a sense of “belonging”

There is no shortage of benefits to making exercise a part of your everyday life. Exercise can decrease depression and lethargy by producing hormones called endorphins that are produced naturally in our bodies. These contribute to our overall feeling of well-being. When a child is diagnosed with cancer, their entire life is turned upside down and unlike adults, they don't have the coping skills to deal with their emotions. When a child spends long periods of time in the hospital, they lose out on “being a kid.” They don't have a normal routine; they are not in a traditional school environment with classes, lunch, and recess as well as after school activities, they may not get to be around their friends because their immune system is compromised, they can't go to a movie, a circus, or participate in team sports. Exercise may also help to improve patterns of sleep, decrease pain, and increase appetite.

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. 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
- Irritability
- Thrombocytopenia (low platelet counts)
- Bleed and bruise easily
- Neutropenia (low white blood cell counts)
- Immunocompromization
- 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.¹⁷ 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.¹⁷ 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 a high risk for infection and contact of any kind with other children should be avoided. If a child has been treated for a brain tumor, swimming may be okay, but no diving or jumping for several weeks after surgery and with permission from their doctor or neurosurgeon (when they feel the wound is fully healed).

It is critical that the doctor's advice be adhered to as to when the child may begin or resume physical activities. The ultimate goal at the end of treatment will be to return to normal activities and their previous fitness level.¹⁷ In some cases where there are more long-term disabilities, adaptations will need to be made. Even when a child is unable to participate in team activities, their friends and teammates can be encouraged to provide updates on team progress. Being able to be at the game and watch the sport, even from the side-lines, may help the child to still feel involved and a "part of the team." The exception would be if blood counts are low and they are susceptible to infection.

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 reluctant to let them participate in P.E. or other sports activities.²⁰¹

A central line is a device that assists in the process of administering chemotherapy and other medications and fluids, and blood sampling. A tube is surgically placed into a blood vessel. This device avoids the need for separate needle insertions for each infusion or blood test. Examples of these devices include Hickman or Broviac catheters, PICC lines and ports. Hickman or Broviac catheters are placed in the upper chest, and there is an external portion that protrudes from the skin. PICC lines are placed in the arm and have an external portion. Ports are placed in the chest but are implanted below the skin, so that nothing shows externally. When a Broviac, Hickman or PICC line are accessed, a syringe is attached to the external portion in a painless procedure. When a port is accessed, the needle is inserted through the skin causing a moment of discomfort, minimized with the use of a special cream (EMLA) applied to the skin. If a child is an avid swimmer, the medical team should be consulted as to whether a 'port' rather than a '**line**' may be possible so that the child may continue swimming.²⁰¹ There may still be times that the child will be advised not to swim; when blood counts are low and they run the risk of infection, or if they are generally not well.²⁰¹ It goes without saying, that contact sports that involve the possibility of being bumped into, pushed, or knocked to the ground, are far too risky if the child has a central line.²⁰¹

Other games and activities may take place with limited or no restrictions.²⁰¹ Advice on how to participate safely will need to be given on an individual basis. It will always be of the utmost importance that the line is secured prior to any games or activities.²⁰¹ The doctor or nurse may suggest a tighter t-shirt or an extra **Tubi-grip stocking (an elastic tubular support bandage)** to give the child extra support as well as confidence to participate.²⁰¹

Not all children will be interested in playing a sport. Some may not be interested in being physically active at all. This may be because they have low energy from their treatment, are weak from poor appetite, are not getting the proper amount, or quality of sleep, are in pain, or any combination. Perhaps they weren't interested in sports prior to their diagnosis of cancer. Exercise may be a critical part of their rehabilitation.



Exercise of any kind may help improve their overall health as well as their sense of well-being, self-confidence, and level of energy.

There is a risk, however, that the child may have a negative experience. If he or she is not able to fully participate, or if their condition is not understood by other teammates, being accepted, and welcomed on the team may take some added time. During this period the child may be able to be a referee, scorer, judge, or commentator. These are all good alternatives that will help to re-introduce the child to the sporting environment until they are able.

GOAL SETTING

Helping the child set realistic and achievable goals is critical.²⁰¹ These goals may be quite different than those they had prior to their diagnosis.²⁰¹ For example:

- Where they once may have dreamed about climbing the highest mountain or swimming the English Channel, maybe they will set out to do a hike in a local park or swim laps (when permissible) in a local pool
- In some cases, their goal may simply be to walk unassisted
- It is good to have an “ultimate” goal, but it should be broken down into easier to achieve, short-term goals
- Each individual goal will need to be assessed and evaluated; they may change due to cancer treatment or other cancer-related issues, or simply from other unexpected changes along the way
- It will not be uncommon to take two steps forward and one step back. The child should not see this as a failure. Help them to understand that this happens; keep them focused on how much progress they have made and help them not to lose sight of their ultimate goals.
- While parents will have an incredible sense of pride in seeing their child's achievements, no matter how big or small, the child may be more critical on themselves. Praise them for the great job they have done and keep them encouraged for the positive changes that the future holds for them.

Sports and play will be a large part of the psychological as well as physiological recovery of a pediatric cancer patient.²⁰¹ There are many concerns, however, that will need to be addressed long before sports even become a consideration. A common problem experienced by most children diagnosed with cancer is muscle wasting or overall weakness and achy muscles.²⁰¹ This may be the result of:

- Long periods of bed rest
- Inactivity
- The effect of steroids and other chemotherapy drugs
- Can also be related to the particular type of tumor

FOLLOWING TREATMENT

Currently statistics show that 1 in every 700 adults (younger than 45) is a survivor of childhood cancer^{17,31,183}. Most of these adults will have a complication from their previous cancer therapy^{17,31,183}. Although most childhood cancer survivors will not develop heart problems, certain types of cancer treatment given during childhood may result in damage to the heart^{17,31,183}. It is not uncommon for issues to occur many years after treatment has finished, therefore, it is important for childhood cancer survivors to be aware of any treatments that have previously undergone^{17,31,183}. Their physician should perform annual tests to monitor their heart function and make any necessary recommendations^{17,31,183}.

There are certain types of chemotherapy that tend to have more **long-term effects** on the heart. Anthracyclines are commonly used to treat childhood cancers and can result in damage to the heart. Common anthracyclines to be familiar with are:

- Adriamycin® (Doxorubicin)
- Daunomycin®, Cerubidine® (Danorubicin)
- Idamycin® (Idarubicin)
- Novantrone® (Mitoxantrone)
- Epirubicin

The following problems may be associated with chemotherapy during childhood^{17,112,143}:

- **Dental abnormalities** – patients should have a yearly exam and cleaning twice a year.
 - Tooth/ root agenesis
 - Root thinning/shortening
 - Enamel dysplasia
 - Microdontia
 - Ectopic molar eruption
- **Testicular/hormonal dysfunction** – patients should have testosterone and growth monitored yearly. Bone density needs to be monitored in androgen deficient patients. May require hormonal replacement therapy.
 - Testosterone deficiency
 - Delayed/arrested puberty

- **Impaired spermatogenesis** – patients should be evaluated for the need for contraception and reproduction/urology referral for mature patients.
 - Reduced fertility
 - Infertility
- **Ovarian hormone deficiencies** – patients should have hormone levels and growth monitored yearly and be evaluated for adverse impact of ovarian hormone deficiencies on growth, bone mineralization, cardiovascular disease, and sexual dysfunction. Bone density evaluation should be conducted at regular intervals.
 - Delayed/arrested puberty
 - Premature menopause
- **Reduced ovarian follicular pool** – patients should be counseled on potential for shorter period of fertility and referred to a reproductive endocrinologist to discuss fertility interventions and preservation.
 - Infertility
- **Acute myeloid leukemia/Myelodysplasia** – up to ten years after treatment, patient should be evaluated for bleeding, easy bruising, and fatigue through an annual dermatologic exam.^{17,112,143} Patients should be advised to seek prompt medical attention for fatigue, pallor, petechiae, or bone pain. CBC and bone marrow exam performed as clinically indicated.
- **Pulmonary fibrosis/toxicity** – patients should have a yearly pulmonary exam and be evaluated for cough, wheezing, shortness of breath, and dyspnea on exertion.^{17,112,143} Patients should receive counseling about tobacco avoidance and smoking cessation. Patients should have pulmonary function test and vaccines for influenza and pneumococcus prior to anesthesia and scuba diving.
 - Pulmonary fibrosis
 - Interstitial pneumonitis
 - Restrictive lung disease
 - Obstructive lung disease
 - Cataracts – patients should have an annual eye exam.
 - Hemorrhagic cystitis
 - Vesicoureteral reflux (VUR)
 - Bladder fibrosis
 - Dysfunctional voiding
 - Hydronephrosis
 - Urinary tract toxicity – patients should be checked yearly for normal urinary stream, hematuria, urinary urgency/frequency, dysuria, and nocturia.

- **Bladder malignancy** – patients should be evaluated yearly for an abnormal urine stream and seek prompt medical attention for dysuria or gross hematuria.^{17,112,143} Patients with microscopic hematuria should have an ultrasound of their kidneys and bladder. Urology and/or nephrology referral when necessary.
- **Renal toxicity/insufficiency** – patients should have their blood pressure evaluated yearly and discuss cardiovascular and kidney health risk factors. Electrolyte supplements should be given to patients with electrolyte wasting and nephrology consultation to those with hypertension or progressive renal
 - Glomerular injury
 - Renal insufficiency
 - Hypertension
 - Tubular injury (renal tubular acidosis, Fanconi syndrome, and hypophosphatemic rickets).
- **Ototoxicity** – patient should be evaluated for hearing difficulties yearly and have an otoscopic examination.^{17,112,143} A complete audiological exam should be done yearly for patients 5 and under, every two years for 6-12, and every five years beginning at age 15.^{17,112,143} Speech and language therapy should be provided for patients with hearing loss. Specialized evaluation for specific needs in school.
 - Sensorineural hearing loss
 - Tinnitus
 - Vertigo
- **Peripheral neuropathy** – patients should be evaluated yearly for paresthesias and dysesthesias until 2-3 years post-therapy.^{17,112,143} PT referral is needed for patients with symptomatic neuropathy. Treat with effective agent for neuropathic pain.



- **Neurocognitive defects** – patients should have a thorough yearly neuropsychological evaluation.^{17,112,143} Referral should be made to school liaison when necessary. Psychotropic medication or evidence-based rehabilitation training, or referral to community service for vocational rehabilitation for those who are developmentally disabled.
 - Planning and organization
 - Sustained attention
 - Memory/sequencing
 - Processing speed
 - Visual-motor-integration
 - Fine motor dexterity
 - Learning deficits in math and reading comprehension
 - Diminished IQ
 - Behavioral change
- **Hepatic dysfunction** – patients should be evaluated yearly for jaundice, scleral icterus, ascites, hepatomegaly, and splenomegaly.^{17,112,143} Screening should be done for viral hepatitis in patients with persistently abnormal liver function and immunization of hepatitis A and B in patients with immunocompromization.
 - Sinusoidal obstruction syndrome (veno-occlusive disease)
- **Reduced bone-mineral density** – ensure adequate daily intake of vitamin D and calcium; use caution with calcium in patients with a history of renal lithiasis.^{17,112,143} Patients should participate in regular weight-bearing exercise. Patients with history of osteoporosis or multiple fractures should have an endocrine consultation.^{17,112,143}
- **Osteoporosis**
- **Clinical Leukoencephalopathy** – patients should be evaluated for seizures, motor and sensory deficits and other neurologic symptoms yearly.^{17,112,143} A brain CT and brain MRI should be conducted with angiography as clinically indicated.
 - Spasticity
 - Ataxia
 - Dysarthria
 - Dysphagia
 - Hemiparesis
 - Seizures

- **Cardiac toxicity** – patients should be evaluated yearly for shortness of breath, dyspnea on exertion, orthopnea, chest pain, and palpitations; if under 25, nausea and vomiting as well.^{17,112,143} Patients should be instructed how to maintain a healthy weight, blood pressure, and heart-healthy diet. Regular exercise should be prescribed for patients who have normal LV systolic function.^{17,112,143} High-risk survivors should consult with a cardiologist and have an echocardiogram every two years if they want to participate in intensive exercise.^{17,112,143}
 - Cardiomyopathy
 - Subclinical left ventricular dysfunction
 - Congestive heart failure
 - Arrhythmia
- **Osteonecrosis** – patients should be evaluated yearly through a musculoskeletal exam, for joint pain, swelling, immobility, and limited range of motion (ROM)^{17,112,143}. Patients should consult an orthopedic doctor if they show positive signs of osteonecrosis in imaging. Patients may consult with PT for evaluation of strength, ROM, pain management, strengthening, stretching, and functional mobility.
- **Vasospastic attacks (Raynaud's phenomenon)** – patients should have a yearly exam of their hands and feet, nose, lips, cheeks, or earlobes related to stress or cold temperatures.^{17,112,143} They should be instructed to wear appropriate clothing in cold conditions and be educated about the vasoconstricting effects of cocaine, nicotine, and pseudoephedrine.^{17,112,143}

The following problems may be associated with radiation therapy - ALL FIELDS - during childhood:

- **Secondary benign or malignant neoplasm (skin cancer, dysplastic nevi, bone malignancies, or oral cancer)** – patients should be evaluated yearly for skin lesions, changing moles, bone pain, or persistent thickening or lump in soft tissue or bone^{17,112,143}
- **Dermatologic toxicity** – patients should be evaluated yearly for skin changes^{17,112,143}
 - Permanent alopecia
 - Altered skin pigmentation
 - Telangiectasia
 - Fibrosis

- **Brain tumor (benign or malignant)** – patients should have a neurological consultation yearly for headaches, vomiting, cognitive, motor or sensory deficits, seizures, and other neurological symptoms.^{17,112,143} Symptomatic patients should have a brain MRI as clinically indicated; patients with neurofibromatosis - every other year beginning two years after radiation is completed.^{17,112,143}
- **Neurocognitive defects** – patients should have a thorough yearly neuropsychological evaluation.^{17,112,143} Referral should be made to school liaison when necessary. Psychotropic medication or evidence-based rehabilitation training, or referral to community service for vocational rehabilitation for those who are developmentally disabled.
 - Planning and organization
 - Sustained attention
 - Memory/sequencing
 - Processing speed
 - Visual-motor-integration
 - Fine motor dexterity
 - Learning deficits in math and reading comprehension
 - Diminished IQ
 - Behavioral change
- **Clinical Leukoencephalopathy** – patients should be evaluated for seizures, motor and sensory deficits and other neurologic symptoms yearly^{17,112,143}. A brain CT and brain MRI should be conducted with angiography as clinically indicated.
 - Spasticity
 - Ataxia
 - Dysarthria
 - Dysphagia
 - Hemiparesis
 - Seizures
- **Cerebrovascular complications** – patients should be evaluated yearly in neurological exam and counseled on the importance of controlling conditions known to increase cardiovascular and stroke risk^{17,112,143}
 - Stroke
 - Moyamoya disease
 - Occlusive cerebral vasculopathy
 - Cavernomas

- **Craniofacial abnormalities** – patient should be evaluated yearly for depression, anxiety, PTSD, social withdrawal, and physical changes and consult with a craniofacial reconstruction specialist^{17,112,143}
- **Chronic sinusitis** – patients should be evaluated yearly for rhinorrhea, post-nasal discharge and have a CT scan and otolaryngology consultation as clinically indicated^{17,112,143}
- **Obesity/overweight** – patients should be evaluated yearly for height, weight, and BMI, referred to dietician, and counseled on risk factors for cardiovascular disease and comorbidities^{17,112,143}
- **Growth hormone deficiency** – patients should be evaluated every 6 months for nutritional status until growth is completed, then yearly.^{17,112,143} Every six months until they are sexually mature, they should be evaluated for height, weight, and BMI, and then yearly.^{17,112,143} Skeletally immature children should be referred to an endocrinologist.
- **Central hypothyroidism** – patients should be evaluated yearly (more often in periods of rapid growth) by endocrinologist for fatigue, weight gain, cold intolerance, dry skin, constipation, brittle hair and nails, and depression^{17,112,143}
- **Hyperthyroidism** – patients should be evaluated by endocrinologist yearly for heat intolerance, tachycardia, palpitations, weight loss, muscular weakness, and hyperphagia^{17,112,143}
- **Central adrenal insufficiency** – patients should be evaluated yearly for failure to thrive, anorexia, dehydration, hypoglycemia, lethargy, and unexplained hypotension.^{17,112,143} Patients should seek counseling on the need for corticosteroid replacement therapy and stress dosing and referred to endocrinologist.^{17,112,143}
- **Cataracts** – patients should have an annual eye exam^{17,112,143}
- **Ocular toxicity** – patients should be evaluated yearly for visual changes, dry eye, persistent eye irritation, excessive tearing, light sensitivity, poor night vision, and painful eye^{17,112,143}
 - Orbital
 - Lacrimal duct atrophy
 - Xerophthalmia
 - Keratitis
 - Telangiectasia
 - Retinopathy
 - Optic chiasm neuropathy
 - Enophthalmos
 - Chronic painful eye
 - Maculopathy
 - Papillopathy
 - Glaucoma
- **Ototoxicity** – patient should be evaluated for hearing difficulties yearly and have an otoscopic examination.^{17,112,143} A complete audiological exam should be done yearly for patients 5 and under, every two years for 6-12, and every five years beginning at age 15.^{17,112,143} Speech and language therapy should be provided for patients with hearing loss. Specialized evaluation for specific needs in school.
 - Sensorineural hearing loss
 - Tinnitus
 - Vertigo
- **Xerostomia** – patients should have a yearly exam and cleaning twice a year^{17,112,143}
- **Dental abnormalities** – patients should have a yearly exam and cleaning twice a year^{17,112,143}
 - Tooth/ root agenesis
 - Root thinning/shortening
 - Enamel dysplasia
 - Microdontia
 - Ectopic molar eruption

- **Osteoradionecrosis of the jaw** – patients should have a yearly exam to check for persistent jaw pain, impaired wound healing, trismus, or swelling^{17,112,143}
- **Thyroid cancer** – patients should have a yearly exam with endocrinologist to check for thyroid problems^{17,112,143}
- **Carotid artery disease** – patients should have a yearly neurological exam to evaluate memory impairment and check blood pressure and diminished carotid pulses.^{17,112,143} Patient should be educated to optimize cardiovascular risk factors including blood pressure, lipid profile, and blood glucose.^{17,112,143} They should be referred to cardiologist when necessary.
- **Subclavian artery disease** – patients should have a yearly exam to check for blood pressure in both arms, diminished brachial and radial pulses, pallor of upper extremities, and coolness of the skin.^{17,112,143} Patients should be educated to optimize cardiovascular risk factors including blood pressure, lipid profile, and blood glucose.^{17,112,143} They should be referred to cardiologist when necessary.
- **Breast cancer** – patients should have a yearly breast exam beginning at puberty through age 25 and then every six months thereafter.^{17,112,143} A mammogram and breast MRI should be conducted yearly starting eight years post-radiation, or at age 25; whichever occurs first.^{17,112,143}
- **Pulmonary fibrosis/toxicity** – patients should have a yearly pulmonary exam and be evaluated for cough, wheezing, shortness of breath, and dyspnea on exertion and receive counseling about tobacco avoidance and smoking cessation.^{17,112,143} Patients should have pulmonary function test and vaccines for influenza and pneumococcus prior to anesthesia.
 - Pulmonary fibrosis
 - Interstitial pneumonitis
 - Restrictive lung disease
 - Obstructive lung disease
- **Lung cancer** - patients should have a yearly pulmonary exam to check for cough, wheezing, shortness of breath, dyspnea upon exertion^{17,112,143}
- **Cardiac toxicity** – patients should be evaluated yearly for shortness of breath, dyspnea on exertion, orthopnea, chest pain, and palpitations; if under 25, nausea and vomiting as well.^{17,112,143} Patients should be instructed how to maintain a healthy weight, blood pressure, and heart-healthy diet.^{17,112,143} Regular exercise should be prescribed for patients who have normal LV systolic function.^{17,112,143} High-risk survivors should consult with a cardiologist and have an echocardiogram every two years if they want to participate in intensive exercise.^{17,143}
 - Cardiomyopathy
 - Subclinical left ventricular dysfunction
 - Congestive heart failure
 - Arrhythmia
- **Functional asplenia** – if patient has a fever greater than 101°, they need to be evaluated for degree of illness and source of infection.^{17,112,143} They should be counseled on the risk of life-threatening infections, risk associated with malaria and tick-borne diseases, and obtain a medical alert bracelet.^{17,112,143} They will need to discuss the need for antibiotics prior to dental procedures with their dentist.^{17,112,143}
- **Esophageal stricture** – patients should be evaluated yearly for heartburn and dysphagia with a surgical or gastroenterology consultation for symptomatic patients^{17,112,143}
- **Impaired glucose metabolism/diabetes** – patients should have their fasting blood glucose evaluated every two years and be referred to an endocrinologist to discuss comorbidities; dyslipidemia, hypertension, and obesity.^{17,112,143} Refer to dietician for weight management.^{17,112,143}
- **Hepatic toxicity** – patients should be evaluated yearly for scleral icterus, jaundice ascites, hepatomegaly, and splenomegaly.^{17,112,143} They should have a platelet count for evaluation of hypersplenism and prothrombin and evaluate hepatic synthetic function in patients with abnormal liver screening tests.^{17,112,143} Patients with persistently abnormal liver function should see a gastroenterologist and be screened for viral hepatitis.^{17,112,143} In patients lacking immunity, they should receive vaccines for hepatitis A and B.^{17,112}
 - Hepatic fibrosis
 - Cirrhosis
 - Focal nodular hyperplasia

- **Bowel obstruction** – patients should be evaluated yearly for abdominal pain, distention, vomiting, constipation, and tenderness
 - **Colorectal cancer** – patients should receive regular screening beginning five years after radiation treatment ends or at age 30, whichever comes first.^{17,112,143} Consult with a gastroenterologist or surgeon as clinically indicated.^{17,112,143}
 - **Renal toxicity/insufficiency** – patients should have their blood pressure evaluated yearly and discuss cardiovascular and kidney health risk factors.^{17,112,143} Electrolyte supplements should be given to patients with electrolyte wasting and nephrology consultation to those with hypertension or progressive renal insufficiency.^{17,112,143}
 - Glomerular injury
 - Renal insufficiency
 - Hypertension
 - Tubular injury (renal tubular acidosis, Fanconi syndrome, and hypophosphatemic rickets)
 - **Urinary tract toxicity** – patients should be checked annually for normal urinary stream, hematuria, urinary urgency/frequency, dysuria, and nocturia^{17,112}
 - Hemorrhagic cystitis
 - Vesicoureteral reflux (VUR)
 - Bladder fibrosis
 - Dysfunctional voiding
 - Hydronephrosis
 - **Bladder cancer** – patients should be checked yearly for normal urinary stream, hematuria, urinary urgency/frequency, dysuria, and nocturia. For patients with a positive history, they should have a urinary analysis and culture, spot urine calcium/creatinine ratio and should see a urologist or nephrologist as clinically indicated.^{17,112,143}
 - **Testicular/hormonal dysfunction** – patients should have testosterone and growth monitored yearly. One density needs to be monitored in androgen deficient patients. May require hormonal replacement therapy.^{17,112,143}
 - Testosterone deficiency
 - Delayed/arrested puberty
 - **Impaired spermatogenesis** – patients should be evaluated for the need for contraception and reproduction/urology referral^{17,112,143}
 - Reduced fertility
 - Infertility
 - **Ovarian hormone deficiencies** – patients should have hormone levels and growth monitored yearly and be evaluated for adverse impact of ovarian hormone deficiencies on growth, bone mineralization, cardiovascular disease, and sexual dysfunction.^{17,112,143} Bone density evaluation should be conducted at regular intervals.^{17,112,143}
 - Delayed/arrested puberty
 - Premature menopause
 - **Musculoskeletal growth problems** – patients should be evaluated yearly for height, weight, and limb-length and have an orthopedic consultation for any deficit noticed in a growing child.^{17,112,143}
 - Hypoplasia
 - Fibrosis
 - Reduced or uneven growth
 - Shortened trunk height
 - Limb-length discrepancy
 - **Scoliosis/kyphosis** – patients should have their back and spine evaluated yearly until their growth is completed; may need more frequent assessment during puberty.^{17,112,143} Patients should see orthopedic specialist as needed based on physical and/or radiologic examination.^{17,112,143}
- The following problems may be associated with *stem cell transplant* during childhood:
- **Acute myeloid leukemia/Myelodysplasia** – up to ten years after treatment, patients should be evaluated for bleeding, easy bruising, and fatigue through an annual dermatologic exam.^{17,112,143} Patients should be advised to seek prompt medical attention for fatigue, pallor, petechiae, or bone pain; CBC and bone marrow exam performed as clinically indicated.^{17,112,143}
 - **Solid tumors** – patients should perform a monthly self-examination and see a dermatologist/oncologist yearly for a dermatologic and abdominal exam^{17,112,143}
 - Basal cell carcinoma
 - Liver cancer
 - Melanoma

- **Hepatic toxicity** – patients should be evaluated yearly for scleral icterus, jaundice, ascites, hepatomegaly, and splenomegaly.^{17,112,143} They should have a platelet count for evaluation of hypersplenism and prothrombin and evaluate hepatic synthetic function in patients with abnormal liver screening tests.^{17,112,143} Patients with persistently abnormal liver function should see a gastroenterologist and be screened for viral hepatitis. In patients lacking immunity, they should receive vaccines for hepatitis A and B.^{17,112,143} PCR testing for hepatitis C in patients who are immunosuppressed.^{17,112,143} A liver biopsy should be done on patients with excessive liver-iron content.^{17,112,143}
 - Chronic hepatitis
 - Cirrhosis
 - Focal nodular hyperplasia
 - Iron overload
 - Cholelithiasis
- **Reduced bone-mineral density** – ensure adequate daily intake of vitamin D and calcium; use caution with calcium in patients with a history of renal lithiasis.^{17,112,143} Patients should participate in regular weight-bearing exercise.^{17,112,143} Patients with history of osteoporosis or multiple fractures should have an endocrine consultation.^{17,112,143}
 - Osteoporosis
- **Renal toxicity/insufficiency** – patients should have their blood pressure evaluated yearly and discuss cardiovascular and kidney health risk factors.^{17,112,143} Electrolyte supplements should be given to patients with electrolyte wasting and nephrology consultation to those with hypertension or progressive renal insufficiency.^{17,112,143}
 - Glomerular injury
 - Renal insufficiency
 - Hypertension
 - Tubular injury (renal tubular acidosis, Fanconi syndrome, and hypophosphatemic rickets).
- **Dermatologic toxicity** – patients should perform a monthly self-exam and be evaluated yearly for skin, hair, and nail changes.^{17,112,143}
 - Permanent alopecia
 - Nail dystrophy
 - Altered skin pigmentation
 - Telangiectasia
 - Fibrosis
 - Vitiligo
 - Sclerodermatous changes
 - Squamous cell carcinoma of the skin
 - Melanoma
- **Oral toxicity** – patients should have a yearly exam and cleaning twice a year.^{17,112,143} Patients should be counseled on safe sex practices to reduce HPV transmission and get HPV vaccination.^{17,112,143}
 - Xerostomia
 - Salivary gland dysfunction
 - Periodontal disease
 - Oral squamous cell carcinoma
- **Pulmonary fibrosis/toxicity** – patients should have a yearly pulmonary exam and be evaluated for cough, wheezing, shortness of breath, and dyspnea on exertion.^{17,112,143} Patients should receive counseling about tobacco avoidance and smoking cessation and have pulmonary function test and vaccines for influenza and pneumococcus prior to anesthesia and scuba diving.^{17,112,143}
 - Chronic bronchitis
 - Bronchiolitis obliterans
 - Bronchiectasis
- **Functional asplenia** – if patient has a fever greater than 101°, they need to be evaluated for degree of illness and source of infection.^{17,112,143} They should be counseled on the risk of life-threatening infections, risk associated with malaria and tick-borne diseases, and obtain a medical alert bracelet.^{17,112,143} They will need to discuss the need for antibiotics prior to dental procedures with their dentist.^{17,112,143}
- **Esophageal stricture** – patients should be evaluated yearly for heartburn and dysphagia with a surgical or gastroenterology consultation for symptomatic patients.^{17,112,143}

- **Amputation-related complications** – patients should be evaluated yearly for residual limb integrity, functional and activity limitations, and phantom pain^{17,112,143}. Prosthetic evaluation should be conducted every six months until skeletally mature; then every year^{17,112,143}. Occupational and physical therapy prescribed as needed and psychological work to deal with emotional difficulties.^{17,112,143}
 - Impaired cosmesis
 - Functional and activity limitations
 - Residual limb integrity problems
 - Pain
 - Increased energy expenditure
 - Impaired quality of life
 - Psychological maladjustment

Exercise is an important tool in minimizing the risk of developing or worsening problems associated with chemotherapy and radiation. Exercise can help to manage (or prevent) obesity, diabetes, high blood pressure, and high cholesterol – all of which may increase the risk of heart problems! In addition, adult survivors of childhood cancer should be strongly encouraged to eat a healthy, low-fat diet, avoid smoking, and engage in physical activity on a regular basis. Each of these factors adds insult to injury.

While it is certainly something to be concerned with, rest at ease in knowing that very few survivors of childhood cancer develop severe heart problems. The risk may be increased based on the following:

- The age of the patient at the time they received treatment
- Having other health conditions that may affect the heart
- Taking medications that may affect the heart
- The total dose of chemotherapy and radiation

When you begin to work with a survivor of childhood cancer, it will be critical to gather as much information as possible during the initial assessment and health history questionnaire. Most people tend to forget what treatments they have undergone (it's a combination of time that has passed as well as not wanting to revisit that time in their life). It is essential that they have a medical clearance signed by their current doctor. They should probably undergo an ECHO, EKG, or MUGA to look for any heart damage prior to beginning an exercise program.

Although they may come to you with a clean bill of health, and not present with any problems in the beginning, closely monitor for the following:^{17,112,143}

- Shortness of breath, dizziness, and lightheadedness (all of which can simply be exercise induced)
- Severe fatigue
- Chest pain that radiates to the arm, chin, or face
- Sweating, nausea, or shortness of breath that accompanies chest pain
- Sharp, stabbing pain in the middle or left side of the chest
- Edema of the feet and ankles
- Ongoing coughing and wheezing
- Irregular or racing heartbeats

EXERCISE RECOMMENDATIONS FOR SURVIVORS OF CHILDHOOD CANCER

Cardiovascular exercise is highly recommended and is relatively safe and beneficial for the heart^{17,112,143}. Make sure that your client starts and progresses slowly. Begin with five minutes and monitor for the above referenced signs and symptoms. Barring any issues, gradually increase the frequency, intensity, and duration of the cardiovascular exercise. **Avoid strenuous isometric exercises such as heavy weightlifting and wrestling.** Blood pressure increases when a person strains; forcing the heart to work harder. A safer approach will be to use lighter weight and high repetitions however, this still comes with its risks. Your client may not like this, in fact they may refuse to listen to you. All you can do is educate them on the safest possible protocol for their situation. Those clients that have been treated with anthracyclines, or those who have had radiation to the chest, **MUST** consult with their physician prior to beginning **ANY** exercise progra.^{17,112,143} If they want to participate in team sports, or other strenuous activities, they can discuss the appropriate guidelines and monitoring with their cardiologist.

Inform your client that drugs/medications such as cocaine, ephedra, diet pills, ma huang, and performance enhancing drugs can increase stress on the heart and lead to worsening heart function and even death in those survivors who received anthracycline chemotherapy. Increasing age increases the risk of heart attacks and hardening of the arteries. Other factors that may increase the risk are:

- Diabetes
- High blood pressure
- High cholesterol
- A high fat diet
- Being sedentary
- Being overweight
- Smoking

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.

Angiography – 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.

Antiarrhythmics – 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.

Bradycardia – 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 60-65% 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.

Corticotropin 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 brain's 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. Cytokines can also be made in the laboratory by recombinant DNA technology and used in the treatment of various diseases, including cancer.

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 skin, 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 spoon-shaped 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 "aesthesia," 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.

Electrodesiccation (electrosurgery) – destroys tissue by 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 of 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.

Glottis – 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.

Hepatomegaly – 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, coarse 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 produced, 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.

Keratitis – 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 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.

Lacrimal 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.

Laryngectomy – 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.

Neuroplasticity – 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 arise around 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 the 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.

Polymphocytes – 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 caused 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 is 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).

Soft 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 orthopaedic 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 (Elzonris™) – 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 thyroxine (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.

Thyroxine – 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.

Topoisomerase 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® (Temozolomide) – 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 spasmodic 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.

Xerophthalmia – 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.



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