Maple Tree
CANCER ALLIANCE

EXERCISE ONCOLOGY INSTRUCTOR

TRAINING & LICENSE MANUAL

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TITLE

Exercise Oncology Instructor: Training & License Manual

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CHAPTER 1

INTRODUCTION

1.1 MAPLE TREE OVERVIEW

Cancer is a significant international health problem. Over the last five years, there have been approximately 43.8 million new cancer diagnoses worldwide. Thanks to early detection and advances in treatment, we have experienced a 13% decline in cancer mortality rates since the year 2004. This increase in cancer survivorship is a positive step forward, and has led to the classification of cancer as a chronic disease. However, its associated treatments often result in long-term physical and psychological co-morbidities that negatively impact the cancer survivor's quality of life. This creates a challenge for health care providers to address the short and long-term effects of current cancer therapy and minimize toxicities. As such, treatments that target several symptoms at once are optimal in order to help patients thrive post-treatment. Exercise is a valid rehabilitative measure that can be introduced at any point along the cancer trajectory, and can successfully attenuate several symptoms that frequently cluster together. However, in spite of the data to support its benefits, less than 5% of cancer patients do not exercise during cancer treatment. This is due, in large part, to a lack of funding and accessibility of health and wellness programs for cancer survivors.

In an effort to increase awareness and activity, Maple Tree Cancer Alliance was founded. Maple Tree is a non-profit organization with the mission of improving the quality of lives of individuals who battle cancer. They accomplish this through supervised, individualized exercise training. Founded in 2011, Maple Tree has grown to more than 50 sites across the world, serving thousands of cancer patients each year. Their published research reveals that patients who exercise in their programs during treatment have reduced symptom severity, improved fitness parameters, and lower health care utilization than those who remain sedentary. In light of this data, Maple Tree is working to spearhead efforts to make exercise a part of the standard of care in cancer treatment.

Over the last five years, there have been approximately 43.8 million new cancer diagnoses worldwide.

1.2 PURPOSE OF THE EOI TRAINING CERTIFICATION

This Exercise Oncology Instructor (EOI) training program was developed in response to a growing demand for a workforce that is appropriately trained and certified to meet the specific needs of a cancer survivor through exercise. With more than 20 million cancer survivors living in the world today, and the 1.8 million new diagnoses added to this total each year, the need for qualified professionals is great. A certified EOI will have the skills and knowhow to safely and effectively implement exercise programs for individuals who battle cancer through whole body exercises that will enhance cardiorespiratory fitness, body composition, muscular strength and endurance, and flexibility. They will have a thorough understanding of cancer-related subject matter, including diagnosis and staging, etiology, treatment, toxicities, and remission. Maple Tree Cancer Alliance's certified EOI's are able to adapt exercise programming to maintain a safe, yet effective environment for the cancer patient, having the potential to improve health-related quality of life and treatment outcome. In addition, the EOI encourages exercise adherence to help improve health-related physical fitness and manage disease.

Maple Tree Cancer Alliance Program Description & Methodology

Maple Tree Cancer Alliance has created a unique phase system of exercise oncology that our patients progress through as they complete their treatment journey. Four basic phases are employed:

0

Phase 0: Prehabilitation
Includes patients at the time of their diagnosis prior to the start of treatment. In this phase, baseline measurements are taken and the patient is provided with wellness education to equip them for their cancer journey. If time allows, exercise programming is initiated.

1

Phase 1: Active Treatment
Includes patients who are currently in chemotherapy/radiation. The focus of this phase is to protect immune function and minimize treatment-related side effects.

2

Phase 2: Pre-Survivorship
Includes patients who have either completed chemotherapy/radiation, or only received surgery and/or hormonal therapy. The primary goal in this program is to bridge the gap between the need for rehabilitation services following surgery/active treatment and survivorship, where the patient is cancer free and able to exercise on their own in a community-based setting.

3

Phase 3: Survivorship
Consists of patients who have successfully completed treatment and are in remission from their cancer. This phase often takes place outside of the clinical setting in the community, with exercise trainers who have been trained and certified to work with a cancer survivor.

Patient Flow

When a patient is referred into Maple Tree, they first undergo a comprehensive fitness assessment, where we measure the following: cardiorespiratory fitness, muscular strength, muscular endurance, flexibility, body composition, health-related quality of life, and symptom severity. In addition, the EOI obtains a full medical and cancer history on the patient and physician clearance to exercise before the initiation of any exercise program. Based on the results of the initial assessment, an exercise prescription is developed. This intervention is individualized according to the patient's current health status and goals, and are in-line with ACSM's published guidelines on exercise for cancer patients. Exercise duration and intensity are systematically progressed, as the patient is able to tolerate. All sessions are completed one-on-one with a certified EOI. With the exception of Phase 0, all phases are designed to last approximately 12-weeks. At the completion of each phase (with the exception of Phase 0), the patient completes the comprehensive fitness assessment again, to measure for progress and to guide future exercise programming.

To date, Maple Tree cancer Alliance has served more than 11,000 cancer patients, worldwide. Our data shows that patients who participate in our programs, on average, experience a 15.2% improvement in cardiovascular endurance, a 18.2% increase in muscular endurance, a 32% increase in flexibility, and a 58.7% increase in quality of life. Further, patients report feeling significantly less pain and fatigue than those who do not exercise ($p<0.05$). Finally, patients who exercise at Maple Tree during cancer treatment see a 27% decrease in emergency room visits, a 19% decrease in the average length of hospital stay, and significantly fewer unplanned hospital encounters than their sedentary counterparts.

CHAPTER 2

PATHOPHYSIOLOGY OF CANCER

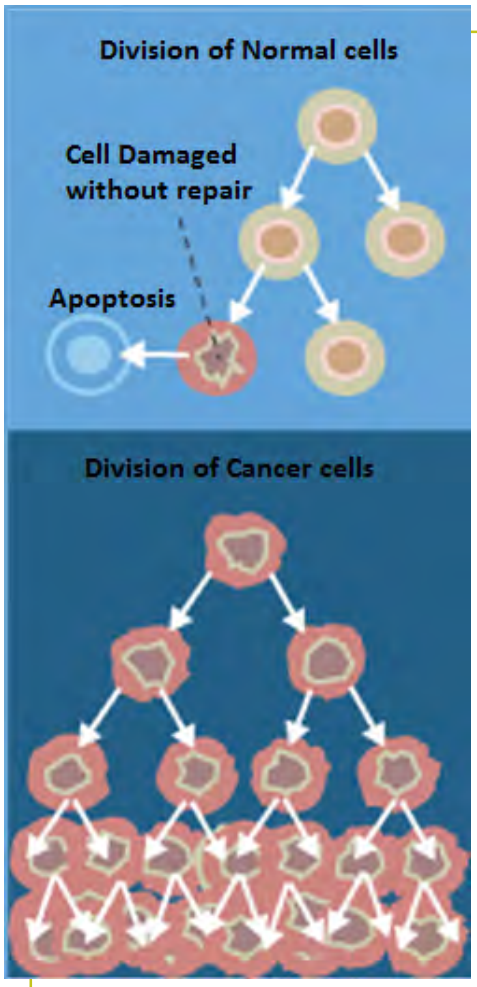
2.1 WHAT IS CANCER?

In normal tissues, the rate of new cell growth and old cell death are kept in delicate balance. Normal cells have different rates of growth and division. For example, once a nerve cell matures, it does not grow anymore and cell division stops. However, epithelial cells on the skin grow and divide rapidly, replacing epithelial cells that have been lost. Cancer, on the other hand, occurs when cells in the body lose their normal mechanisms of control, resulting in an uncontrolled division of cells in the body. These abnormal cells form a mass of tissue, called a tumor, and have the ability to form new blood vessels through a process called angiogenesis. This allows the tumor to become self-sufficient and spread throughout the body. The development and progression of cancer occurs when cell abnormalities accumulate via genetic abnormalities, or mutations, within the cell. These mutated genes, called oncogenes, have the potential to cause cancer through increased cell division and expression. Mutations can also inactivate genes that normally control cellular activity. These genes are called tumor suppressor genes.

Cancer is not a contagious disease and not all tumors are cancerous. Tumors can either be classified as benign or malignant. A benign tumor is considered non-cancerous, and does not have the ability to invade surrounding tissue. Benign tumors can grow anywhere in the body and are generally only considered to be serious if they press on vital structures such as blood vessels or nerves. One example of a benign tumor is a lipoma, which is a slow growing fatty tumor usually located between the skin and the muscle layer. Upon palpation, the lump will typically feel doughy and moves readily with slight finger pressure. Malignant tumors are indicative of a cancerous mass. This tumor has the ability to multiply uncontrollably, spread throughout the body, and invade the lymphatic system, blood stream, and other surrounding tissues.

CANCER DEFINED

Cancer occurs when cells in the body lose their normal mechanisms of control, resulting in an uncontrolled division of cells in the body. These abnormal cells form a mass of tissue, called a tumor, and have the ability to form new blood vessels through a process called angiogenesis. This allows the tumor to become self-sufficient and spread throughout the body.

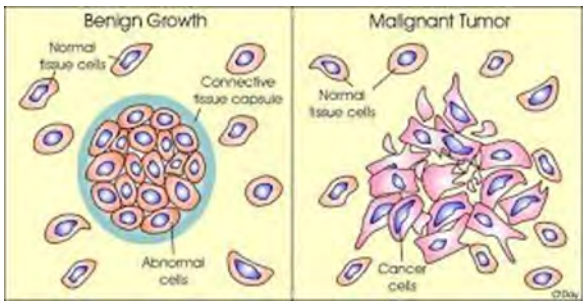


Most Common Types of Malignant Tumors

From a histological standpoint, there are thousands of different cancer types. Typically cancer is named for the organs or tissues they originate from. Cancer that originates in the breast is called breast cancer. Cancer that originates in the lung is called lung cancer. Tumors are classified according to the type of tissue in which the cancer cells begin to develop. There are five major tumor classifications: carcinoma, lymphoma, leukemia, myeloma, and sarcoma.

Classification	Description	Example
Carcinoma	Cancers that originate in the tissue that lines organs and tubes	Breast, prostate, lung, pancreas, colon cancers
Lymphoma	Cancer that originate in the lymphatic tissue	Hodgkin Lymphoma; non-Hodgkin lymphoma
Leukemia	Cancer that originates in the blood	Acute lymphocytic leukemia, chronic lymphocytic leukemia, acute myeloid leukemia, chronic myeloid leukemia
Myeloma	Cancer that originates in the bone marrow	Multiple myeloma
Sarcoma	Cancer that originates in the connective or supportive tissue	Bone, cartilage, fat, nerve

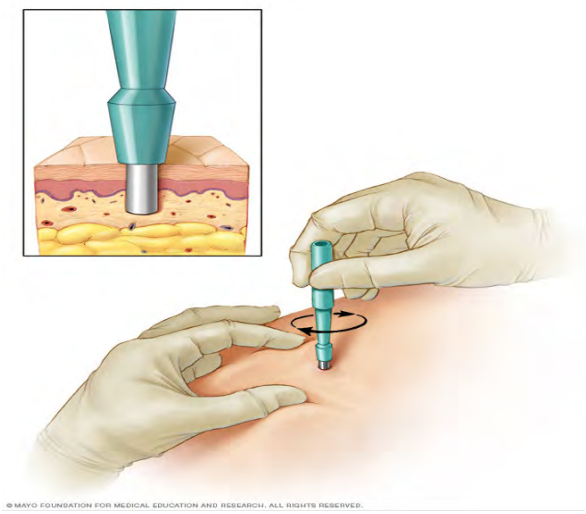
Early detection is the key to cancer survival. It is important to educate the public on the signs and symptoms of disease, so that treatment can begin as early as possible. For many types of cancer, mortality rates are much lower the earlier cancer is diagnosed. For example, melanoma has a 98% survival rate if found early, but only a 16% survival rate for later stages.



Specific signs and symptoms of cancer:

- Unexplained weight loss
- Fever
- Fatigue
- Pain
- Skin changes
- Change in bowel or bladder function
- Sores that do not heal
- Unusual bleeding or discharge
- Lump
- Change in mole
- Cough that does not go away

It is also important to note that some types of early cancer may not have symptoms. This is why regular screenings are so important. When preliminary symptoms or screenings indicate possible existence of cancer, the doctor will perform a biopsy, which is the surgical removal of small piece of tissue for microscopic examination. This procedure will indicate whether a tumor is present and if it is malignant or benign, based on the appearance of the cells. Cancer tissue has a distinct appearance under a microscope. Cancer cells grow and divide at an abnormally rapid rate, present large, variably shaped nuclei, have many diving cells, disorganized arrangement, and overall loss of normal features. More specifically, cancer cells may develop self-sufficiency and proliferate, insensitivity to antigrowth signals, programmed cell death (apoptosis), as well as tissue invasion and metastasis. These mutated cells can subvert cell checkpoints and continue to grow and divide indefinitely.



Characteristics of cancer cell appearances:

- Irregularly shaped
- Variation in nuclear size and shape
- Variation in cell size and shape
- Loss of specialized features
- Loss of normal tissue organization
- Poorly defined tumor boundary

After cancer has been diagnosed, the tumor is staged. The cancer staging system is a standardized way to describe the extent to which a cancer has spread. Staging is typically based on a compilation of a patient's physical examination, imaging, and measurements taken after surgical removal of a tumor. There are four primary stages of cancer ranging from stage 0 (noninvasive) to stage IV (advanced). Additionally, solid tumors are generally grouped according to the TNM classification system. T refers to the size of the tumor, N is a measure of the degree of lymph node involvement, and M describes the presence or absence of distant metastasis A basic summary of tumor staging is presented in the table below.

Stage	Description
Stage 0	Cancer limited to surface cells
Stage 1	Cancer limited to tissue of origin
Stage II	Limited local spread of cancerous cells
Stage III	Extensive local and regional spread
Stage IV	Distant metastasis

Cancer Treatment

The current armaments for treating cancer include surgery, chemotherapy, irradiation, and biological, hormonal and targeted therapies [6]. Treating cancer, for the most part, is based on an understanding of cellular kinetics and the growth of tumor cells [6]. Cancer cells involve DNA mutations that often occur during DNA replication. In the normal cell cycle, checkpoints facilitate DNA repair; however, tumor cells lose their checkpoint integrity and escape DNA repair [7]. The resulting mutations impact the regulatory mechanisms that restrict normal cell proliferation [7]. Chemotherapeutic agents, for example, interrupt the cell cycle to prevent cell proliferation[8] and typically are most effective when cells are actively dividing[7]. Chemotherapy can be delivered intravenously or prescribed orally. Treatment is individualized according to type and duration. Using a combination of agents rather than just one provides a synergistic cell kill with the potential that less drug-resistant cells remain. The negative of systemic chemotherapeutic agents is that normal cells, as well as malignant cells, are disrupted, leading to many side and untoward effects and often long-term morbidities[8]. Treatment-related morbidities impact functional ability and quality of life. Many co-morbidities are encountered by cancer survivors.

Chemotherapy side effects:

- Nausea
- Vomiting
- Alopecia
- Fatigue
- Constipation/diarrhea
- Bone marrow supression
- Cardiovascular dysfunction
- Muscle weakness
- Pain
- Mucositis
- Sleep disturbances
- Peripheral neuropathy[6, 8]

Surgery side effects:

- Pain
- Limited range of motion
- Fatigue
- Changes in body image

Surgery is the oldest form of cancer treatment. Most people with cancer will have some type of surgery. There are fivemain types of cancer surgery:

Preventative: Performed to remove body tissue that is likely to become malignant.

Diagnostic: Performed to determine if cancer is present and/or what type it is.

Staging: Performed to determine how much cancer is present and how far it has spread.

Curative: Performed when cancer is localized to one area and all of the tumor can be removed.

Debulking: Surgery performed when removing all of the tumor would cause too much damage to the organ or nearby tissues. Therefore, the surgery removes some, but not all, of the tumor.

Radiation uses high-energy particles or waves, such as x-rays, gamma rays, electron beams, or protons to destroy or damage cancer cells. Radiation works by damaging the genetic material of the cell, making it impossible for the cell to grow and divide. Cells going through mitosis, or division, are affected by radiation. Often, damage to normal tissue is limited to the area being treated, and most normal cells recover and function properly after radiation treatment.

Hormonal therapies are used to slow or stop the growth of cancer that uses hormones to grow, such as prostate or breast cancer. Hormone therapy works to block the ability of the body to produce hormones. They can also interfere with the way hormones function in the body. Often, hormone therapies are delivered orally and with other treatments. Biologic therapy, or immunotherapy, involves the use of living organisms or substances derived from living organisms to treat disease. In cancer patients, biologic therapies may be used to treat the cancer itself, or to manage side effects of other cancer treatments. The side effects of cancer treatment may be acute, chronic, or late. Acute effects resolve in a period of a few days or weeks, while chronic effects persist for years after treatment ends. Late effects do not appear for months or even years after the completion of treatment. The table on the next page presents the adverse effects of cancer treatment.

Hormonal therapy side effects:

- Hot flashes
- Decreases in bone density
- Diarrhea
- Nausea
- Fautigue[10]

Radiation side effects:

- Fatigue
- Pain
- Mouth sores
- Hair loss
- Taste changes
- Esophagitis
- Dry mouth
- Cardiovascular dysfunction
- Pulmonary changes
- Reproductive changes
- Lymphedema
- Skin changes, and damages to bone health[9].

Adverse Effect of Cancer Treatment	Description
Muscular Degeneration	Cancer treatments can damage the integrity of muscle tissue by decreasing protein synthesis. The release of hormones that cause muscle cell growth and development are blunted [11, 12].
Cardiotoxicity	Cancer treatments can lead to left ventricular dysfunction, reduced ejection fraction, diminished contractility, reduced cardiac output, decreased nutrient and oxygen delivery to tissues [11, 12].
Pulmonary toxicity	Cancer treatments can cause a disruption in the structural integrity of the airways [13, 14].
Fatigue	Cancer treatments cause persistent, whole-body exhaustion that interferes with daily functioning [15].
Pain	Pain can be caused by damage to tissue and nerves from the original tumor by the cancer itself or its related treatment.
Neuropathy	Damage to the peripheral nervous system caused by chemotherapy is referred to as chemotherapy-induced peripheral neuropathy, and produce pain symptoms that are often described as burning, paroxysmal, stabbing, or electric shock-like sensations[16] and are often accompanied by pins-and-needles sensations and itching[17].
Immune Dysfunction	White blood cells have the ability to destroy foreign cells, including cancer cells in the body. Certain cancer treatments may cause a decrease in the body's white blood cell count, making it harder to fight off infection[18].
Endocrine changes	The majority of endocrine changes are tumor-specific and treatment-specific. Reproductive function, thyroid health, and bone health are often adversely affected.
Gastrointestinal dysfunction	Cancer treatments can often result in disruption to the gastrointestinal system, causing constipation, malabsorption, diarrhea [19].
Weight loss	Some patients may experience weight loss both before diagnosis and as an effect of chemotherapy and radiation treatments. Factors that contribute to weight loss during treatment Include loss of appetite, early satiety (feeling full), altered sense of taste and smell, difficulty chewing and swallowing, nausea, vomiting, diarrhea, and compromised nutrient intake

2.2 INCIDENCE AND MORTALITY

The most common cancers in 2020 were lung, breast, prostate, colon and rectal, melanoma, and stomach cancer[2]. In the US, cancer is second only to heart disease as the most common cause of death in adults of all ages. For women between the ages of 40-79 years, and men between 60-79 years, it is the leading cause of death[1]. Cancer mortality is higher among men than women[2]. Positively, the overall death rate has declined by 13% since the year 2004, primarily due to early detection and advances in treatment options[1]. However, more than 15.5 million men and women are living today as cancer survivors[3]. This indicates that although the overall cancer mortality rates have declined, the number of cancer survivors have increased. Therefore, much work remains to be done. Cancer is now identified as a chronic disease[6], and its associated treatments often result in long-term physical and psychological side effects that impact the cancer survivor's quality of life. The financial costs of cancer alone are substantial, and are projected to reach $158 billion by the year 2020[2]. The challenge for health care providers today is to develop systems of long-term follow-up care, address the short and long-term effects of current cancer therapy, and develop new curative therapies with minimal toxicities[4].

2.3 RISK FACTORS FOR CANCER

Studies have shown that there are certain risk factors that may increase an individual's chance of developing cancer. Some of these risk factors are:

Increasing age: The median age of a cancer diagnosis is 66 years. One-fourth of all new cancer diagnoses occur in people aged 65-74 years.

Alcohol: Increases the risk for certain types of cancer (mouth, throat, esophagus, liver, and breast).

Chronic Inflammation: An inflammatory response is a normal physiological response that occurs in response to damage to a tissue. Once an injury is healed, the inflammatory process ends. However, with chronic inflammation, the inflammatory response does not end when it should. Overtime, this can lead to DNA changes that may lead to cancer.

Diet: Research indicates that certain foods may be associated with an increased risk for cancer. These include charred meat, foods with genetically modified foods (GMOs), microwave popcorn, canned goods, refined sugar, white flour, hydrogenated oils, carbonated beverages, and salted, pickled, or smoked foods.

Environmental Carcinogens: Exposure to certain substances in the environment may increase cancer risk. Some of these substances include aflatoxins, aristolochic acids, arsenic, asbestos, benzene, benzidine, formaldehyde, nickel compounds, radon, second hand smoke, and thorium.

Hormones: Research indicates that breast cancer risk may be related to long-term estrogen and progesterone exposure, resulting from early menarche, late menopause, and never having given birth.

Immunosuppression: Immunosuppressive medications may make the immune system less able to detect and destroy cancer cells and/or fight infections that can cause cancer.

Infectious Agents: Infectious agents such as viruses and bacteria can increase the risk of cancer by disrupting cell signaling that normally keeps cell growth and proliferation in check.

Overweight (BMI 25-29.9 kg/m2) and obesity (BMI ≤ 30): Overweight and obesity increases the risk for certain types of cancer (breast, colon, rectum, endometrium, esophagus, kidney, pancreas, and gallbladder).

Radiation: Radiation can cause damage to DNA and cause cancer.

Sunlight: Exposure to UV radiation through sunlight, sunlamps, or tanning booths can cause skin damage that can lead to skin cancer.

Tobacco: Tobacco is the leading cause of cancer and death from cancer, as it has many chemicals that cause damage to DNA.

2.4 COMMON CANCER TYPES

Lung Cancer

Lung cancer is the leading cause of cancer death worldwide. Approximately 90% of all cancers of the lung are related to smoking. Those who are exposed to secondhand smoke are also at an increased risk of developing lung cancer. Genetically, gene mutations can also be inherited from parents. It is believed that inherited genes alone are not enough to cause most cases of lung cancers. However, lifestyle factors, such as environment and smoking status can amplify the risk of developing the disease. There are three main types of lung cancers, classified according to the appearance of their cancer cells:

1. **Non-Small Cell Lung Cancer,** the most common type of lung cancer, comprising approximately 80-85% of all lung cancer cases. Squamous cell carcinoma, adenocarcinoma, and large cell carcinoma are all subtypes. This type of lung cancer often develops as a result of smoking. It is more common in women and younger individuals. Typically, this form of lung cancer is found on the outer parts of the lung and tends to grow slower than other forms of lung cancer.

Approximately 90% of all cancers of the lung are related to smoking.

2. **Small Cell Lung Cancer,** also called oat cell cancer, represents approximately 10-15% of all lung cancer cases. Small Cell Lung Cancer tends to be more aggressive and spreads more rapidly than Non-Small Cell Lung Cancer. Widespread metastases to the lymph nodes, liver, bones, adrenal glands, and brain are common early on in the disease. The primary cause of Small Cell Lung Cancer is smoking, comprising approximately 98% of all cases. Smoking cessation is associated with improved survival rates.

3. **Lung Carcinoid Tumor,** is a fairly uncommon form of lung cancer. Carcinoid tumors tend to originate in cells of the neuroendocrine system, which help control levels of oxygen and carbon dioxide in the lungs. This form of lung cancer tends to be slower growing than other types.

Symptoms of Lung Cancer

Depending on the location and magnitude of the tumors, symptoms of lung cancer can present differently. Tumors that are localized and obstruct the airways and/or infiltrate lung and surrounding tissue may cause symptoms such as cough, shortness of breath, and coughing up blood. Metastasis of cancer cells into adjacent structures may present with such symptoms as chest pain, accumulation of fluid in the space surrounding the lungs (pleural effusion), or shoulder and arm pain. Muscle and bone wasting in more advanced stages of lung cancer are also common.

! LUNG CANCER DEFINED

Lung cancer is a cancer that begins in the lungs and most often occurs in people who smoke. Those who are exposed to secondhand smoke are also at an increased risk of developing lung cancer. Genetically, gene mutations can also be inherited from parents.

Diagnosing Lung Cancer

If lung cancer is suspected, the physician will perform a series of tests for diagnosis. The patient will likely undergo a chest x-ray or CT scan of the brain, chest, and abdomen to obtain detailed pictures of the areas inside the body. A sputum cytology can be used to check for cancer cells in the mucus coughed up from the lungs. If cancer is indicated following these tests, the physician will likely perform a biopsy of the lung, whereby a small piece of tissue is removed through a needle and examined for signs of cancer. A bronchoscopy can also be performed to look inside the trachea and large airways in the lung by inserting a small tube through the mouth, trachea, and major bronchi of the lung. A thoracoscopy is a surgical procedure that examines abnormalities inside the chest cavity. The removal of fluid from the pericardial cavity can be conducted via thoracentesis. The cells and/or fluid removed during the biopsy procedure is examined via electron microscopy or immunohistochemistry, which identify abnormal cells.

Treating Lung Cancer

Treatments for lung cancer will vary depending on the severity of the cancer. The most appropriate course of action is determined after the cancer is staged and the overall health of the patient is assessed. In general, surgery, radiation, chemotherapy, immunotherapy, and targeted drug therapy methods can be employed, with the goal of destroying the cancer, managing pain, or providing comfort care as the patient progresses toward end of life.

Types of lung cancer surgery:

- Wedge resection
- Segmental resectioning
- Lobectomy
- Pneumonectomy

If the cancer is confined to the lungs, surgery is often used as the first treatment option. The goal of surgery is to remove all, or much, of the lung cancer that is present, as well as a margin of healthy tissue. Different types of surgical procedures include a *wedge resection*, which involves the removal of a small section of lung that contains the tumor, along with a margin of healthy tissue. *Segmental resectioning* is the removal of a larger portion of the lung, but not the entire lobe. A *lobectomy* is the removal of the entire lobe of one lung, and finally, a *pneumonectomy* is the removal of an entire lung. During surgery, the lymph nodes from the chest are also often removed to check for signs of cancer. If the lung cancer is more progressed, the doctor may recommend chemotherapy or radiation therapy prior to surgery in an effort to shrink the tumor. If there is a risk that cancer cells were left behind after surgery, the doctor will recommend chemotherapy or radiation after surgery.

For people with locally advanced lung cancer, radiation is often used in combination with chemotherapy and surgery. If surgery is not an option, then radiation and chemotherapy are used as the primary treatment. Finally, for advanced lung cancers, radiation may be used to help relieve symptoms, such as pain. Similarly, immunotherapy treatments are often used for people with locally advanced lung cancers that have spread to other parts of the body. Finally, for individuals with specific abnormalities present on their cancer cells or gene mutations, targeted drug therapy may be used. Most of the time, targeted therapy drugs are reserved for people with advanced or recurrent cancers.

Breast Cancer

Breast cancer refers to tumors that form in different parts of the breast. Other than skin cancer, breast cancer is the most common cancer diagnosed in US women. The American Cancer Society predicts that in 2017, there will be 252,710 new diagnoses of breast cancer, and 40,610 deaths from the disease. Less than 1% of breast cancer diagnoses occur in men [24]. As with other cancers, breast cancer develops from DNA mutations that occur within the cells of the breast. Most DNA changes are related to lifestyle factors, such as poor nutrition and lack of exercise. A small amount of DNA mutations are hereditary. For example, the BRCA1 and BRCA2 genes are tumor suppressor genes. If one of these genes becomes mutated, it will no longer suppress abnormal cell growth, making cancer likely to develop. Although men do not develop breast-stimulating hormones, sometimes they can develop breast gland tissue because of certain medicines or abnormal hormone levels.

Diagnosing Breast Cancer

Signs and symptoms of breast cancer include swelling in the breast, skin irritation, breast pain, nipple retraction, redness or thickening of the nipple or breast, and abnormal nipple discharge [25]. Often, a lump will form that is palpatable, or able to be seen on an x-ray. However, not all lumps are cancerous. Some lumps are simply a fluid-like mass called a cyst. It is very difficult to tell the difference between a cancerous lump and a cyst, so it is very important to have any lump screened by a health care professional.

If breast cancer is suspected, a doctor will likely perform a mammogram, which is an x-ray of the breast. If the breast change indicates the likelihood of cancer, a physician will likely follow up with a biopsy, where cells from the mass are removed and analyzed to determine the presence of cancer.

Metastasis

A breast cancer that has not spread is referred to as *in situ*. Breast cancer that has spread is called *invasive*. Breast cancer uses the lymphatic system and blood vessels to spread throughout the body. Most of the lymph vessels of the breast drain into axillary nodes, supraclavicular and infraclavicular lymph nodes, and internal mammary lymph nodes. Breast cancer has the ability to grow in the lymph nodes. The higher the number of breast cancer cells found in the lymph nodes, the more likely cancer has metastasized, affecting treatment plans.

Four types of biopsy to check for breast cancer:

- **Excisional biopsy**
  The removal of an entire lump of tissue.
- **Incisional biopsy**
  The removal of part of a lump or sample of tissue.
- **Core biopsy**
  The removal of tissue using a wide needle.
- **Fine-needle aspiration biopsy**
  The removal of tissue or fluid with a thin nail.

! IN SITU & INVASIVE DEFINED

Breast cancer that **has not** spread is defined as in situ. Breast cancer that **has** spread is defined as invasive.

Types of Breast Cancer

Most breast cancers are ductal, in that they originate in the ducts that carry milk to the nipple. Another common type of breast cancer originates in the glands that make breast milk, and are referred to as lobular cancers. The following are commonly diagnosed types of breast cancer.

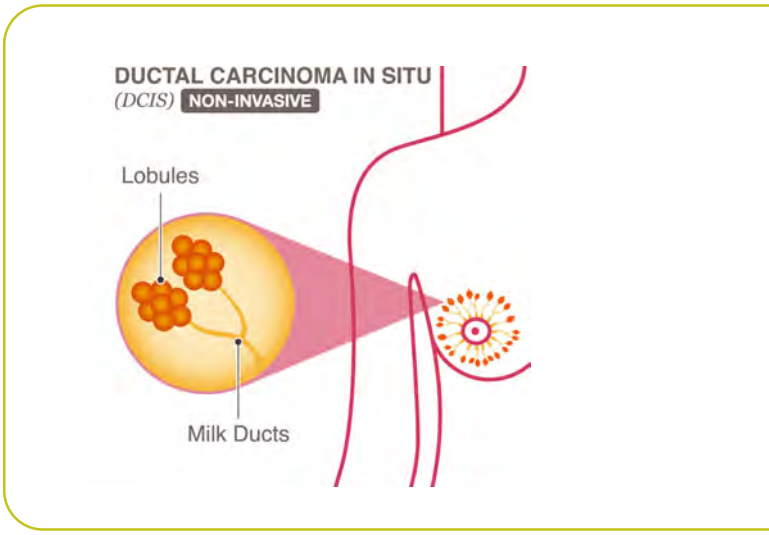
Ductal carcinoma in situ (DCIS): a non-invasive cancer where abnormal cells have been found in the lining of the breast milk duct. Because the atypical cells have not spread outside of the ducts into the surrounding tissue, is typically a stage 0, or pre-invasive, breast cancer.

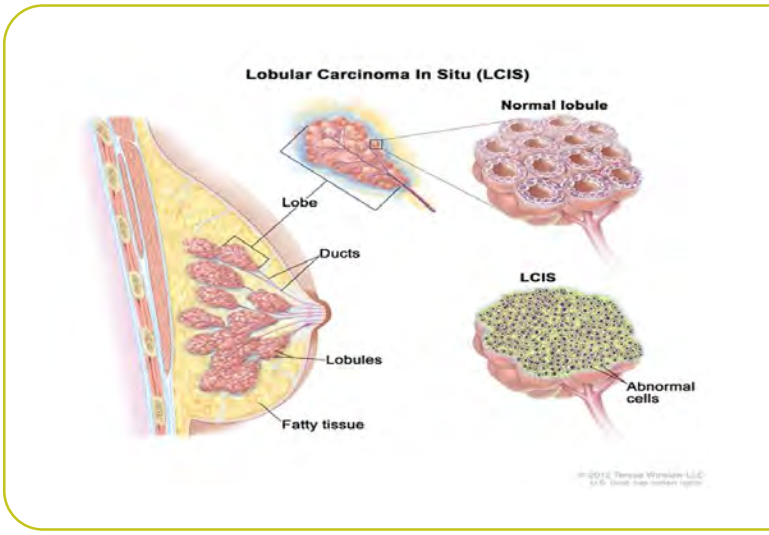
Invasive ductal carcinoma: is the most common type of breast cancer. This form of breast cancer originates in a milk duct and grows into the fatty tissue of the breast.

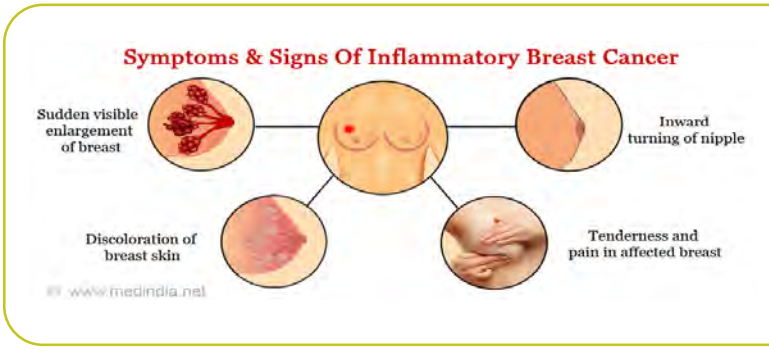
Lobular carcinoma in situ: cells that have the appearance of cancer, but have not yet grown through the walls of the lobules. Therefore this breast change is not considered cancerous.

Invasive lobular carcinoma: begins in the milk-producing glands and can spread to other parts of the body.

Inflammatory breast cancer: accounts for 1-3% of all breast cancers. It is harder to diagnose because it does not present like typical breast cancer. Generally, inflammatory breast cancer involves the thickening and/or redness of the skin of the breast. The breast may feel warm, heavy, tender, painful, or itchy. Inflammatory breast cancer tends to be more aggressive than other types of breast cancer, and is typically more advanced upon diagnosis because breast cancer cells have grown into the skin. This makes successful treatment outcomes more difficult.



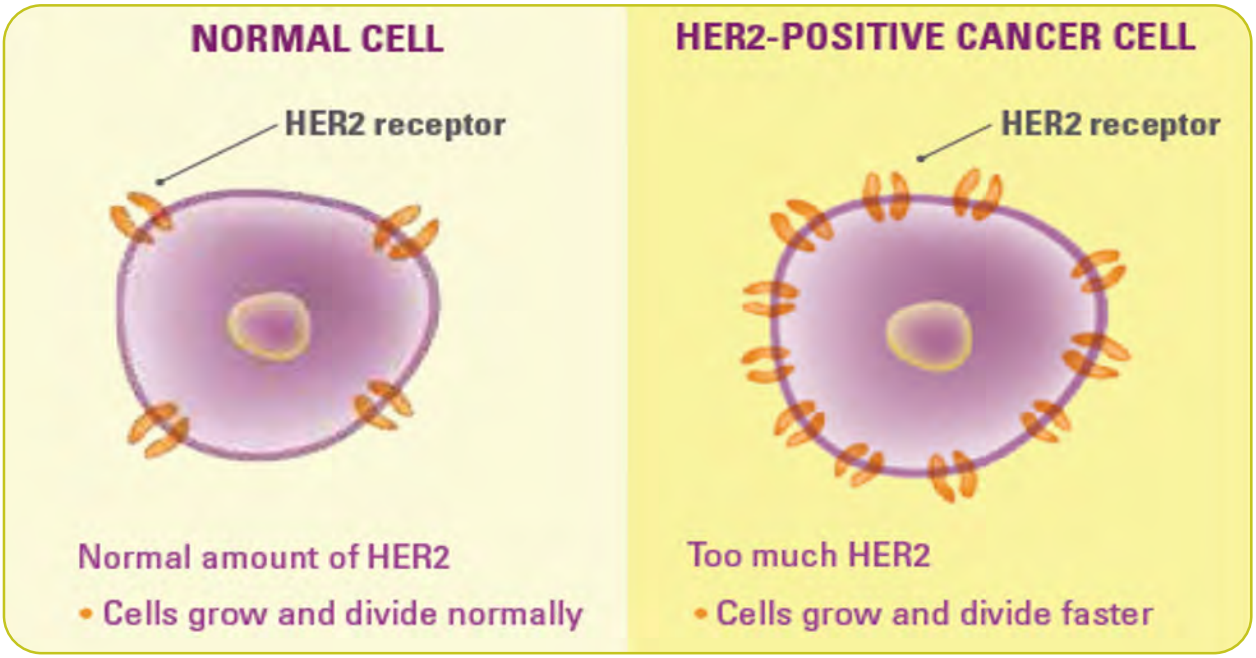




Hormone receptor breast cancer: refers to breast cancer cells that have receptors that attach to estrogen and progesterone, and uses them to grow. Breast cancers that have estrogen receptors are called ER-positive cancers. Similarly, breast cancers that have progesterone receptors are called PR-positive cancers. Most types of hormone therapy work by decreasing estrogen levels in the body, interfering with their ability to act on breast cancer cells, making them highly effective with this type of breast cancer.

Hormone receptor-negative breast cancer: does not have estrogen or progesterone receptors, making hormone therapy ineffective. These cancers tend to be more aggressive and grow faster than hormone receptor positive cancers.

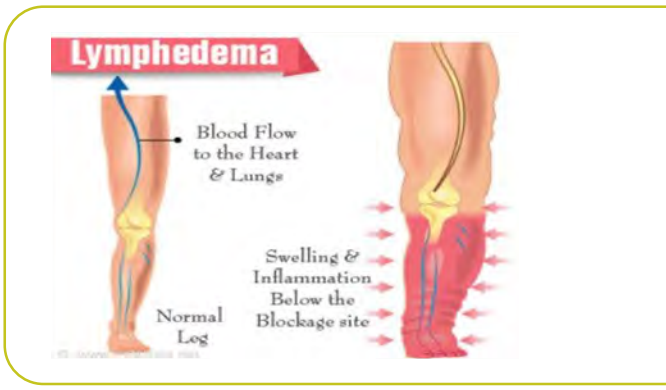
HER2 positive breast cancer: involves the HER2 protein, which is found in the lining of the breast walls, and acts as receptor proteins for estrogen. In normal breast tissue, the HER2 receptors help control the growth, division, and repair processes of the tissue. In about 25% of breast cancer cases, the HER2 gene functions improperly, making too many copies and producing an over-abundance of receptors on the cells. This overexpression causes breast cells to grow and divide uncontrollably and leads to more aggressive types of breast cancer. In a pathology report, this amplification and overexpression is represented as HER2 positive.



Triple-negative breast cancer: lacks estrogen and progesterone receptors and do not have the HER2 protein. This type of breast cancer tends to grow and spread faster than other types of breast cancer.

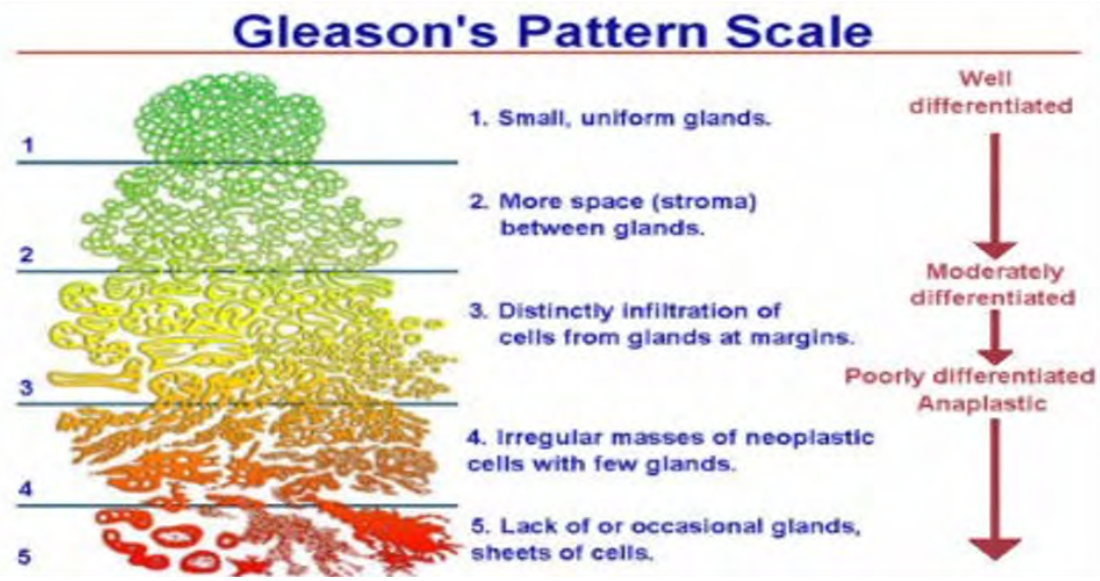
Treatment of Breast Cancer

The treatment of breast cancer is dependent upon the stage and type of breast cancer. Factors such as the aggressive nature of the tumor, chance of recurrence, and general health status of the patient is considered. In most cases, surgery is performed. This surgery is either a mastectomy or a lumpectomy. A mastectomy is removal of the entire breast. A lumpectomy removes a cancerous tumor or other abnormal tissue that surrounds the breast. Radiation is often used in addition to surgery to treat an early stage cancer. Sometimes surgery and radiation can cause swelling in the area right around the treatment site. This is referred to as acute swelling, and typically goes away after a few weeks. However, when fluid builds up in an arm or leg as a result of abnormal lymph drainage, lymphedema can develop. Lymphedema is caused by the removal or damage of lymph nodes during treatment of cancer and results in a painless swelling. Typically, this occurs in the arms and/or legs. The body contains approximately 500-700 lymph nodes and once they've been removed, they cannot grow back. Finally, systemic treatments, such as, hormone therapy, and targeted therapy are also used for certain types of breast cancer.



Prostate Cancer

Among men, prostate cancer is the most common cancer malignancy, accounting for approximately 28% of new cancer cases. Most prostate cancers are found during a digital rectal exam or a prostate-specific antigen (PSA) blood test. PSA blood tests are mainly used to screen men without symptoms. A PSA level above 4 ng/mL of blood is indicative of prostate cancer[21]. Follow up procedures for clinical diagnosis often include prostate biopsy or transrectal ultrasound. Once diagnosed, prostate cancers are graded according to the Gleason system, which assigns a grade ranging from 1 to 5, based on the appearance of cancer cell. The more normal the cancer looks, the lower the grade it is assigned. If the cancer looks like normal prostate tissue, it is assigned a grade of 1. A very abnormal tissue is assigned a grade of 5. Grades 2 through 4 vary between these extremes[21]. Prostate cancers often have areas with different grades. Therefore, a grade is assigned to two areas that make up most of the cancer. The two grades are added to yield a score referred to as the Gleason sum. A Gleason score of 6 or less is a low-grade cancer. A score of 7 is classified as intermediate-grade. Finally, a Gleason score between 8-10 is classified as a high-grade cancer[22].



The median age at diagnosis for prostate cancer is 68 years. Thus, treatment regimen is often determined by the health status, age, and possible side effects of treatment [20]. Surgery is often used as a therapy for patients in good health. In addition, localized prostate cancer is typically treated with radiation. Because the growth of prostate cancer is often driven by androgens, common treatments often target androgen levels in the body. These treatments are commonly referred to as androgen deprivation therapy (ADT), and they work by lowering the level of androgens in the body, thereby causing prostate tumors to shrink or grow more slowly for a time [23]. Often, ADT is used when cancer has spread or recurred. It is also used before radiation to try and shrink the cancer, making radiotherapy more effective. ADT does come with some negative side effects. They include cardiotoxicity, increased fat levels circulating in the blood which increases the risk of diabetes and heart disease. Reduced muscle mass and strength, fatigue, weight gain, and loss of bone mass.

Colorectal Cancer

Colorectal cancer is cancer that starts in the colon or rectum, both of which make up the large intestine. It is the leading cause of death for both men and women. In a healthy individual, the colon absorbs water and salt from the remaining food after it travels through the small intestine. The waste that is left after going through the colon goes out the rectum. Most colorectal cancers begin as a growth on the inner lining of the colon or rectum. These growths are called polyps. Polyps can either be cancerous or non-cancerous. Some of the non-cancerous forms of polyps are treated like the cancerous polyps because they increase the individual's risk of developing cancer. In general, polyps that are cancerous often are larger than 1cm, numerous (i.e. more than 3), and have dysplasia of the cells.

If cancer forms a polyp in the colon or rectum, it can grow into the wall of the colon or rectum over time. Once in the wall, they have the ability to grow into blood vessels or the lymph system, where they can travel to distant parts of the body and metastasize. Staging of colorectal cancer, therefore, take into consideration how deeply cancer has grown into the wall and if it has spread outside the colon or rectum.

Types of Colorectal Cancer

Most colorectal cancers are adenocarcinomas. These cancers start in cells that make mucus to lubricate the inside of the colon and rectum. Other, less common, types of colorectal tumors include carcinoid tumors, which begin from hormone-making cells in the intestine, gastrointestinal stromal tumors, which start from cells in the walls of the colon, lymphomas, which are cancers of the immune system cells, and sarcomas, which are cancers that form in the blood vessels, muscles, or other connective tissues in the wall of the colon and rectum.

Risk factors for colorectal cancer include obesity, sedentary lifestyle, diets that are high in red meats and processed foods, smoking, high alcohol use, being over age 50, history of colorectal polyps or inflammatory bowel disease, family history, and gene mutations.

Regular screening can often find, or even prevent, colorectal cancer. Colorectal cancer that is found early, before it has spread, is often easier to treat and is associated with a better prognosis than advanced colorectal cancer. In fact, when colorectal cancer is found at an early stage, the five year survival rate is about 90%. However, only 4 in 10 colorectal cancers are found in an early stage. Once cancer has spread outside of the colon or rectum, survival rates are lower.

! COLORECTAL DEFINED

A cancer of the colon or rectum, located at the digestive tract's lower end.

Only 4 in 10 colorectal cancers are found in an early stage.

Diagnosing Colorectal Cancer

If an individual is experiencing any of these symptoms, or if a screening test shows an abnormality, a physician may recommend one or more of the following exams be done to determine the cause:

- Physical exam – including both abdominal palpation and digital rectal exam
- Stool test to determine the presence of blood
- Blood test to measure for anemia or tumor markers
- Liver Function test measuring liver enzymes
- Diagnostic colonoscopy or proctoscopy
- Biopsy
- Imagine/Ultrasound/MRI/X-ray/PET scan

Treating Colorectal Cancer

If the tumor is localized, the patient will undergo surgery to remove it. This is typically followed up by radiotherapy and chemotherapy. If the cancer is advanced, radiation is often used prior to surgery to help shrink the size of the tumor to make it easier to remove. Giving chemotherapy prior to surgery is also helpful, as it can lower the chances of damaging the sphincter muscles in the rectum when surgery is performed. Chemotherapy and radiation can also be given after surgery, with the goal of killing cancer cells that may have been left behind after surgery because they were to small. For advanced cancers, chemotherapy can be used to help shrink tumors and ease cancer-related problems the patient may be experiencing.

Signs and symptoms of colorectal cancer:

- Change in bowel habits (including diarrhea, constipation, or narrowing of the stool) lasting for more than a few days
- Feeling that you need to have a bowel movement that is not relieved by having one
- Rectal bleeding with bright red blood
- Blood in the stool, making the stool appear dark brown or black
- Weakness and fatigue
- Unexplained weight loss

CHAPTER 3

PHYSIOLOGY OF EXERCISE

3.1 OVERVIEW

Benefits of Exercise

Participating in a regular exercise program is one of the most important things someone can do for their health. The benefits of exercise are numerous, and extend to healthy individuals, not simply those who are battling cancer. The American College of Sports Medicine (ACSM) recommends that adults participate in an average of 150 minutes of cardiovascular exercise each week. Further, they recommend adults engage in a whole-body strength training program a minimum of 2 days each week. When an individual is able to meet these recommendations, they can expect to experience numerous acute and chronic adaptations.

3.2 ACUTE AND CHRONIC ADAPTATIONS TO EXERCISE

Exercise can elicit both acute and chronic adaptations. An acute physiological response to exercise is an immediate increase or decrease in one or more of the body's systems in response to the exercise stimuli. A chronic physiological response to exercise refers to adaptations to one or more of the body's systems as a result of a long term, consistent exercise stimulus. The type and degree of the physiological responses is dependent on the type and dose of exercise.

The acute and chronic adaptations to exercise are listed on the tables on the next page.

EXERCISE PHYSIOLOGY TERMINOLOGY

- **Exercise Physiology:** The study of the acute and chronic adaptations to exercise.
- **Metabolism:** Refers to the chemical processes that occur within a living organism to sustain their life.
- **Muscular Physiology**: Refers to the biological system of a human that produces movement.
- **VO2:** The Volume of Oxygen Consumption. It is a measure of the maximum amount of oxygen that the body can utilize during exercise. It is used as a measure of aerobic fitness, whereby a higher VO2 level is indicative of a higher fitness level.
- **MET**: Represents the metabolic equivalent of a task. One MET is approximately equal to a VO2 of 3.5mL/Kg/min, or resting level. As exercise intensity increases, so does the MET level of the activity. Therefore, if something requires 2 METs, then it requires twice the resting metabolism.
- **Principles of FITT**: The FIIT Principles are used in exercise prescription.

  F: Frequency – the number of days/week that person should exercise

  I: Intensity – how difficult that exercise should be

  T: Time – How long the exercise should last (expressed in minutes for aerobic exercise, or sets/reps for resistance training).

  T: Type – The type of exercise the individual will utilize (for example, running on a treadmill, swimming, free weights, bands, etc).

Acute Responses to Exercise

Body System	Acute Response
Respiratory System	Increased respiratory rate Increased ventilation Increased tidal volume
Cardiovascular System	Increased heart rate Increased stroke volume Increased cardiac output Increased systolic blood pressure Increased a-vO2 difference Redistribution of blood flow to active muscles
Muscular System	Increased fuel metabolism Increased muscle recruitment Increased oxygen consumption Increased production of metabolic byproducts Increased body temperature

Chronic Adaptations to Exercise

Body System	Chronic Response
Neuromuscular System	Improved motor unit recruitment
Muscular System	Hypertrophy (increase in size of muscular fibers) Improved rate of amino acid transport Improved body composition
Skeletal System	Increased bone density
Cardiovascular System	Enlarged muscular walls of the heart Increased stroke volume Decreased resting heart rate Increased blood volume
Autonomic System	Decreased sympathetic nervous system activity Increased parasympathetic nervous system activity

3.3 PHYSIOLOGIC EFFECTS OF EXERCISE ON A CANCER DIAGNOSIS

Exercise is safe and effective both during and after most types of cancer treatment, and should therefore be included as an integral part of an individual's cancer care plan[43]. More than two decades of research[44-49] support a link between a physically active lifestyle and positive physiological and psychological changes in cancer survivors. These include improvements in VO2 max, which in turn improve heart and lung function and promote a healthy blood pressure, blood volume, and gas exchange[50]. In addition, improvements in quality of life[45], muscular strength and endurance[51], fatigue reduction[52-56], anxiety[57, 58], depression[58], body image[59], immune function[43] and emotional well-being[57] have been reported. Specific benefits as they relate to the aforementioned toxicities are presented below.

Adverse Effect of Cancer Treatment	Description	Physiological Effect of Exercise
Muscular Degeneration	Cancer treatments can damage the integrity of muscle tissue by decreasing protein synthesis. The release of hormones that cause muscle cell growth and development are blunted [11, 12].	Exercise increases the integrity of muscle tissue and protein synthesis, stimulates the release of numerous hormones that increase muscle cell growth and development, and improves metabolism[27,28].
Cardiotoxicity	Cancer treatments can lead to left ventricular dysfunction, reduced ejection fraction, diminished contractility, reduced cardiac output, decreased nutrient and oxygen delivery to tissues[11, 12].	Exercise can improve cardiovascular efficiency by strengthening the myocardium, increasing cardiac output and stroke volume, and decreasing resting heart rate and lowering exercise heart rate [27,28].
Pulmonary toxicity	Cancer treatments can cause a disruption in the structural integrity of the airways[13, 14].	Exercise can improve ventilation and transport of oxygen from the environment to the cellular level[29,30].
Fatigue	Cancer treatments cause persistent, whole-body exhaustion that interferes with daily functioning[15].	Exercise has been shown to decrease fatigue and anxiety, and improve quality of life [31].

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Adverse Effect of Cancer Treatment	Description	Physiological Effect of Exercise
Pain	Pain can be caused by damage to tissue and nerves from the original tumor by the cancer itself or its related treatment.	Pain thresholds and pain tolerance levels have been reported to increase both during and following exercise. In addition, intensity ratings of pain appear to decrease following exercise[32-37].
Neuropathy	Damage to the peripheral nervous system caused by chemotherapy is referred to as chemotherapy-induced peripheral neuropathy, and produce pain symptoms that are often described as burning, paroxysmal, stabbing, or electric shock-like sensations[16] and are often accompanied by pins-and-needles sensations and itching[17].	Several studies report improvements in muscular strength following moderate resistance exercise programs in patients with hereditary motor and sensory neuropathies[38-41].
Immune Dysfunction	White blood cells have the ability to destroy foreign cells, including cancer cells in the body. Certain cancer treatments may cause a decrease in the body's white blood cell count, making it harder to fight off infection[18].	Chronic exercise training at a moderate intensity is associated with improved immune function through increases the amount of white blood cells and therefore strengthens the immune system.
Endocrine changes	The majority of endocrine changes are tumor-specific and treatment-specific. Reproductive function, thyroid health, and bone health are often adversely affected.	During exercise, extracellular substrates are mobilized that augment the effects of the endocrine system.

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Adverse Effect of Cancer Treatment	Description	Physiological Effect of Exercise
Gastrointestinal dysfunction	Cancer treatments can often result in disruption to the gastrointestinal system, causing constipation, malabsorption, diarrhea[19].	Exercise can improve gastric emptying and lower the relative risk of colon cancer. Over time, regular physical activity can strengthen the digestive tract, making muscles more efficient.
Weight loss	Some patients may experience weight loss both before diagnosis and as an effect of chemotherapy and radiation treatments. Factors that contribute to weight loss during treatment include loss of appetite, early satiety (feeling full), altered sense of taste and smell, difficulty chewing and swallowing, nausea, vomiting, diarrhea, and compromised nutrient intake.	Exercise training has been suggested as a promising measure to prevent cachexia and restore muscular strength and endurance.

Effects of Exercise on Health-Related Outcomes in Those with Cancer

What can exercise do?

- **Prevention of 7 common cancers***
  Dose: 2018 Physical Activity Guidelines for Americans: 150-300 min/week moderate or 75-150 min/week vigorous aerobic exercise
- **Survival of 3 common cancers****
  Dose: Exact dose of physical activity needed to reduce cancer-specific or all-cause mortality is not yet known; Overall more activity appears to lead to better risk reduction

**bladder, breast, colon, endometrial, esophageal, kidney and stomach cancers*
***breast, colon and prostate cancers*

Overall, avoid inactivity, and to improve general health, aim to achieve the current physical activity guidelines for health (150 min/week aerobic exercise and 2x/week strength training).

Outcome	Aerobic Only	Resistance Only	Combination (Aerobic + Resistance)
Strong Evidence	Dose	Dose	Dose
Cancer-related fatigue	**3x**/week for **30** min per session of moderate intensity	**2x**/week of **2** sets of **12-15** reps for major muscle groups at moderate intensity	**3x**/week for **30** min per session of moderate aerobic exercise, plus **2x**/week of resistance training **2** sets of **12-15** reps for major muscle groups at moderate intensity
Health-related quality of life	**2-3x**/week for **30-60** min per session of moderate to vigorous	**2x**/week of **2** sets of **8-15** reps for major muscle groups at a moderate to vigorous intensity	**2-3x**/week for **20-30** min per session of moderate aerobic exercise plus **2x**/week of resistance training **2** sets of **8-15** reps for major muscle groups at moderate to vigorous intensity
Physical Function	**3x**/week for **30-60** min per session of moderate to vigorous	**2-3x**/week of **2** sets of **8-12** reps for major muscle groups at moderate to vigorous intensity	**3x**/week for **20-40** min per session of moderate to vigorous aerobic exercise, plus **2-3x**/week of resistance training **2** sets of **8-12** reps for major muscle group at moderate to vigorous intensity
Anxiety	**3x**/week for **30-60** min per session of moderate to vigorous	Insufficient evidence	**2-3x**/week for **20-40** min of moderate to vigorous aerobic exercise plus **2x**/week of resistance training of **2** sets, **8-12** reps for major muscle groups at moderate to vigorous intensity
Depression	**3x**/week for **30-60** min per session of moderate to vigorous	Insufficient evidence	**2-3x**/week for **20-40** min of moderate to vigorous aerobic exercise plus **2x**/week of resistance training of **2** sets, **8-12** reps for major muscle groups at moderate to vigorous intensity
Lymphedema	Insufficient evidence	**2-3x**/week of progressive, supervised, program for major muscle groups does not exacerbate lymphedema	Insufficient evidence
Moderate Evidence			
Bone health	Insufficient evidence	**2-3x**/week of moderate to vigorous resistance training plus high impact training (sufficient to generate ground reaction force of **3-4** time body weight) for at least **12** months	Insufficient evidence
Sleep	**3-4x**/week for **30-40** min per session of moderate intensity	Insufficient evidence	Insufficient evidence

Citation: bit.ly/cancer_exercise_guidelines

Moderate intensity (40%-59% heart rate reserve or VO_2R) to vigorous intensity (60%-89% heart rate reserve or VO_2R) is recommended.

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3.4 PHYSICAL ACTIVITY GUIDELINES FOR A CANCER POPULATION

The most current recommendations for the health-related benefits of exercise in those with cancer were published by the American College of Sports Medicine in 2019. These guidelines recommend avoiding inactivity. They go further to say that in order to improve general health, an individual should perform moderate aerobic exercise training at least three times/week for a minimum of 30 minutes per session. Resistance training should also be included at least two days/week, at least two sets of 8 to 15 repetitions that are at least 60% of the individual's one repetition maximum (63). Initially, intensity will depend on the patient's functional status and exercise history prior to cancer diagnosis. Typically, previously active cancer patients may continue their exercise regimen, although intensity may need to be decreased during treatment. Progression should consist of increases in frequency and duration rather than intensity (61). Exercise programs that are supervised appear to be more effective than unsupervised or home-based programs, and finally, oncologists are asked to "Assess, Advise, and Refer" to connect cancer survivors to the most appropriate available exercise programming. The table below summarizes these guidelines.

	Aerobic Training	Strength Training	Flexibility Training
Frequency	3-5 days/wk	2-3 days/w	2-7 days/wk
Intensity	40-60% HRR	40-60% HRR*	Stretch to the point of mild discomfort
Duration	20-60 min/session	1-3 sets, 8-12 reps per exercise	10-30 seconds per stretch
Mode	Walking, cycling, cross trainers, swimming	Free weights, machines, resistance bands, resistance balls	Static stretching

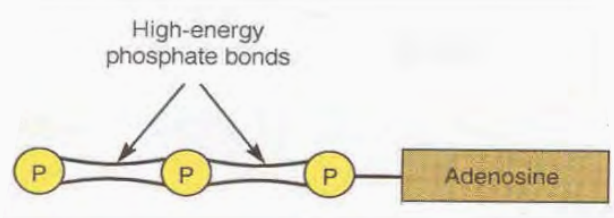
3.5 EXERCISE PHYSIOLOGY

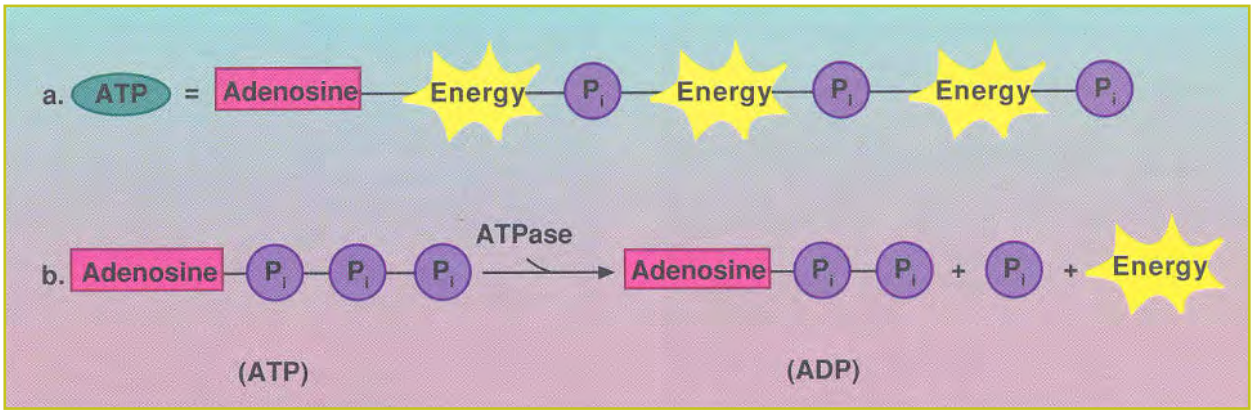
Knowledge of exercise physiology provides a backdrop for understanding the role of physical activity and exercise in the cancer population. As such, in this section we will study cellular respiration, neuromuscular physiology, and basic exercise training principles.

Cellular Respiration

Basically, all plants and animals rely on energy to support life. This energy originates from the sun in the form of light energy. Through the process of photosynthesis, plants use light energy from the sun to drive the chemical reactions necessary to form carbohydrates, fats, and proteins. Humans acquire these nutrients by eating plants and the animals who feed on these plants. In turn, the body uses the carbohydrates, fats, and proteins obtained from food to provide the necessary energy to maintain cellular activities both at rest and during exercise. The nutrients we obtain from eating plants and animals may be broken down through the process of metabolism to release the stored energy. Metabolism is the sum of the chemical reactions occurring in living organisms.

The energy within the molecular bonds of carbohydrates, fats, and proteins is chemically released in the form of the high-energy phosphate compound adenosine triphosphate (ATP). The formation of ATP occurs by combining adenosine diphosphate (ADP) and inorganic phosphate (Pi). Energy is stored within the chemical bond that joins ADP and Pi. Accordingly, if this bond breaks, energy that may be used for muscular contraction is released:

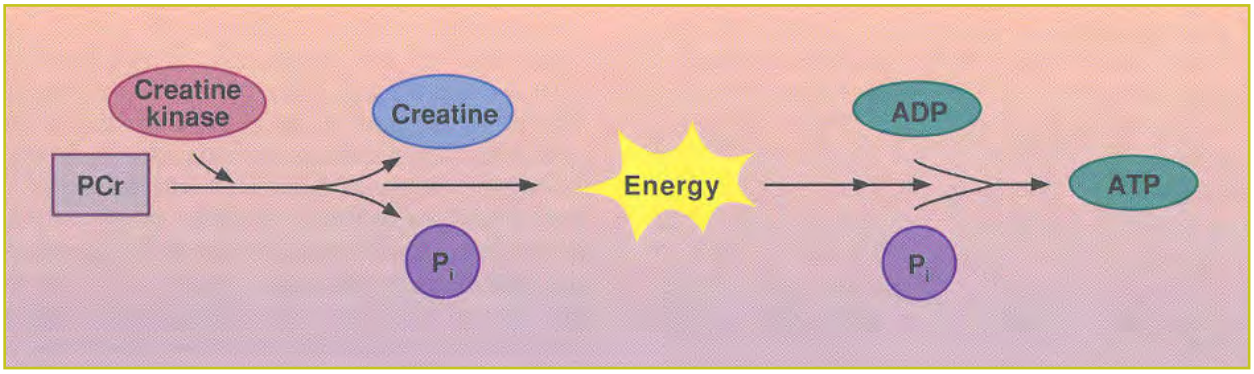




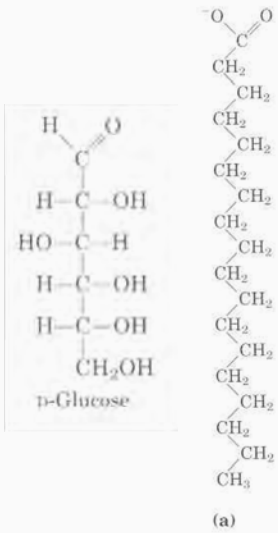
A limited amount of ATP is stored within the body cells and serves as an immediate source of energy for muscular contraction. Since muscular exercise requires a constant supply of ATP to sustain muscular contraction, three metabolic pathways exist within muscle cells, giving them the capacity to produce ATP. The first pathway is called the phosphagen system, and involves the formation of ATP by the breakdown of phosphocreatine (PC). As ATP is broken down into ADP + Pi at the onset of exercise, PC donates a phosphate to the ADP molecule, thereby reforming ATP. Thus:

Three metabolic pathways that exist within muscles:

- Phosphogen System
- Glycolosis
- Oxidative Phosphorylation

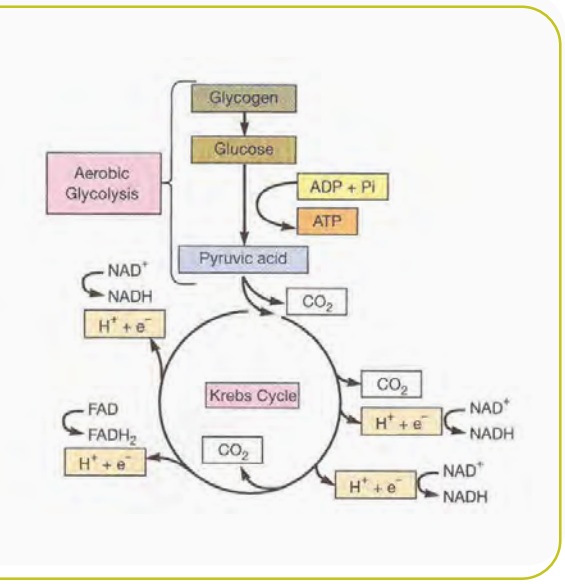


The phosphagen pathway is anaerobic (does not use oxygen) and can rapidly form ATP. However, just as with stores of ATP, the body only stores limited amounts of PC. Therefore, only a small amount of ATP can be formed through this system. Consequently, the phosphagen system supplies energy at the onset of exercise and during short duration (i.e. less than 10 seconds), high-intensity exercise.



The second metabolic pathway used to make ATP is glycolysis. In the body, carbohydrates are ultimately converted to the simple sugar, glucose. Glucose is transported via the blood to body tissues. At rest, glucose is taken up by the muscles and liver and is stored as a more complex sugar molecule called glycogen. During exercise, glycogen is converted back to glucose and transported to active tissues where it is metabolized, via glycolysis. Glycolysis is an anaerobic pathway that involves a series of reactions, whereby glucose is ultimately degraded into two molecules of pyruvic acid. The presence of oxygen determines the fate of pyruvic acid.

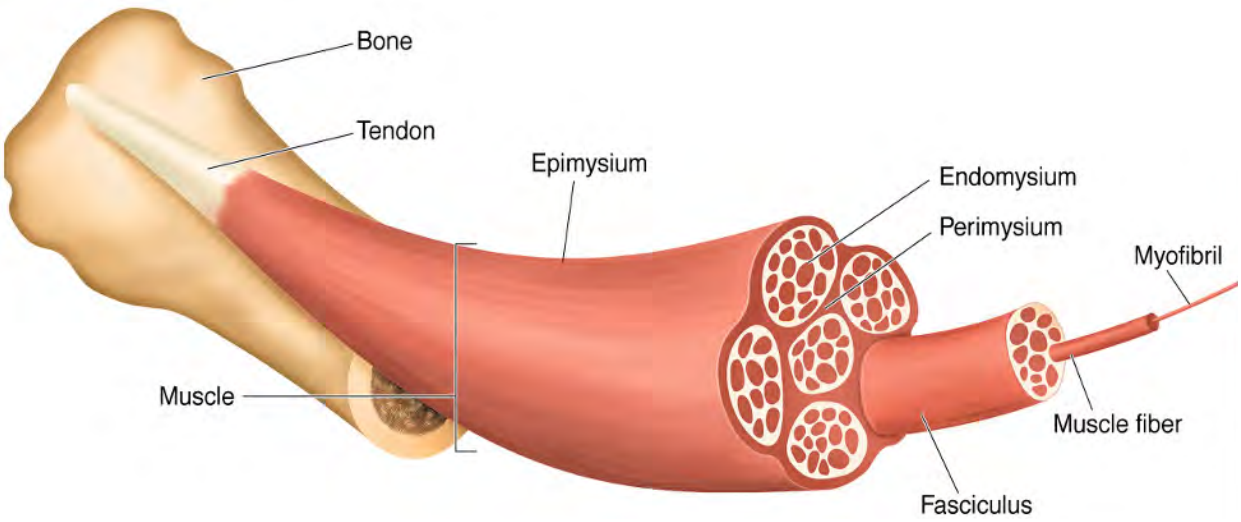
In the absence of oxygen, pyruvic acid is converted to lactic acid, and a net of two ATP molecules are formed.In the presence of oxygen, pyruvic acid is converted to the compound acetyl coenzyme A (acetly CoA), and the production of ATP continues via the third metabolic pathway, oxidative phosphorylation. This is the most complex of the three energy systems, and involves the interaction of two metabolic pathways: the Krebs cycle and the electron transport chain. Once formed, acetyl CoA enters the Krebs cycle. A series of complex reactions follows, leading to the complete oxidation of acetyl CoA. The end products of the Krebs cycle are 2 molecules of ATP, carbon dioxide, and hydrogen. The hydrogen released during the Krebs cycle combines with two electron carriers, nicotinamide adenine dinucleotide (NAD) and flavin adenine dinucleotide (FAD). NAD and FAD carry the hydrogen atoms to the electron transport chain, whereby the hydrogen ultimately combines with oxygen to form water. During this process, electrons are split from the hydrogen, and pass through a series of reactions. These electrons provide energy needed for the phosphorylation of ADP, thus forming ATP.



The energy for muscular contraction comes from the breakdown of ATP. During maximal, short-duration exercise, ATP is generated primarily from the degradation of carbohydrates, while stored body fat is considered the ideal fuel for prolonged exercise, as it contains large quantities of energy per unit of weight. In order for fats to be metabolized, fatty acids have to be mobilized, or broken off the glycerol backbone of the triglyceride. Circulating free fatty acids are taken out of the blook and into the working muscle. Through a process called beta-oxidation, fatty acids are converted to Acetyl CoA. From here, the metabolic process proceeds like before, with the Krebs cycle and the electron transport chain. Because fatty acids have so many carbons, they are able to be converted into more acetyl CoA's. As a result, fatty acids typically produce a high number of ATP molecules. Finally, proteins typically provide little energy for cellular function, and are instead used as the body's building blocks.

3.6 MUSCULAR PHYSIOLOGY

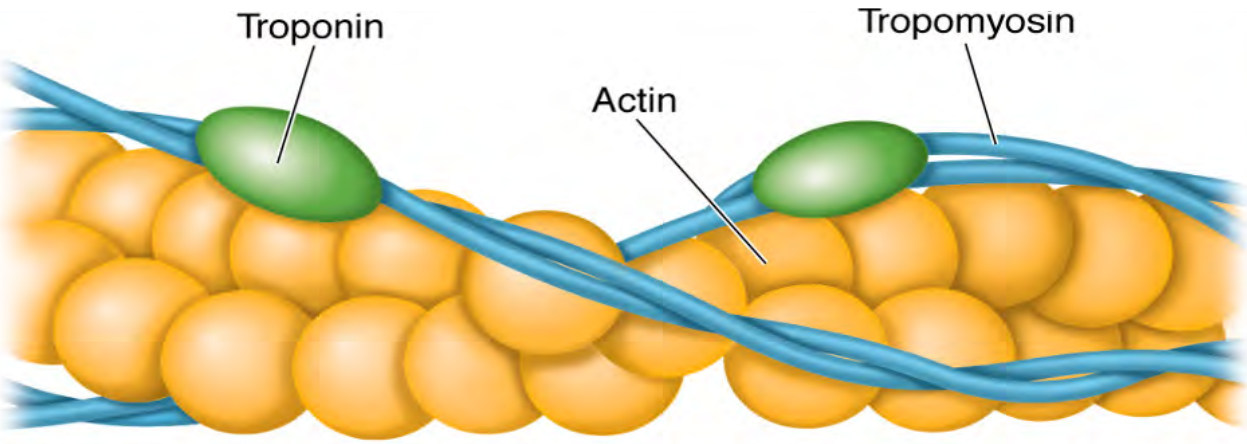
There are three different kinds of muscle in the body: skeletal, cardiac, and smooth. This section will focus specifically on the contraction of skeletal muscle. Each skeletal muscle is composed of muscle cells, or fibers, which are multinucleated and can be as long as 2 cm.



Within each muscle fiber are sarcomeres, composed of myofilaments. It is the myofilaments that make up the contractile element of skeletal muscle. Within each myofilament are two primary contractile proteins, a actin (thin filaments) and myosin (thick filaments). The actin myofilament has two additional contractile proteins associated with it, troponin and tropomyosin. At rest, tropomyosin covers myosin binding sites that are found on the actin molecule, and troponin essentially locks the tropomyosin in place.

Three different kinds of muscle in the body:

- Skeletal
- Cardiac
- Smooth



The energy to perform the power stroke is supplied by the breakdown of an ATP molecule. After the power stroke, the myosin crossbridge disengages from the original binding site and binds to a new binding site further down the actin molecule. This happens hundreds of times during a one-second muscle contraction, and causes the actin and myosin filaments to essentially slide past each other as the muscle shortens.

Types of Muscle Fibers

There are two different types of muscle fibers in the body, slow-twitch and fast-twitch. These muscle fibers are classified according to how they produce energy. The percentage of fast or slow-twitch fibers within a given muscle varies from person to person and is determined by genetics. Training can influence a particular fiber to take on characteristics of another, but cannot change a slow-twitch to a fast-twitch fiber and vice versa.

Slow-twitch (Type I): contain mitochondria, enabling them to provide their own source of energy through ATP production. In addition, they also contain myoglobin, giving them a darker appearance and allowing them to store and carry oxygen. Combined, these characteristics allow slow-twitch fibers to sustain force for an extended period of time. Therefore, slow-twitch muscle fibers tend to be more aerobically efficient.

> Slow-twitch muscle fibers have a low activation threshold, which means they are the first to be recruited when a muscle contracts. However they are generally not able to generate a significant amount of force, so therefore fast-twitch fibers are often engaged.

Fast-twitch (Type II): have a high activation threshold and are recruited only when the force demands are greater than what the slow-twitch fibers can meet. Therefore, they are better suited for explosive, strength and power-based sports. Fast-twitch fibers take a shorter time to reach peak force and can generate higher amounts of force than slow-twitch fibers. They are also quicker to fatigue and are often called "white fibers" because they lack myoglobin, giving them a lighter appearance than slow-twitch fibers. Fast-Twitch fibers can be further classified into:

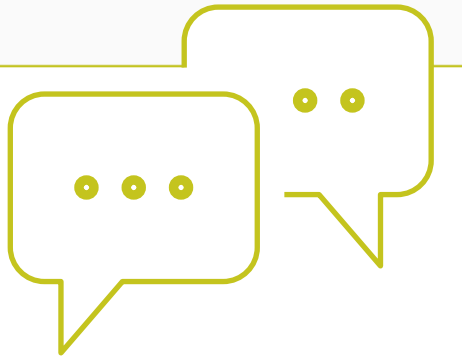
> **Fast-twitch IIa:** fast oxidative glycolytic, use oxygen to convert glycogen to ATP
>
> **Fast-twitch IIb:** fast glycolytic, rely on ATP stored in the muscle cell to generate energy.

Four types of muscle contraction:

- **Isometric:** Muscle contracts with constant length.
- **Isokinetic:** Muscle contracts with constant speed.
- **Plyometric** : Rapid lengthening followed by contraction of muscle groups.
- **Isotonic:** Muscle contract with constant tension

There are two types of muscle contraction within isotonic contraction:

- **Concentric:** Muscle shortens during contraction.
- **Eccentric:** Muscle lengthens during contraction.



3.7 FORMS OF EXERCISE

When prescribing exercise in cancer patients, we recommend four forms of exercise be addressed in each exercise session – cardiorespiratory endurance, resistance training, flexibility, and balance. A well-rounded exercise program that targets these four areas will allow for the highest degree of impact on patient outcomes.

3.8 CARDIORESPIRATORY ENDURANCE

Cardiorespiratory endurance refers to the ability of the body's heart and lungs to supply oxygen during sustained physical activity. The individual's is the best indicator of their level of cardiorespiratory endurance. Individuals with a higher VO_2max are better able to perform endurance exercise, and vice versa.

CARDIORESPIRATORY ENDURANCE DEFINED

Refers to the ability of the body's heart and lungs to supply oxygen during sustained physical activity.

Direct measurement of VO_2max requires a maximal graded exercise test, completed with the use of a computerized metabolic cart. This is the most valid and reliable marker of cardiorespiratory fitness. It is also expensive, time-consuming, and requires highly trained personnel, making it not often practical for most testing environments. Therefore, several regression equations to predict VO_2max have been developed. These are typically based on physiological responses (usually heart rate) to submaximal exercise. In submaximal exercise tests, the workload is typically fixed and heart rate is measured during and at the completion of the test. Three assumptions allow for the prediction of VO_2max from submaximal exercise tests:

1. A linear relationship exists between heart rate, oxygen uptake, and workload.
2. The maximum heart rate at a given age is uniform.
3. The mechanical efficiency is the same for everyone.

Once an individual's VO_2max has been determined, it can be useful in prescribing exercise intensity. In order to make improvements to an individual's VO_2max, one must exercise at a percentage of his/her VO_2max. In healthy populations, this percentage is generally around 60% to 70%. In a cancer population, ACSM recommends that patients exercise at an intensity that is equal to approximately 40-60% of their VO_2max. At Maple Tree, we determine exercise intensity within these parameters, but also take into consideration where the patient is in their cancer journey when we prescribe exercise intensity.

A well-rounded exercise program that targets the four areas of recommended exercise will allow for the highest degree of impact on patient outcomes.

Resistance Exercise

Resistance exercise involves activities designed to improve the strength and endurance of the musculoskeletal system. Depending on how the exercise program is set up, individuals can expect to see improvements to their muscular strength or muscular endurance. Muscular strength refers to the ability of the muscles to exert a maximal force during an activity. Typically programs that help improve muscular strength involve those that are of a high intensity, with a short duration. On the other hand, muscular endurance is the ability of the muscles to continue to perform without fatigue. Exercise programs that positively influence muscular endurance are generally that of a low intensity, high duration.

3.9 PRINCIPLES OF EXERCISE

When designing any kind of individualized exercise program, the Principles of Exercise should be used as a guide. They are as follows:

The principles of exercise:

- Overload
- Progression
- Specificity
- Rest
- Flexibility
- Balance

Overload

In order for adaptation to occur, the volume of exercise must load that is beyond that of which it is already accustomed to. In order for a load to be considered a true 'overload', it must be at least 30% of the individual's one repetition maximum. However, depending on the goals of the individual, overload can be adjusted. If the patient is looking to develop muscular strength, then the appropriate overload should be around 60-70% of that individual's one repetition maximum. One safe way to determine this is to have the patient perform between 6-8 repetitions of an exercise. By the last repetition, the patient should feel a high amount of muscular fatigue – to the point where they could not potentially perform another repetition without breaking form. Conversely, if the patient is looking to improve their muscular endurance, they should exercise at a lower percentage of their overload – generally around 30-45%. To safely determine this, the patient should be able to perform between 10-15 repetitions of an exercise with proper form. By the last few repetitions, they should feel fatigued, but not to the point where they couldn't perform another repetition.

Progression

For continual adaptation, the dose of exercise must increase as the patient adjusts to the exercise program. Because of the neurological gains in strength training observed at the start of an exercise program, what once started out as an overload might quickly be adapted to in the body. Therefore, the overload must be continually adjusted, or progressed, in order for the patient to continue to see gains in muscular strength or endurance. It is important to note the concept of a "training ceiling", which occurs as fitness improves to the point where the relative and absolute increases in fitness will plateau, even with continual overload. Similarly, if training were to cease, it can lead to a reversal of the beneficial effects of exercise – a concept referred to as reversibility.

Specificity

The training stimulus must be specific to the desired outcomes of the patient. In other words, if a patient has the goal of wanting to be able to pick up their grandchild, we must design a program that will allow them to do so. Therefore, the program must focus on building muscular strength. On the other hand, if the patient wants to be able to walk to their mailbox to check their mail without feeling fatigued, they must have a program that will develop cardiovascular and muscular endurance. It is important that the exercise program mimic the specific goal movement as closely as possible, taking into consideration the motor skills, energy system involved (a.k.a. anaerobic glycolysis or oxidative metabolism), muscles involved, joint angles, and even muscle fiber type, if applicable.

Rest

When the body performs resistance training, it can cause small tears to occur within the muscle fiber. These tears are microscopic and should not cause harm to the patient, if given the proper time to heal. Therefore, optimal adaptation requires periods of rest interspersed with training sessions so that muscle repair and recovery may take place. As a rule of thumb, it is best not to train the same body part on consecutive days. This does not allow adequate time for the muscle to heal and can lead to an overuse injury.

Flexibility

Flexibility refers to the range of motion around a joint. The body is comprised of joints that favor stability, such as around the lumbar spine or knees, and mobility, such as the ankles, hips, thoracic spine, and shoulders. Often, cancer surgery will significantly limit the range of motion around a particular joint, which is why it must be addressed in the exercise program. It is imperative that proper levels of joint mobility be established in order to ensure quality movement and directly impact activities of daily life. Studies have demonstrated that a high level of flexibility plays a role in reducing the risk of injury and reducing the risk of delayed onset muscle soreness following strength training. Yet, traditionally, flexibility is the most overlooked aspect of most fitness programs.

As a rule of thumb, it is best to not train the same body part on consecutive days.

Flexibility training is most effective following a light aerobic activity, when the muscles are warm. This ensures adequate blood flow to the working muscles before static stretching and can reduce the risk of injury. When performing static stretching, stretch to a point of feeling mild tightness to slight discomfort to ensure the greatest levels of safety and effectiveness.

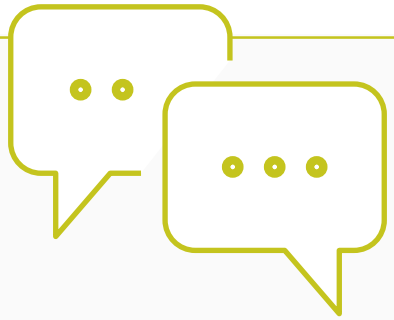
Flexibility training is joint specific. This means that there is not one specific exercise or stretch to improve overall flexibility. Therefore, it is important to incorporate a variety of different movements and stretching techniques into the training program that target all the major muscle units of the neck, chest, shoulder girdle, trunk, lower back, hips, legs, and ankles.

Balance

Balance dictates an individual's ability to control themselves in space as they move about their lives. A loss of balance occurs when someone is unable to efficiently maintain their center of gravity and safely transfer their weight.

Balance is often impacted as a result of cancer treatment. Sometimes issues with balance can be brought on by certain medications, especially those that can cause peripheral neuropathy. Physical weakness in the muscles, impaired reflexes, diminished coordination, and sensory issues all contribute to decreases in balance levels. The ability to maintain balance is actually quite complex, and involves a coordinated action of the muscles, eyes, ears, tendons, bones, and brain.
A proper balance workout should include both static and dynamic exercises. Ideally, they should be incorporated a few times each week. Static balance exercises include movements such as Tandem Standing, where the individual stands up straight with their feet hip-width apart and their weight evenly distributed on both feet. From here, the patient should put their left foot directly in front of their right foot, standing heel to toe. The arms can be lifted to shoulder level to help maintain balance, or a chair can be used for added stability.

An example of a dynamic balance exercise is the Rock Step. To perform the rock step, the patient should begin by standing up straight with their feet together and weight evenly distributed on both feet. From here, they should step forward with their left foot and lift up, and then lower their right knee. From here, the patient should step forward with their right foot, and bend their left knee. To make this exercise more difficult, have the patient hold their knee up for a count of four before lowering the leg back down. For added stability, the patient can hold on to the back of a chair during the exercise.



An example of a dynamic balance exercise is the Rock Step.

3.9 TUMOR-SPECIFIC EXERCISE CONSIDERATIONS

Lung Cancer and Exercise

Lung cancer is the leading cause of cancer death worldwide. Non-small cell lung cancer and small cell lung cancer are the main histological sub-types of lung cancer, accounting for approximately 85% of all lung cancer cases. Despite meaningful diagnostic and therapeutic advances, the overall prognosis remains poor for affected patients. Further, these patients often experience debilitating symptoms related to their cancer, including dyspnea, cough, fatigue, anxiety, depression, insomnia, and pain. This high symptom burden is often exacerbated by co-existing conditions. These issues, combined with the indirect effects of cancer treatment, can lead patients to become deconditioned and present with a low exercise capacity. This is concerning, because exercise capacity is considered a measure of whole body health, and is critically important in the patient's ability to perform activities of daily living. Further, physical fitness levels – especially that of cardiorespiratory endurance and muscular strength are independent predictors of survival from lung cancer. Conversely, patients with low levels of physical activity often see a worsening of symptoms, such as dyspnea, as well as decreased quality of life and functional capacity.

As such, exercise should serve as a standard non-pharmacological intervention for patients with lung cancer. Exercise has been shown to improve fatigue, quality of life, cardiorespiratory fitness, pulmonary function, muscle mass and strength in patients with lung cancer.

Cancer-related fatigue is defined as a "distressing, persistent, subjective sense of physical, emotional, and/or cognitive tiredness or exhaustion related to cancer and/or cancer treatment that is not proportional to recent activity and interferes with usual functioning."[64]. With lung cancer, about 90% of patients who have undergone chemotherapy and 57% of patients who have undergone surgical resection experience fatigue. Further, genetic mutations and behavioral risk factors can predispose patients to cancer-related fatigue. Often, symptoms of cancer-related fatigue include weakness, sleep disturbance, lower concentration abilities – all of which can negatively impact mood, social relationships, and work.

Several theories have attempted to explain the underlying mechanisms of cancer-related fatigue. Among them include an increase in proinflammatory cytokines and angiogenic modulators, anemia, altered brain serotonin metabolism, and a defect in the regeneration of ATP.

Exercise has been found to modulate these biological mechanisms, thereby improving the management of cancer-related fatigue. In fact, a recent meta-analysis found that exercise and psychological interventions are more effective at attenuating cancer-related fatigue than pharmacological approaches[65].

Exercise has been found to improve the managemnet of cancer-related fatigue.

Quality of Life

Quality of life is a subjective and multidimensional concept that includes physical, psychological, and social domains. Patients with lung cancer often have a long-lasting quality of life impairment, which appears to be dependent on disease stage, prognosis, and tumor localization. However, many studies have demonstrated the beneficial effect of exercise on quality of life. Specifically, a longitudinal study among 107 patients with lung cancer showed a direct correlation between quality of life level and time dedicated in walking activities over a 6-month period. Quality of life increased by 0.03 points per minute of walking time per week.

Cardiorespiratory Fitness

Cardiorespiratory fitness reflects the capacity of the body to introduce, transport, and use oxygen, and is held as an important index of functionality, health, and longevity. VO_2max is inversely related to perioperative and postoperative complications, and is an independent predictor of survival. Cardiorespiratory fitness encompasses respiratory and cardiovascular systems, vasculature, blood, and skeletal muscle. In lung cancer, many factors concur in diminishing the cardiorespiratory fitness of the patient. Namely, the presence of a tumor mass combined with surgical procedures may affect the respiratory system by diminishing diffusion capacity. Further, in the case of advanced disease, the oxidative capacity of skeletal muscles is impaired due to a reduction in capillarization and mitochondrial density. Finally, chemotherapy and radiotherapy may harm the cardiac pump, blood cell populations, and overall vascular function.

Exercise has been demonstrated to mitigate these impairments and improve cardiorespiratory fitness in a lung cancer patient. Recent investigations have revealed significant improvements in in VO_2max[66] as well as a 13% risk reduction in cancer mortality[67].

Pulmonary Function

Pulmonary Function may be assessed by a global spirometry test. This is crucial in lung cancer, as it helps to define therapeutic perspectives and respiratory functionality. The predicted post-operative of force expiratory volume in one second and the diffusion capacity of carbon monoxide are the most utilized parameters to evaluate the surgical risk and prognosis of patients with lung cancer.

Quality of life can increase by 3% per minute of walking time per week.

The treatments associated with lung cancer, including surgical resection, chemotherapy, and radiotherapy, as well as pre-existing comorbidities may be harmful for the pulmonary system. As such, the effect of exercise on the pulmonary parameters of lung cancer patients has been extensively studied. In short, studies testing different training programs have consistently revealed improvements in respiratory muscle strength and/or functionality. This holds true, even in former smokers. However, the reader is encouraged to interpret these findings cautiously, because of a potential role in postsurgical compensatory mechanisms that might play an additive role in these measured increases in pulmonary function.

Muscle Mass and Strength

Muscle mass and strength are used to evaluate muscle function. Patients with lung cancer may suffer from muscle dysfunction for disease-related metabolic disorders, oncological treatments, physical inactivity, and mal-nutrition. This is significant because muscle mass alterations during cancer may be indicative of pathological conditions, such as cachexia and sarcopenia – both of which are associated with a poor prognosis.

Exercise, especially resistance training, is a potent modulator of skeletal muscle and could counteract the muscle dysfunction in patients with lung cancer. The majority of interventional studies that included a strength assessment found a positive effect of exercise on muscular strength[69-71] as well as increases in muscle mass[72].

Exercise Considerations for Patients with Lung Cancer

Exercise is safe and effective in patients with lung cancer, both after surgery and during/after medical treatments. Different programs with a variety of activities, such as tai chi, aerobic, resistance training, walking, balance, and breathing techniques have all been found to be beneficial.

When prescribing exercise, the most often applied frequency of exercise is two to three days/week, ranging from 5 to 120 minutes at a time. A common goal among lung cancer patients is to improve lung capacity/volume. To do this, we initially begin with the patient on a recumbent bike, then have the patient progress to walking back and forth (or down the hallway) where we set step goals and try to improve 10% more steps each week. From here, the patient can progress to a treadmill when they are able.

For resistance training, working up to two sets of 10-12 repetitions helps to prevent exhaustion and delayed onset muscle soreness in patients who are deconditioned. Many patients with advanced lung cancer have severe atrophy of their muscles and cachexia. In these instances, functional/bodyweight activities should be at the onset of the program before progressing to heavy machines/weights. This will allow the patient to maintain the highest QOL completing daily tasks.

A common goal among lung cancer patients is to improve lung capacity.

All levels of training intensity – low, moderate, and vigorous appear to be well tolerated by patients, when the program was individualized to each patient's ability levels. This is why it is important to get an accurate baseline assessment that addresses the physical, psychosocial, and clinical conditions of the patient. Recognizing the presence of relevant comorbidities and adapting the exercise program accordingly will avoid potential risks.

Contraindications to exercise in a lung cancer population include the presence of extreme fatigue or high physical limitations. Patients presenting with a low cardiorespiratory fitness will need to start with a lower intensity of exercise initially, and have their pulse ox monitored throughout the exercise session. If the patient's oxygen saturation level drops below 95%, it is recommended that they sit and rest until it gets higher. If oxygen saturation level drops below 91%, the exercise session should be terminated.

In addition to these, it is important to understand specific limitations that may be brought upon by the various treatments for lung cancer. Specifically:

- Pain from surgery may limit shoulder ROM, and therefore, great caution should be utilized in weight bearing activity in those planes of motion.
- Chemotherapies commonly prescribed for lung cancer are known to cause peripheral neuropathies and a decrease in proprioception. Therefore, exercises for fine motor skills and balance should be included in the workout plan.
- Avastin, which is a common targeted treatment, is known to cause excessive bleeding. High impact exercises should be avoided to decrease the risk of internal bleeding.
- Radiation to the lung may induce fibrosis, presenting as chest pain or shortness of breath during activity. With these patients it might be better to begin with chair exercises until their tolerance to physical activity increases. Simply practicing deep breathing from the diaphragm or with pursed lips is a great way to improve the lung's functional capacity.

Some barriers to exercise in a lung cancer population appear to be related to health status, disease course, and therapeutic approach. Further, lung cancer is associated with a higher risk of psychosocial distress because of the widely shared stigmatization of this disease and the link between lung cancer and smoking. Therefore, it is recommended to make the exercise program enjoyable and customized to personal exercise preferences, fun, and a social experience. As such, the exercise program should be flexible, easy to start, and progress slowly according to the patient's body response.

Breast Cancer and Exercise

Breast cancer is the most common cancer in women worldwide, accounting for 23% of total cancer cases and 14% of cancer deaths. Due to significant improvements in screening protocols, diagnoses, and treatment over the past few decades, breast cancer mortality has progressively decreased. As a result, people are living as breast cancer survivors longer than ever before. A negative to this is that survivors are experiencing long term and late effects of cancer treatments that can severely impact quality of life. Exercise is widely recognized as an effective non-pharmacological therapy in cancer patients. A growing body of evidence supports the idea that increasing physical activity in breast cancer patients provides important benefits to promote psychological outcomes and physical well-being. These exercise regimens need to be tailored to address individual needs and abilities at various points along the survivorship trajectory.

Breast cancer treatments cause profound debilitation that leads to reduced physical function and impairs quality of life. Negative sequelae have been observed across a range of treatment types – from surgery, to radiation, to hormonal treatment and targeted therapies. Specifically, aerobic capacity has been shown to decrease by 10-33% over a 12-week period of chemotherapy for breast cancers. Almost one third of breast cancer survivors have aerobic capacity below the minimum physiologic threshold required for functional independence. Peak oxygen consumption may also be an independent predictor of survival in breast cancer patients with metastatic disease.

Breast cancer is the most common cancer in women worldwide

The declines in physical abilities and psychologic function that are commonly observed in breast cancer patients can be minimized or prevented with a targeted, individualized program of restorative exercise. Exercise during and following treatment has been associated with reductions in cancer recurrence and disease-specific mortality rates of 30% to 60% in breast cancers. Exercise has also been found to prevent or ameliorate many treatment-related effects, including fatigue, lymphedema, muscle weakness, declines in cardiovascular function, functional ability, neuropathy, body composition, and reduced quality of life. These have been found during and after treatment, and at differing stages of breast cancer. Worth mentioning is that only a moderate amount of physical activity is required to achieve many of the protective benefits of exercise. Specifically, walking for 30-minutes 5 days/week at a speed of about 2.5 miles per hour conveys health benefits and is an attainable goal for most breast cancer survivors. During a period when patients expect to be debilitated for an extended period of time (e.g. following surgery), simple exercises, such as walking 3-4 days/week can prevent the typical declines in functional ability.

Cancer-Related Fatigue

Cancer-related fatigue is a persistent problem for approximately 33% of long-term breast cancer survivors, and appears to be exacerbated by other symptoms. Rest and sedentary lifestyles tend to compound fatigue by accelerating debilitation. However, data demonstrate that physical activity reduces fatigue. These exercise programs should progress slowly and gradually, focusing on gains to cardiovascular endurance and muscular strength.

Peripheral Neuropathy

Peripheral neuropathy is a side effect of many breast cancer chemotherapy regimens, and impacts nearly 60% of patients up to 3 months following treatment. Some preliminary studies suggest that symptoms of peripheral neuropathy may be improved through exercise. Programs should focus specifically on improving and restoring balance, as well as core muscle and pelvic girdle strength. These exercises will reduce the risk of falls and bone fracture, and also build self-confidence regarding movement.

Cardiopulmonary

Cardiopulmonary complications become especially problematic at later stages of survivorship following breast cancer treatment. Heart failure is a specific adverse effect that may occur with certain combinations of chemotherapeutic agents (doxorubicin and trastuzumab). In fact, trastuzumab-induced cardiotoxicity has been reported to occur in up to one-third of patients with breast cancer when associated with anthracycline therapy. Other cardiac complications include hypertension, arrhythmia, arterial stenosis, conduction disorders, and valvular heart disease. Women with early-stage breast cancer are at increased risk for coronary artery disease and heart failure, and cardiovascular disease is the leading cause of mortality in this population. Pulmonary effects from chemotherapy and/or radiation therapy may include radiation pneumonitis pulmonary fibrosis, and a reduction in pulmonary function. These cardiac declines can largely be reversed with physical activity.

Cardiac complications include:

- Hypertension
- Arrhythmia
- Arterial stenosis
- Conduction disorders
- Valvular heart disease

Lymphedema

Lymphedema has been reported in up to 70% of breast cancer survivors. Risk factors for lymphedema include the extent of axillary surgery and treatment with radiation therapy and/or chemotherapy. However, a study of breast cancer survivors showed that those who engaged in a slow, progressive program of resistance exercise not only strengthened their affected arms, but also had a lower incidence and severity of lymphedema.

To provide optimal care during and following treatment, health care providers should refer patients to programs of restorative exercise to reduce the negative effects of their treatment. ACSM recommends at least 150 minutes of moderate or 75 minutes of vigorous aerobic activity per week and 2 days/week of resistance exercise at a moderate to high intensity for all major muscle groups. In addition, the guidelines recommend flexibility exercises for the major muscle groups. Exercises to improve balance are recommended for older adults and those patients who are at an increased risk of falling. Any planned exercise program should be adapted to the individual's needs and abilities and should focus on improving specific physical limitations.

Prostate Cancer and Exercise

Among men, prostate cancer is the most common cancer malignancy, accounting for approximately 28% of new cancer cases. Because the prostate is close to several vital structures, it can disrupt normal urinary and bowel functioning. The most common site of prostate cancer metastasis is bone, with bone mets occurring in 85-90% of patients with metastatic prostate cancer. As cancer cells settle in the bone, they interfere with the bones normal health and strength, often leading to bone pain, fracture, or complications that can reduce quality of life. These bone metastases increase the patient's risk of osteoporosis and injuries from falls.

The treatment regimen is often determined by the health status, age, and potential side effects of treatment. Surgery is often used as a therapy for patients in good health. One potential side effect of surgery is some degree of urinary incontinence for up to two years. Pelvic floor training can help minimize these effects. Localized prostate cancer is typically treated with radiation. Urinary symptoms are also a common occurrence with radiation. Long term complications that may arise also include rectal inflammation, bowel dysfunction, and renal toxicity. Finally, declining neuromuscular efficiency and mitochondrial dysfunction are two major debilitating side effects of radiation therapy, and can persist for some time after treatment.

Chemotherapy is often used to treat advanced prostate cancer. Chemotherapy works through non-hormonal mechanisms to prevent cancer cells from dividing and making new cells. About 50% of men will experience significant fatigue at some point during chemotherapy. One-third will experience numbness or weakness in their fingers or toes, as well as shortness of breath.

Finally, hormone therapy is often used in the treatment of prostate cancer. The primary systemic treatment for prostate cancer is androgen deprivation therapy (ADT), which works to lower testosterone. This can slow the growth of cancer and shrink the tumor. Side effects of ADT include loss of bone density and increased risk of fracture, increased body mass and higher levels of fat in the blood, reduced muscle mass, low red blood cell count, fatigue, and increased risk for diabetes and heart disease. In particular, the decline in musculoskeletal fitness secondary to loss of lean mass with aging is exacerbated by ADT, and is believed to contribute to a reduced physical reserve capacity that may be prevented or even reversed by targeted resistance training.

Exercise is a feasible intervention that can help improve the quality of life of a patient who is being treated for prostate cancer. Several investigations have reported that moderate to vigorous activity improves prostate cancer prognosis and decreases prostate cancer-specific mortality[71]. Further, these interventions have consistently been shown to improve strength and physical functioning, fatigue, bone health, physical function, body composition, cardiometabolic health, and quality of life [72]. The majority of these studies have either focused on patients before or after radical prostatectomy or ADT. Very little attention has been given to exploring whether there are potential benefits of exercise in patients receiving radiation therapy alone. However, given the benefits seen on other tumor sites receiving radiation, we can assume these benefits would translate to a prostate cancer patient, as well.

Exercise has been shown to reduce the rate of falls in older individuals.

The role of exercise in improving multiple aspects of physical function include increases in cardiorespiratory endurance, muscular strength, and mitigation of urinary toxicity. Limited evidence also shows improvements to intestinal toxicity, depressive symptoms, and sleep disturbance. This improvement in functional status may allow patients to remain independent and perform activities of daily living without any significant restrictions. Further, exercise has been shown to reduce the rate of falls in older individuals and is an important strategy in osteoporosis management. This will reduce the risk of fractures, which is of particular concern in men treated with ADT.

Fatigue is a multi-etiological problem that must be addressed through exercise. Fatigue in prostate cancer is correlated with late urinary and rectal toxicity following radiation therapy. Many studies have demonstrated that a combination of aerobic and resistance training may potentially mitigate the onset and/or severity of fatigue. Conversely, maintaining a sedentary lifestyle may lead to development or aggravation of chronic comorbidities that may further affect fatigue.

Specific exercise recommendations for prostate cancer patients have not been published. However, general exercise guidelines for patients with cancer include multimodal, moderate-to-high intensity, and individualized to the patient's circumstances. Any accompanying health issues, exercise-related preferences, and goals must be considered, and the exercise program adapted accordingly.

Based on our years of experience working with patients with prostate cancer at Maple Tree, we have the following exercise considerations:

- After prostate surgery, patients often have 10 lb lifting restrictions. During this time, it may be uncomfortable to do seated exercises for more than a few minutes at a time. Exercises that cause excessive abdominal strain should also be avoided.
- To reduce the risk of sarcopenia, our goal is not to increase lean muscle tissue via hypertrophy-based programming, but with a program that aims at maintaining their current level of muscle mass. This will help our patients maintain their QOL.
- Monitor patient for signs of lower extremity lymphedema following a prostatectomy with limb circumference measurements. Movement of the lower extremity (e.g. daily walking) will significantly reduce the risk of lymphedema in the pelvic region/lower extremity.
- If the patient has neuropathy, repeated use will improve motor learning, and help the patient become more functional/independent.
- A patient who is experiencing any kind of incontinence should avoid high-impact activities and straining while lifting. Rather, they should try to incorporate kegels into their routines in different positions such as laying down, kneeling, standing up and throughout exercises such as deadlifts, and squats where it might be appropriate to do so.

Colorectal Cancer and Exercise

Colorectal cancer is the third most common cancer worldwide, with approximately 1.8 million new cases each year. The median age at diagnosis is 69 for females and 66 for males. Over the last 20 years, improvements in screening, diagnosis, and treatment have contributed to improvements in survival rates up to 30%. At present, the overall survival rate of colorectal cancers is 65%, making colorectal cancer survivors the largest group of cancer survivors in the world.

Treatment for colorectal cancer involves surgery, radiation, chemotherapy, and targeted therapies. Up to 98% of patients will have surgery, and at least one-third will receive chemotherapy and/or radiation. Common surgeries include hemicolectomy and partial colectomy, both of which are associated with a high risk of complication. These include wound infection, anastomotic leakage and hemorrhaging. Other adverse effects of treatment include weakness, fatigue, cardiotoxicity, bowel dysfunction, anxiety, depression, reduced physical function, and decreased quality of life. Finally, more than 30% of colorectal patients will experience disease recurrence, contributing to threatened long-term survival.

Colorectal cancer is the third most common cancer with approximately 1.8 million new cases each year.

The results from several meta-analyses indicate that exercise is safe and feasible for individuals with colorectal cancer during and following treatment. These findings indicate that physical activity is associated with higher overall, as well as disease-specific survival in individuals with colorectal cancer. These benefits appear to be irrespective of mode, duration or timing with respect to chemotherapy or surgery for the majority of health outcomes.

Following a diagnosis, physical activity is associated with a 24% risk reduction in cancer-specific mortality. A 38% risk reduction for females and 20% risk reduction for males has been reported for the protective effect of exercise from all-cause mortality following a colorectal cancer diagnosis.

When interventions are supervised, exercise has a favorable effect on quality of life and fatigue. During treatment, exercise training has produced measured improvements in cardiorespiratory endurance and upper-body strength Post treatment, aerobic exercise training has been shown to improve quality of life and reduce body fat.

Most of the studies in the meta-analyses included 1 to 5 bouts of supervised aerobic exercise training each week for 15-90 minutes/session, at continuous and interval bouts at 50-95% of the patient's HRmax (RPE 11-15). Resistance training included 8-15 repetitions, 1-3 sets per exercise, with the patient performing between 2-8 exercises that targeted major muscle groups.

Based on the large number of colorectal patients trained at Maple Tree, we have included the following exercise considerations:

- Following colorectal surgery, parastomal hernia risk is significantly elevated. If hernia is present, bending activities, excessive rotation of the abdominals, and lifting over 10 lbs should be avoided until the issue is medically addressed and cleared.
- Patients with colorectal cancer have noted that seated activity is painful. In these cases, an inflatable pillow can be used to ease their pain while sitting. However it is important to note that this may alter the patient's center of gravity while doing unilateral movements. If this happens, those movements should be completed while the patient is standing.
- Patients who are using the chemotherapy agents 5-FU and Capectibine often have issues with fluid consumption. Therefore, be sure to encourage proper hydration to avoid dehydration or negative effects on their blood pressure.
- It is best to avoid any exercises that cause excessive intra-abdominal pressure if the patient has had an ostomy or a parastomal hernia.
- Often patients will come in on a chemo pump, such as FOLFOX. The size of the device can be awkward. As such, the EOI will need to choose exercises that are comfortable and low impact.
- A patient receiving radiation is at risk for developing fibrosis around the hip and pelvis. This is painful and can significantly restrict range of motion. The EOI can help attenuate symptoms by focusing on segmental flexion, extension, and rotation in the spine/trunk, and designing an exercise program that improves the activation and integration of the abdominal muscles.
- When performing abdominal exercises, start with exercises in the supine position to decrease the risk of herniation.

The above list is exercise considerations based on the large number of colorectal patients we have trained at Maple Tree.

Pediatric Cancer and Exercise

Childhood cancer occurs when cancer develops in anyone aged 0-19, and is the leading cause of death by disease in children past infancy. Around 400,000 children and adolescents are diagnosed with childhood cancer each year. Pediatric cancer can occur anywhere throughout the body. The most common childhood cancer is leukemia. The next most common childhood cancers are brain and central nervous system, lymphomas, or neuroblastomas.

While adult cancers are often linked to lifestyle or environmental factors, the cause of most childhood cancers is often unknown. Childhood cancers are often caused by genetic mutations, and finding where the mutation is often key to diagnosing and treating the cancer more effectively.

The treatment options for childhood cancer are the same as adult cancer. These include surgery, chemotherapy, radiation, or immunotherapy. Stem cell therapy is also a common treatment for adolescents.

Right now, there are around half a million adult childhood cancer living survivors. Follow up care is essential for these survivors to be able to be functional as they continue back into their normal lives. Health problems in survivorship can occur months or years after treatment is finished. Late occurring issues are often a worry because they can lead to much more extreme issues. Late effects of cancer affect both the body and mind. Long term follow up care is crucial to the survivorship of adolescents into adulthood, as well as good health habits to maintain their bodies. Most late effects are not life threatening, but can change the quality of life and affect general health.

Areas of life that can be affected by late term effects:

- Organs, tissue, and body function
- Growth and development
- Mood, feelings, and actions
- Thinking, learning, and memory
- Social and psychological adjustments
- Risk of second cancer

The three biggest factors of the risk of late effects are:

- Tumor related factors (type of cancer, location, how it affects the organ/tissue)
- Treatment related factors (type of surgery, chemo, radiation, and transplant)
- Patient related factors (sex, hormone levels, other health issues, health habits)

To monitor these issues, it is recommended that childhood cancer survivors get a yearly check up by a healthcare professional who knows the risk of late effects into survivorship.

Pediatric Participation in Physical Activity

The participation of children and adolescents in physical activity programs has many benefits. Getting 60 minutes of activity per day can have a positive impact on a child's development of motor skills, body composition, blood sugar, aerobic fitness, and muscular strength. Daily activity can also improve academic performance, mood, and attitude. It is crucial to teach children the importance of being physically active when they are young, so that these habits carry on to adulthood.

Exercise is recommended for a few reasons beyond basic health for pediatric cancer patients. Research indicates that it will improve the quality of life of the patients. There are many factors that can be improved such as: decreased fatigue, increased mobility, and decreased depression. It also can prevent the decline of physical fitness that can lead to secondary health complications such as obesity or muscular atrophy. Exercise can also improve the efficacy of the patients' chemotherapy treatment. Finally, it can attenuate side effects during active treatment and the off times.

When working with a pediatric population, there are special considerations to keep in mind. A few things to keep in mind are:

- Children should not be exposed to strength training before the age of 7
- High impact and repetitive movements should be avoided when working with children. This increases their risk of injury and can contribute negatively to their growth
- The thermoregulatory systems of children are still developing, therefore it is crucial to make sure they hydrate before, during ,and after their workout
- It is more important to make sure you are developing a well-rounded program for children that focuses on all aspects of fitness rather than just focusing on strength. Other areas to focus on include endurance, flexibility, agility, and skill building activities
- Real muscle gains are unlikely in prepubescent children due to the lack of muscle-building hormones.
- The overload principle is both safe and effective if done correctly with children and adolescents

Exercise is crucial for any cancer patient, but it is especially crucial for the patients who fight this disease so early in their lives. Educating pediatric patients on a healthy lifestyle will set them up to continue to make healthy decisions throughout adulthood.

Exercise is crucial for any cancer patient, but it is especially crucial for the patients who fight this disease so early in their lives.

PATIENT ONBOARDING RESOURCES

CLIENT PROFILE & HEALTH HISTORY

Maple Tree CANCER ALLIANCE

The health history form is a quick and effective way of screening patients about to participate in physical activity of anykind to ensure you are safely able to take part without risk to yourself. The questionnaire will identify health issues andrecent injuries, illness, ailments and cardiovascular conditions that require the attention of your Exercise Oncology Specialist prior to taking part in any type of physical training through any phase. The role of this form and screening process is not necessarily diagnostic but rather assessing risk.

Name _____ **Date** _____

Date of Birth (MM/DD/YR) _____ **Age** _____

Address _____

City _____ **State** _____ **Zip Code** _____

E-mail _____

Preferred Contact Number *(select and provide number)*

☐ Home _____ ☐ Cell _____ ☐ Work _____

Is it okay to leave a message? ☐ Yes ☐ No

Profession _____

Referred by

☐ Physician *(please provide name)* _____

☐ Family/Friend ☐ Website ☐ Social Media ☐ Other _____

Ethnicity

☐ American Indian/Alaska Native ☐ Asian ☐ American/Pacific Islander ☐ Black/Non-Hispanic

☐ White/Non-Hispanic ☐ Other _____ ☐ Prefer not to answer

Emergency Contact _____ **Phone** _____

Form continued on next page >>

CLIENT PROFILE & HEALTH HISTORY

Maple Tree CANCER ALLIANCE

PRE-EXISTING CONDITIONS
(Check each condition that currently applies to you.)

Condition	Date	Additional Information
☐ High Blood Pressure	_____	_____
☐ Chest Discomfort	_____	_____
☐ Neuropathy	_____	_____
☐ Lung Disease	_____	_____
☐ Stomach or Intestinal Problems	_____	_____
☐ Anemia	_____	_____
☐ Stroke	_____	_____
☐ Migraine	_____	_____
☐ Dizziness or Fainting Spells	_____	_____
☐ Leg Pain	_____	_____
☐ Back/Neck Pain	_____	_____
☐ Lymphedema	_____	_____
☐ High Cholesterol	_____	_____
☐ Diabetes	_____	_____
☐ Thyroid Problems	_____	_____
☐ Respiratory Problems	_____	_____
☐ Fatigue	_____	_____
☐ Arthritis	_____	_____
☐ Epilepsy	_____	_____
☐ Anxiety/Depression	_____	_____

Form continued on next page >>

CLIENT PROFILE & HEALTH HISTORY

Maple Tree CANCER ALLIANCE

PREVIOUS SURGERIES *(Non-cancer related)*

1. _____ **Date** _____

2. _____ **Date** _____

3. _____ **Date** _____

4. _____ **Date** _____

5. _____ **Date** _____

Are you a cigarette/cigar/pipe smoker? ☐ Yes ☐ No

If yes, how many or much do you smoke per day? _____

Were you previously a cigarette/cigar/pipe smoker? ☐ Yes ☐ No

If yes, when did you quit? _____

MEDICATION LIST *(Please include ALL medications.)*

	Medication	Dose	Date Started
1.			
2.			
3.			
4.			
5.			
6.			

Form continued on next page >>

CLIENT PROFILE & HEALTH HISTORY

Maple Tree CANCER ALLIANCE

MEDICAL HISTORY - CANCER

What was the date of your cancer diagnosis? (MM/YR) _____

What type of cancer were you diagnosed with? (e.g., breast, lung, prostate) _____

Please list specific location _____

What stage was your cancer? (Include stage with any parameter listed below.)

☐ 0 ☐ I ☐ II ☐ III ☐ IV ☐ Undetermined ☐ I don't know

☐ A ☐ B ☐ C ☐ D ☐ E ☐ S ☐ Other _____

What types of cancer treatments have you received, or will you receive in the future?

Surgeries ☐ No ☐ Current ☐ Complete Date (MM/YR) _____

Future Date (MM/YR) _____ Type(s) of Surgery (if applicable) _____

_____

Chemotherapy ☐ No ☐ Current ☐ Complete Date (MM/YR) _____

Future Date (MM/YR) _____ Type(s) of Chemotherapy (current or future) _____

_____

Radiation ☐ No ☐ Current ☐ Complete Date (MM/YR) _____

Future Date (MM/YR) _____

If radition was completed, how many total sessions did you have? _____

Lymph Nodes Removed ☐ No ☐ Current ☐ Complete Date (MM/YR) _____

Future Date (MM/YR) _____ If yes, how many were removed? _____

Drug Allergies _____

_____

_____

_____

Form continued on next page >>

CLIENT PROFILE & HEALTH HISTORY

Maple Tree CANCER ALLIANCE

GENERAL INFORMATION

What is the main goal related to starting an exercise program?

☐ Physical Fitness ☐ Start a new activity or participate in an event _____

☐ Lose Weight ☐ Other _____

Do you anticipate any barriers to starting an exercise program?

☐ Lack of Time ☐ Lack of Enjoyment from Exercise ☐ Lack of Self-Discipline

☐ Lack of Equipment ☐ Fatigue or Feeling Unwell ☐ Weather ☐ Financial

☐ Other responsibilities (e.g., family, job, volunteer position) ☐ Other_____

Do you have any specific cancer-related concerns about exercise?

☐ Type of exercise that is safe during or following cancer treatment

☐ Risk of infection at the fitness center or public facilities ☐ Risk of developing lymphedema

☐ Knowledge of the Exercise Oncology Specialist related to working with cancer survivors

☐ Other _____

Are you currently active in an exercise program?

☐ No ☐ Yes (please specify) _____

How many days a week do you exercise?

☐ 0 ☐ 1 to 2 ☐ 3 to 4 ☐ 5+

Is your exercise light, moderate, or vigorous? _____

What types of physical activities do you currently do or have done in the past? _____

_____

_____

_____

_____

PHYSICIAN RELEASE FORM

Maple Tree CANCER ALLIANCE

Patient Name _____ **Date of Birth** (MM/DD/YR) _____

Phone _____ **CPT Code(s)** _____

E-mail _____

Physician Name _____ **Physician Phone** _____

Physician Address _____

City _____ **State** _____ **Zip Code** _____

Exercise Restrictions _____

_____

_____

Medications that may affect exercise response _____

_____

_____

_____

_____

I hereby give medical approval to the person named above to participate in a post-rehabilitation program that may include cardiovascular, resistance training, and functional conditioning for the body.

Physician's Signature _____ **Date** _____

Please submit this release form through direct messaging to:
WellDirect Address: mapletree@direct.mywelld.com (note: WellDirect is a Direct-verified HISP)
You may also submit referrals through our fax line: (937) 688-3940

FACT B FORM

Maple Tree CANCER ALLIANCE

Below is a list of statements that other people with your illness have said are important. Please circle or mark one number per line to indicate your response as it applies to the **past 7 days.**

PHYSICAL WELL-BEING	Not at all	A little bit	Some what	Quite a bit	Very much
I have a lack of energy	0	1	2	3	4
I have nausea	0	1	2	3	4
Because of my physical condition, I have trouble meeting the needs of my family	0	1	2	3	4
I have pain	0	1	2	3	4
I am bothered by side effects of treatment	0	1	2	3	4
I feel ill	0	1	2	3	4
I am forced to spend time in bed	0	1	2	3	4

SOCIAL/FAMILY WELL-BEING	Not at all	A little bit	Some what	Quite a bit	Very much
I feel close to my friends	0	1	2	3	4
I get emotional support from my family	0	1	2	3	4
I get support from my friends	0	1	2	3	4
My family has accepted my illness	0	1	2	3	4
I am satisfied with family communication about my illness	0	1	2	3	4
I feel close to my partner (or the person who is my main support)	0	1	2	3	4

☐ *Regardless of your current level of sexual activity, please answer the following question. If you prefer not to answer it, please mark this box and go to the next section*

I am satisfied with my sex life	0	1	2	3	4

Form continued on next page >>

FACT B FORM

Maple Tree CANCER ALLIANCE

Please circle or mark one number per line to indicate your response as it applies to the **past 7 days.**

EMOTIONAL WELL-BEING	Not at all	A little bit	Some what	Quite a bit	Very much
I feel sad	0	1	2	3	4
I am satisfied with how I am coping with my illness	0	1	2	3	4
I am losing hope in the fight against my illness	0	1	2	3	4
I feel nervous	0	1	2	3	4
I worry about dying	0	1	2	3	4
I worry that my condition will get worse	0	1	2	3	4

FUNCTIONAL WELL-BEING	Not at all	A little bit	Some what	Quite a bit	Very much
I am able to work (include work at home)	0	1	2	3	4
My work (include work at home) is fulfilling	0	1	2	3	4
I am able to enjoy life	0	1	2	3	4
I have accepted my illness	0	1	2	3	4
I am sleeping well	0	1	2	3	4
I am enjoying the things I usually do for fun	0	1	2	3	4
I am content with the quality of my life right now	0	1	2	3	4

Form continued on next page >>

FACT B FORM

Maple Tree CANCER ALLIANCE

Please circle or mark one number per line to indicate your response as it applies to the **past 7 days.**

ADDITIONAL CONCERNS	Not at all	A little bit	Some what	Quite a bit	Very much
I have been short of breath	0	1	2	3	4
I am self-concious about the way I dress	0	1	2	3	4
One or both of my arms are swollen or tender	0	1	2	3	4
I feel sexually attractive	0	1	2	3	4
I am bothered by hair loss	0	1	2	3	4
I worry that other members of my family might someday get the same illness I have	0	1	2	3	4
I worry about the effect of stress on my illness	0	1	2	3	4
I am bothered by a change in weight	0	1	2	3	4
I am able to feel like a woman	0	1	2	3	4
I have certain parts of my body where I experience pain	0	1	2	3	4

BRIEF FATIGUE INVENTORY

Maple Tree CANCER ALLIANCE

Study ID # _____ **Hospital #** _____

Date (MM/DD/YR) _____ **Time** _____

Name _____

Throughout our lives, most of us hve times when we feel very tired or fatigued. Have you felt unusually tired or fatigued in the last week? ☐ Yes ☐ No

1. **Please rate your fatigue (weariness, tiredness) by circling the one number that best describes your fatigue right NOW.**

0	1	2	3	4	5	6	7	8	9	10
No Fatigue	←								→	As bad as you can imagine

2. **Please rate your fatigue (weariness, tiredness) by circling the one number that best describes your USUAL level of fatigue during the past 24 hours.**

0	1	2	3	4	5	6	7	8	9	10
No Fatigue	←								→	As bad as you can imagine

3. **Please rate your fatigue (weariness, tiredness) by circling the one number that best describes your WORST level of fatigue during the past 24 hours.**

0	1	2	3	4	5	6	7	8	9	10
No Fatigue	←								→	As bad as you can imagine

4. **Circle the one number that best describes how, during the past 24 hours, fatigue has interfered with each area of your life, with 0 being "did not interfere" and 10 being "completely interfered."**

A. General Activity

0 1 2 3 4 5 6 7 8 9 10

B. Mood

0 1 2 3 4 5 6 7 8 9 10

C. Walking Ability

0 1 2 3 4 5 6 7 8 9 10

D. Normal work (includes both work outside the home and daily chores)

0 1 2 3 4 5 6 7 8 9 10

E. Relations with other people

0 1 2 3 4 5 6 7 8 9 10

D. Enjoyment of life

0 1 2 3 4 5 6 7 8 9 10

FITNESS ASSESSMENT PROCEDURES

WHAT IS A FITNESS ASSESSMENT?

A fitness assessment is a series of tests that help determine a patient's current level of physical fitness. The results can be used to design or modify the exercise program accordingly. Fitness assessments are not a replacement for a physician's physical.

WHY IS A FITNESS ASSESSMENT IMPORTANT?

There are many benefits of fitness assessments:

- Identify the major risk factors for coronary heart disease, as well as other health conditions which may be affected by exercise;
- Identify patient's current level of physical fitness;
- Identify patient's strengths and weaknesses;
- Establish a baseline and set future benchmarks prior to starting an exercise program;
- Provide key information that can be used to develop realistic goals and design an exercise program that will help meet personal needs and achieve goals;
- Allow the EOI to create an individualized exercise program for the patient.

REASSESSMENTS

At Maple Tree Cancer Alliance, fitness assessments are repeated every 12 weeks. This allows the EOI to:

- Track patient progress;
- Keep the patient motivated and adhere to the exercise program;
- Determine whether a training technique or program is meeting patient needs and allowing them to achieve their goals;
- Modify exercise program accordingly to ensure safe participation and to maximize health benefits;
- Provide feedback and demonstrate program effectiveness.

THE AREAS TESTED IN FITNESS ASSESSMENTS

- Body Composition
- Cardiorespiratory Fitness
- Flexibility
- Muscular Strength
- Muscular Endurance

Also check for issues with balance, mobility, and coordination and make notes/comments wherever deemed appropriate.

INITIAL ASSESSMENT & RE-ASSESSMENT GUIDELINES

1. Make sure all patient pre-participation paperwork is completed before conducting the fitness assessment.
2. Have all equipment cleaned and set out for the assessment.
3. When finished with initial assessment prepare the data for the EOI, attaching to paperwork in folder, recording data onto appropriate sheets.
4. Enter all data into online database.
5. When completing a re-assessment, give final data results to supervisor to input information into system and place paperwork in patient folder.
6. Be sure to complete all calculations for patient on the appropriate data collection sheet.

Fitness Assessments. *(2014, December 12). Retrieved March 03, 2017, from http://www.bidmc.org/about-BIDMC/Tanger-Be-Well-Center/Programs-and-Services/Fitness-Assessments.aspx*

TEST TERMINATION CRITERIA

Trainers must be aware of signs and symptoms that merit immediate test termination and physician referral.

- Onset of angina pectoris or angina-like symptoms that center around the chest.
- Significant drop (>10mmHg) in SBP despite a increase in exercise intensity.
- Excessive rise in blood pressure: SBP >250 mmHg or DBP >115 mmHg.
- Fatigue, shortness of breath, difficult or labored breathing, or wheezing (does not include heavy breathing due to intense exercise).
- Signs of poor perfusion: lightheadedness, pallor (pale skin), cyanosis, nausea, or cold and clammy skin.
- Increased nervous system symptoms.
- Leg cramping or claudication.
- Physical or verbal manifestations of severe fatigue.

The test should also be terminated if the client requests to stop or the testing equipment fails.

FITNESS ASSESSMENT DATA COLLECTION SHEET

Maple Tree CANCER ALLIANCE

Patient Name _____ **Date of Birth** (MM/DD/YR) _____

Patient Email _____ **Patient Phone** _____

Physician Address _____

Height (in) _____ **Weight** (lb) _____

Age _____ **Sex** _____ **Date of Assessment** _____

Name of Instructor _____

Comments _____

Blood Pressure _____ **Max Heart Rate** (220-age) _____

Resting Heart Rate _____ **Body Mass Index** (BMI) _____

CIRCUMFERENCE MEASUREMENTS	**Left**	**Right**
Forearm (3" up from styloid process of ulna)	_____	_____
Upper Arm (5" up from olecranon process)	_____	_____
ower Leg (5" up from lateral malleolus)	_____	_____
Upper Leg (5" up from superior ridge of patella)	_____	_____

BODY COMPOSITION: Skinfold Assessment

Female Patients

Tricepts	Suprailiac	Thigh
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
Average _____	Average _____	Average _____

Sum of all 3 Averages _____

Body Fat % _____

Male Patients

Chest	Abdomen	Thigh
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
Average _____	Average _____	Average _____

Sum of all 3 Averages _____

Body Fat % _____

Form continued on next page >>

FITNESS ASSESSMENT DATA COLLECTION SHEET

ALTERNATE BODY COMPOSITION ASSESSMENT

Bio Electrical Impedance Analysis _____%

CARDIOVASCULAR ASSESSMENT

RMCRI Treadmill Test _____ ml/kg/min *(See chart for step-by-step guidelinesto determine VO_2 max)*

ALTERNATE CARDIOVASCULAR ASSESSMENT

Get Up and Go Test: Time _____ Rating (1-5) _____

3 Minute Step Test: Score _____

MUSCULAR STRENGTH ASSESSMENT

Handgrip Dynamometer

Side	Dominant/Non-Dominant	MMT 1	MMT 2	MMT 3	Highest Value
Right	_____	_____	_____	_____	_____
Left	_____	_____	_____	_____	_____

**MMT = Measurement*

MUSCULAR ENDURANCE ASSESSMENT

Modified Curl Up: Repetitions _____

ALTERNATIVE MUSCULAR ENDURANCE ASSESSMENT

60 Second Squat Test: Repetitions _____

30 Second Dominant Arm Curl: Repetitions _____

FLEXIBILITY ASSESSMENT

Sit and Reach Flexibility: MMT 1 _____ MMT 2 _____ MMT 3 _____

**Circle and use highest value, measure to nearest 1/2 inch.*

ALTERNATE FLEXIBILITY ASSESSMENT

Chair Sit and Reach: Inches _____

MEASUREMENTS & ASSESSMENTS

HOW TO MEASURE RESTING HEART RATE

Begin in a seated position after resting for at least 5-10 minutes, with your wrist supinated so the hand faces up away from the ground. Place 2 fingers between the radius and the radial tendons near the base of the thumb. Once you have identified your pulse, keep your fingers there and begin to count the number of beats you feel for 15 seconds. At the end of the 15 seconds, multiply this value by 4 to get your average resting heart rate in beats per minute.

HOW TO MEASURE BODY WEIGHT

Use a digital scale and place it flat on the floor. You may need to step on and off of the scale before getting on it for the first time to help "zero" out the scale. Once the scale has been "zerod", instruct the person to remove their shoes, empty their pockets and take off as many excessively baggy articles of clothing as possible such as sweatshirts, coats, etc. Have the person step onto the center of the scale and ensure they are not holding onto/resting their weight on anything which may result in an inaccurate value. Record the weight to the nearest 1/10th of a pound.

HOW TO CALCULATE BODY MASS INDEX

Using pounds and inches:

[Weight (lbs.)/Height (in.)2] x 703 = BMI

BMI _____

- BMI <18.5 = underweight
- BMI 18.5 – 25 = healthy
- BMI 25 – 30 = overweight
- BMI >30 = obese

CIRCUMFERENCE MEASUREMENTS

Purpose: The purpose of the circumference measurement test is to measure the girths of a patient, for comparison over a period of time.

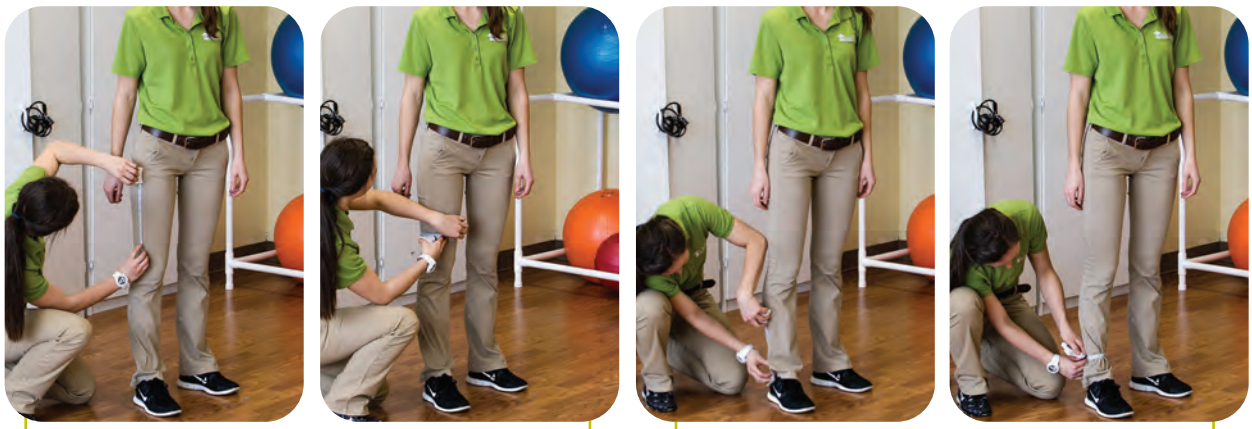
Equipment: Tape measure

Procedure

1. Make sure patient is unflexed during all the measurements.
2. Have the patient extend arm. Using the tape measure, measure the forearm 3 inches up from the styloid process of the ulna and mark the spot, wrap the tape measure around that mark and record the data.
3. Have the patient extend arm. Using the tape measure, measure the upper arm 5 inches up from the olecranon process and mark the spot, wrap the tape measure around that mark and record the data.
4. Have the patient stand in a wide and relaxed stance. Using the tape measure, measure the lower leg 5 inches up from the lateral malleolus and mark the spot, wrap the tape measure around that mark and record the data.
5. Have the patient stand in a wide and relaxed stance. Using the tape measure, measure the upper leg 5 inches up from the superior ridge of the patella and mark the spot, wrap the tape measure around that mark and record the data.
6. Be sure to measure girths of both the patient's left and right side on all four measurement sites.

Forearm: 3" up from styloid process of ulna

Upper Arm: 5" up from olecranon process



Upper Leg: 5" up from the superior ridge of patella

Lower Leg: 5" up from the lateral malleolus

BODY COMPOSITION ASSESSMENT SKINFOLD MEASUREMENT

Three-Site Skinfold Assessment

Purpose: The purpose of the circumference measurement test is to measure the body fat percentage of a patient, for comparison over a period of time.

Equipment: Skinfold calipers, Tape measure, Calculator

Procedure

1. All measurements are made on the right side of the body while the patient is standing upright. *In case of an injury, surgery, amputation, etc. take the skinfold measurements on the left side and make note of the change on the Fitness Assessment Data Collection form.*
2. Grasp each fold with the thumb and forefinger of the non-dominant hand, using an over-handed grip.
3. Place the skinfold caliper directly on the skin surface, approximately 1 cm away and perpendicular from the fold of the skin, half way between the base and the crest of the fold.
4. Maintain the pinch while reading the caliper.
5. Wait no longer than 1-2 seconds before reading the caliper.
6. Take duplicate measures at each site and retest if duplicate measures are not within 1-2 mm.
7. Rotate through measurement sites to allow time for skin to regain normal texture and thickness between successive measurements at consecutive sites.

SKINFOLD SITES & PROCEDURES

Female Patients

Triceps

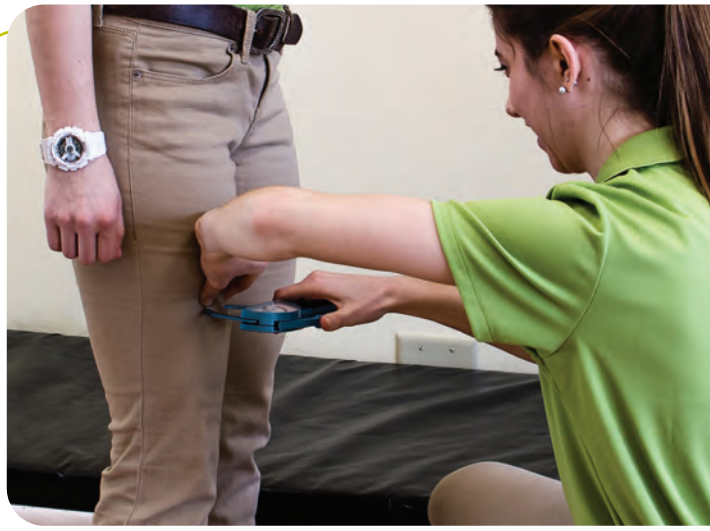
- Direction of Fold: Vertical (midline)
- Anatomical Reference: Between acromion process of scapula and olecranon process of elbow
- Measurement: Distance between lateral projection of acromion process and inferior margin of olecranon process is measured on lateral aspect of arm with the arm relaxed and hanging by the side using tape measure. Midpoint is marked on lateral side of arm. Fold is lifted 1 cm above marked line on posterior aspect of arm. Caliper is applied at marked level.

Suprailiac

- Direction of Fold: Oblique
- Anatomical Reference: Iliac crest
- Measurement: Fold is grasped posteriorly to midaxillary line and superiorly to iliac crease along natural cleavage.

Thigh

- Direction of Fold: Vertical (midline)
- Anatomical Reference: Vertical (midline)
- Measurement: Fold is lifted on anterior aspect of thigh midway between inguinal crease and proximal border of patella. Body weight is shifted to left foot and caliper is applied 1 cm below fingers.



Source: *ACSM's Guidelines for Exercise Testing and Prescription (7th ed.). Lippicott & Wilkins 2006*

SKINFOLD SITES & PROCEDURES

Male Patients

Chest

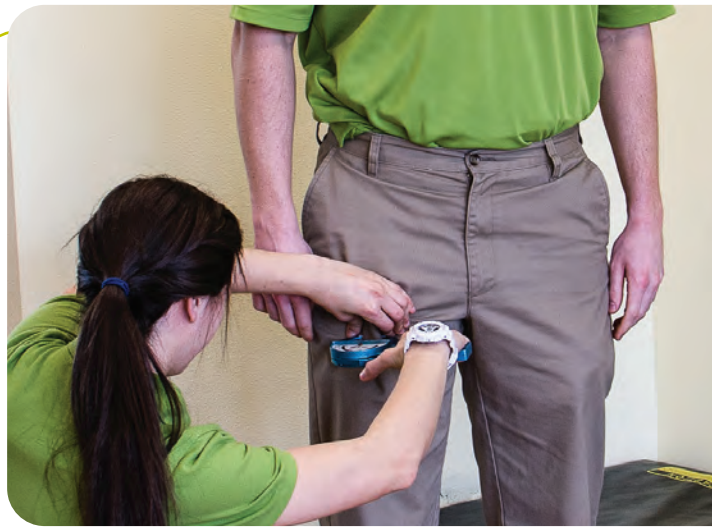
- Direction of Fold: Diagonal
- Anatomical Reference: Anterior axillary and nipple
- Measurement: Fold is taken one-half distance between the anterior axillary line and the nipple.

Abdomen

- Direction of Fold: Horizontal
- Anatomical Reference: Umbilicus
- Measurement: Fold is taken 3 cm lateral and 1 cm inferior to center of umbilicus.

Thigh

- Direction of Fold: Vertical (midline)
- Anatomical Reference: Between Inguinal crease and patella
- Measurement: Fold is lifted on anterior aspect of thigh midway between inguinal crease and proximal border of patella. Body weight is shifted to left foot and caliper is applied 1 cm below fingers.



Source: *ACSM's Guidelines for Exercise Testing and Prescription (7th ed.). Lippicott & Wilkins 2006*

PREDICTION EQUATIONS FOR SKINFOLD MEASUREMENTS

Body Density (Db) Prediction Equations

Female

Three-site Formula (triceps, suprailiac, thigh)

Body density equals: 1.099421 – 0.0009929 (Sum of three skinfolds) + 0.0000023 (Sum of three skinfolds)2 – 0.0001392 (age)

Male

Three-site Formula (chest, abdomen, thigh)

Body density equals: 1.10938 – 0.0008267 (Sum of three skinfolds) + 0.0000016 (Sum of three skinfolds)2 – 0.0002574 (age)

Converting Body Density to Percent Body Fat

Population/Race	Age	Gender	% Body Fat
American Indian	18-60	Female	(4.81/Db) – 4.34
African American	18-32	Male	(4.37/Db) – 3.93
	24-79	Female	(4.85/Db) – 4.39
Hispanic	20-40	Female	(4.87/Db) – 4.41
Japanese Native	18-48	Male	(4.97/Db) – 4.52
		Female	(4.76/Db) – 4.28
	61-78	Male	(4.87/DB) – 4.41
		Female	(4.95/Db) – 4.50
Caucasian	7-12	Male	(5.30/Db) – 4.89
		Female	(5.35/Db) – 4.95
	13-16	Male	(5.07/Db) – 4.64
		Female	(5.10/Db) – 4.66
	17-19	Male	(4.99/Db) – 4.55
		Female	(5.05/Db) – 4.62
	20-80	Male	(4.95/Db) – 4.50
		Female	(5.01/Db) – 4.57
Levels of Body Fatness			
Anorexia	15-30	Female	(5.26/Db) – 4.83
Obesity18-32	17-62	Male	(5.00/Db) – 4.56

** To obtain percent body fat, multiply the value calculated from the equation by 100.*

BIOELECTRICAL IMPEDANCE ANALYSIS (BIA) ASSESSMENT

Purpose: The purpose of measuring BMI and BIA is a method of calculating one's body fat percentage and body mass of a patient.

Equipment: Bioelectrical Impedance device

Procedure

1. Use the Bioelectrical Impedance device, turn it on and enter the patient's information: gender, age, height, and weight.
2. Have the patient hold the device out in front of them with their arms extended. The patient should be holding the device on the metal sections.
3. Press the "start" button.
4. Wait a few seconds for the devise to calculate the information and record the data.

Body Fat % _____

Source: ACSM's Guidelines for Exercise Testing and Prescription (7th ed.). Lippicott & Wilkins 2006

Alternative Body Composition Assessment

The Bioelectrical Impedance Analysis (BIA) would be used in place of skinfold caliper testing. Reasons to use this test include:

- Morbid obesity or anorexia that wouldn't allow the caliper to obtain measurement
- Surgical procedures that interfere with the ability to place calipers appropriately
- Patient objection to skinfold calipers
- No access to skinfold caliper

MUSCULAR STRENGTH ASSESSMENT

Hand Grip Dynamometer

Purpose: To test muscular strength.

Equipment: Dynamometer

Procedure

1. Allow 3 attempts for each hand.
2. Make sure to designate which hand is the dominant hand on evaluation sheet.
3. Zero out the Dynamometer after each attempt.
4. Instruct the patient to squeeze the Dynamometer 2-3 seconds and then relax for each attempt.
5. Record the number.
6. Either sitting or standing, have the patient hold the Dynamometer with a straight arm perpendicular (Image A) to their body. If holding the arm perpendicular is painful in any way, hold it parallel to the body (Image B).
7. Using the highest score for each hand, add those numbers together to get the super score.

Canadian Physical Activity, Fitness & Lifestyle Approach: CSEP-Health & Fitness Program's Health-Related Appraisal & Counseling Strategy, 3rd ed. 2003, 7-47 and 7-48 pp. Reprinted with permission from the Canadian Society for Exercise Physiology.

CARDIORESPIRATORY ASSESSMENT

RMCRI Treadmill Test

Purpose: The RMCRI Treadmill test is a graded exercise test where treadmill speed and grade are gradually increased until patient volitional fatigue. The final workload and the time it takes for the individual to reach volitional fatigue is used to calculate the individuals VO2max.

Equipment: Treadmill, Stop Watch, Heart rate monitor , RPE chart

Procedure

1. Before the patient starts the test, have them put on a heart rate monitor and sit for 10 minutes to obtain their resting heart rate.
2. To begin the test, have the patient stand on the treadmill while holding on the handrails. Once the belt reaches the appropriate speed, have the patient walk for 1 minute at 1.0 mph and 0% grade. (i.e. Stage 1)
3. Follow the chart to know mph and grade progression for each subsequent stage.
4. Continually check on patient and give a warning before changing a speed or grade.
5. Watch to see if the patient is holding on handrails or walking/running. Once they hold on the handrails, use the intensity appropriate for the handrails.
6. Make sure to stand slightly behind and off to the side of the patient for their safety.
7. Once the patient voluntarily terminates the test, stop the timer and gradually lower the speed and grade. Note the time they stopped.
8. Have the patient cool down at a comfortable speed with 0% grade for 3-5 minutes to lower heart rate.

PROGRESSION CHART

Stage	Speed (mph)	Grade (%)	Estimated VO2 peak (ml/kg/min)		METS	Estimated VO2 peak (Handrails)		METS (Handrails)
1	1.0	0	6.2 (walk)		1.7	6.2 (walk)		1.7
2	1.5	0	7.5 (walk)		2.1	7.5 (walk)		2.1
3	2.0	0	8.9 (walk)		2.5	8.9 (walk)		2.5
4	2.5	0	10.2 (walk)		2.9	10.2 (walk)		2.9
5	2.5	2	12.6 (walk)		3.6	12.1 (walk)		3.5
6	3.0	3	15.9 (walk)		4.5	14.4 (walk)		4.1
7	3.3	3	17.1 (walk)		4.9	15.2 (walk)		4.3
8	3.4	4	19.1 (walk)		5.5	16.6 (walk)		4.7
9	3.5	5	21.3 (walk)		6.1	18.1 (walk)		5.2
10	3.6	6	28.0 (run)	23.6 (walk)	8.0/6.7	22.8 (run)	19.7 (walk)	6.5/5.6
11	3.7	7	29.6 (run)	25.9 (walk)	8.5/7.4	23.9 (run)	21.3 (walk)	6.8/6.1
12	3.8	8	31.3 (run)	28.4 (walk)	8.9/8.01	25.0 (run)	23.0 (walk)	7.1/6.6
13	3.9	9	32.9 (run)	30.9 (walk)	9.4/9.6	26.2 (run)	24.8 (walk)	7.5/7.1
14	4.0	10	34.6 (run)	33.5 (walk)	9.9/9.6	27.3 (run)	26.6 (walk)	7.8/7.6
15	4.1	11	36.4 (run)	36.3 (walk)	10.4/10.4	28.6 (run)	28.5 (walk)	8.2/8.1
16	4.2	12	38.2 (run)	39.0 (walk)	10.9/11.1	29.8 (run)	30.4 (walk)	8.5/8.7
17	4.3	13	40.0 (run)	42.0 (walk)	11.4/12.0	31.1 (run)	32.5 (walk)	8.9/9.3
18	4.4	14	41.9 (run)	45.0 (walk)	12.0/12.9	32.4 (run)	34.6 (walk)	9.3/9.9
19	4.5	15	43.9 (run)	48.1 (walk)	12.5/13.7	33.8 (run)	36.7 (walk)	9.7/10.5
20	4.6	16	45.9 (run)	51.3 (walk)	13.1/14.7	35.2 (run)	38.9 (walk)	10.0/11.1
21	4.7	17	48.0 (run)	54.6 (walk)	13.7/15.6	36.6 (run)	41.2 (walk)	10.5/11.8

Alternative Cardiorespiratory Assessment

Get-Up-And-Go or 3-Minute Step

These tests would be used in place of the RMCRI Treadmill test. Reasons to perform these tests include:

- Patient's inability to walk on treadmill due to age, condition (mobility, balance, coordination, etc.) or injury
- Patient objection to preferred test
- No access to treadmill at facility, or treadmill is broken/defective

GET-UP-AND-GO ASSESSMENT

First Alternative Choice

Purpose: The Get-Up-and-Go Test is used to measure mobility.

Equipment: Chair, Stop Watch, Measuring Tool, Tape

Procedure

1. Find an open space with at least 3.5 meters to walk.
2. Take a measuring tool and 2 pieces of tape, and measure them 3 meters apart from each other.
3. If the patient needs any type of walking aid, they may use one.
4. Start with the patient sitting in a chair behind the first piece of tape.
5. To start the test, Instruct the patient to do the following when you say "Go":
   - Stand up from the chair (Image A).
   - Walk to the other piece of tape (3 meters), and turn around (Image B).
   - Walk back to the chair (Image C).
   - Sit down (Image A).
6. Time how long it takes for the patient from "go" to sitting back down in the chair.
7. Observe the patient's gait, stability, and steps.
8. Scoring is based on how their gait, stability,and steps look.
9. Record time and score 1-5.

Get-up and Go Test in: Mathias S. Nayak USL, Isaacs B. Balance in elderly patients"The "Get Up and Go"Test, Arch Phys Med Rehabil (1986)67:387-389; Podsiadlo D, Richardson S. The Timed "Up and Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991; 39:142-148.

3-MINUTE STEP ASSESSMENT

Second Alternative Choice

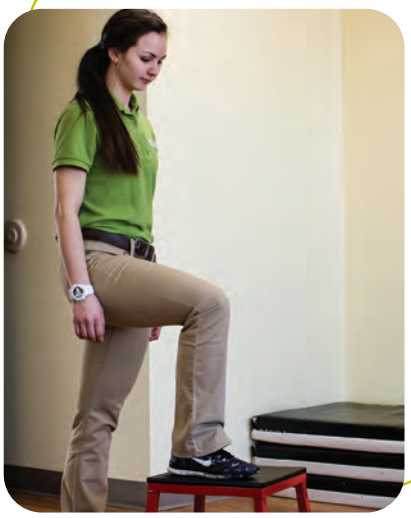
Purpose: The 3-Minute Step Assessment measures a patient's aerobic cardiovascular fitness level based on how quickly their heart rate returns to normal after exercise.

Equipment: Stop Watch, 12" Step/Box/Bench, Metronome, Heart Rate Monitor

Procedure

1. Make sure step, box, or bench is sturdy.
2. Set metronome to 96 beats per minute and let the patient get used to the beat (up, up, down, down).
3. Once they have the beat down, start the test by stepping up and down for 3 minutes.
4. The patient may rest during the test, but if they do they must stay standing.
5. Once the 3 minutes are over, have the patient sit down and record pulse.
6. Measure heart rate before the test, every 30 seconds during the test, directly after the 3 minutes are over, and 1 minute after the test is over.

1



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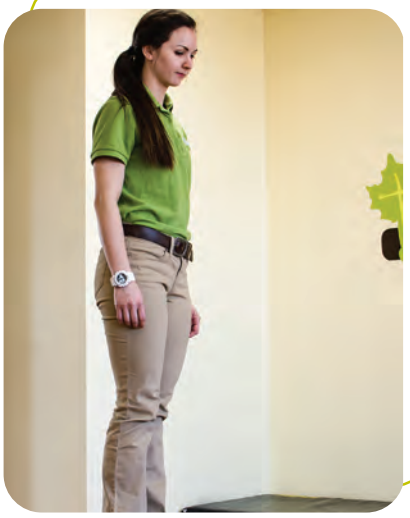

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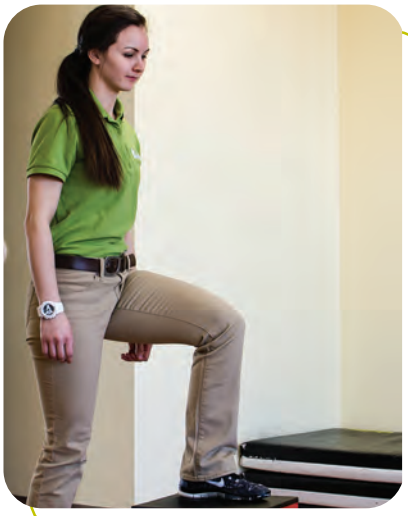

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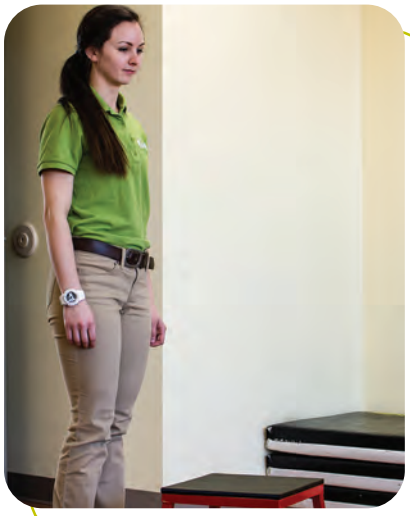


MUSCULAR ENDURANCE ASSESSMENT

Modified Curl-Up Assessment Protocol

Purpose: The purpose of the curl-up crunch test is to access the muscular endurance of the patient's abdominal muscles.

Equipment: Mat, Measuring Tape , Masking Tape, Metronome

Procedure

1. Instruct the patient to lie on a mat on his/her back with their knees flexed at a 90° angle and the arms straight at their side. This is called the "starting point."
2. Place a small piece of masking tape at the tip of the patient's fingers to mark the starting point.
3. If the patient is ≤45 years of age, measure out 12 cm for the stopping point. If the patient is >45 years of age, measure out 8cm for the stopping point.
4. A 36" wood stick may be used to provide the patient a stopping point, as they might not be able to feel the second piece of tape.
5. Set the metronome to a rate of 40 beats per minute.
6. Instruct the patient to slide his/her hands from the starting point to the stopping point, keeping pace with the metronome.
7. One repetition is counted each time the shoulder blades touch the floor.
8. The test continues until the individual reaches volitional fatigue or the maximum 75 reps.

Source: Trainer, Jason Anderson Certified Personal. "The 3-Minute Step Test." SparkPeople. N.p., 24 June 2008.

Alternative Muscular Endurance Assessment

Get-Up-and-Go or 3-Minute Step

These tests would be used in place of the RMCRI Treadmill test. Reasons to perform these tests include:

- Patient's inability to walk on treadmill due to age, condition (mobility, balance, coordination, etc.) or injury
- Patient objection to preferred test
- No access to treadmill at facility, or treadmill is broken/defective

60-SECOND BODY WEIGHT SQUAT ASSESSMENT

First Alternative Choice

Purpose: The purpose of the body-weight squat test is to test the muscles in the lower body on their ability to perform repeated muscular contractions.

Equipment: Seated Bench, Stopwatch

Procedure

1. Stand in front of a chair or bench with the feet shoulder width apart, facing away from the bench.
2. Hand should be placed on hips, or out in front of the patient.
3. Patient will push their hips back and bend their knees to lower down into a squat.
4. Once their hips touch the chair/bench, they will stand back up.
5. Patients have 60 seconds to complete as many repetitions as they can. Patients may rest anytime during the test.

Source: Mackenzie, B. (2005) Squats Test [WWW] Available from: http://www.brianmac.co.uk/squatest.htm [Accessed29/7/2016]

30 SECOND ARM CURL ASSESSMENT

Second Alternative Choice

Purpose: The purpose of this test is to measure upper extremity muscular endurance.

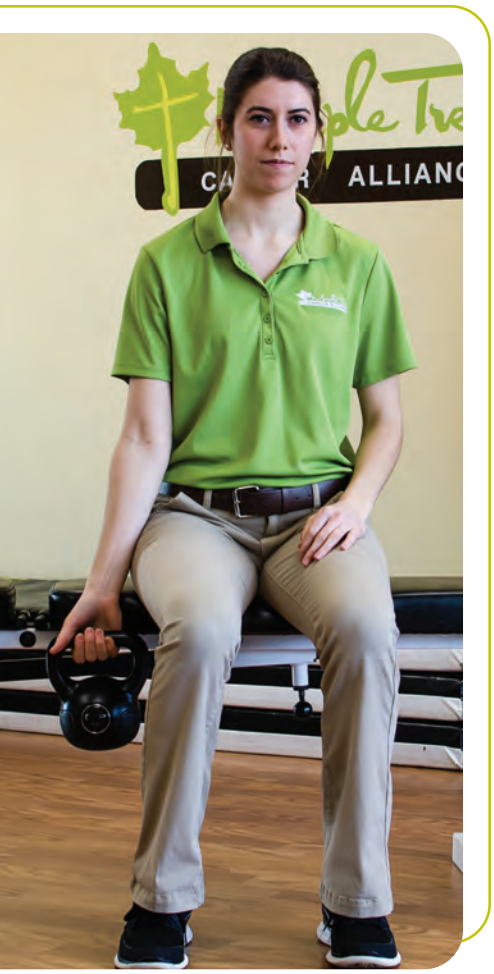
Equipment: Weight, Seat, Stopwatch

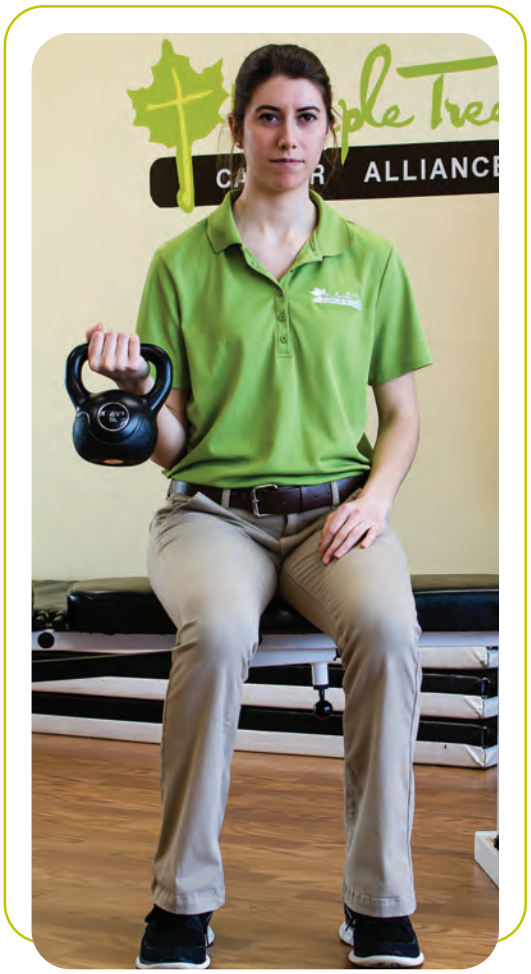
Procedure

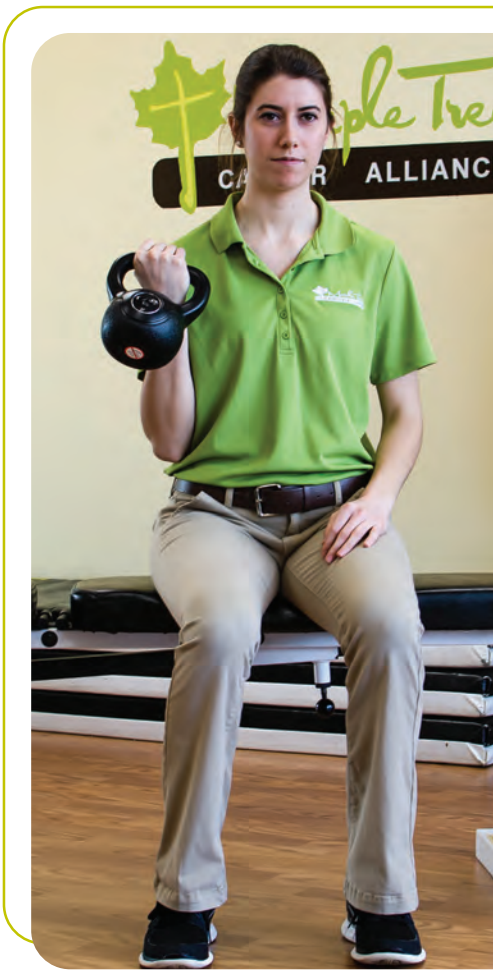
1. The client/patient is seated in a chair holding a weight (4 lbs for women, 8 lbs for men) with the palm facing the body. The arm should be against the trunk to avoid using other muscle groups.
2. As the arm is brought up to the shoulder and lowered to 90°. This movement will be one rep.
3. The goal is to complete as many reps (through the entire available range of motion) in 30 seconds.

Anna Rozanska-Kirschke, Piotr Kocur, Malgorzata Wilk, Piotr Dylewicz, The Fullerton Fitness Test as an index of fitness in the elderly, Medical Rehabilitation 2006; 10(2): 9-16.

Jones C.J., Rikli R.E., Measuring functional fitness of older adults, The Journal on Active Aging, March April 2002, pp. 24-30.







FLEXIBILITY ASSESSMENT

Sit and Reach

Purpose: Measure lower body flexibility

Equipment: Sit and reach box

Procedure

1. Sit on the floor with legs stretched out straight ahead.
2. Shoes removed.
3. The soles of the feet are placed flat against the box.
4. Both knees should be locked and pressed flat to the floor.
5. Place hands on top of each other, reach forward along the measuring line as far as possible. Exhale as they bend forward and push bar forward.
6. This position is held for 1-2 seconds while the distance is recorded.
7. Three measurements are taken. Use the highest measurement as the score.

CHAIR SIT AND REACH

Alternative Choice

Purpose: Measure lower body flexibility

Equipment: Ruler or measuring tape, Chair with flat surface

Procedure

1. Sit in a chair with legs extended, knees straight, heels on the floor, and ankles bent at 90 degrees.
2. Place one hand on top of the other, with tips of the middle fingers even.
3. Inhale reach forward as they exhale, by bending at the hip.
4. Keep the back straight and the head up.
5. Measure the distance between the tip of the fingertips and the top of the shoes.

HOW TO CONDUCT THE RANGE OF MOTION (SEATED OR SUPINE)

Seated Upper

Shoulder Flexion

Patient is seated with upright posture and the measured arm is straight down by their side. The patient will keep their arm straight as they lift it forward while trying to keep the wrist in line with the shoulder.

The instructor is oriented laterally on the same side of the patient as the moving arm. After the patient moves their arm, the instructor will place the axis of the goniometer on the lateral aspect of the glenohumeral joint and the stationary arm parallel to the spine. They will then rotate the movement arm forwards so the movement arm runs atop the humerus.




Shoulder Extension

Patient is seated with upright posture and the measured arm is straight down by their side. The patient will keep their arm straight as they lift it backwards while trying to keep the wrist in line with the shoulder.

The instructor is oriented laterally on the same side of the patient as the moving arm. After the patient moves their arm, the instructor will place the axis of the goniometer on the lateral aspect of the glenohumeral joint and the stationary arm parallel to the spine. They will then rotate the movement arm backwards so the movement arm runs atop the humerus.

Shoulder Abduction

Patient is seated with upright posture and the measured arm is straight down by their side. The patient will keep their arm straight as they lift it laterally away from the body trying to keep the wrist in line with the shoulder and get the arm to be overhead.

The instructor is oriented in front of the patient, on the same side of the patient as the moving arm. After the patient moves their arm, the instructor will hover from a distance the axis of the goniometer so it is oriented with the anterior aspect of the glenohumeral joint and the stationary arm parallel to the spine. They will then rotate the movement arm so the movement arm runs atop the humerus.

Shoulder External Rotation

Patient is seated with upright posture and the measured arm is laterally abducted away from the body with the elbow bent at 90 degrees, the elbow in line with the shoulder and wrist in line with the elbow and the palm facing towards the floor. The patient should maintain this position as they let their hand rotate up towards the ceiling by allowing their elbow to pivot.

The instructor is oriented laterally to the patient on the same side of the patient as the moving arm. After the patient rotates their arm, place the axis of the goniometer so it is oriented with the olecranon process of the elbow and the stationary arm runs parallel to the floor. The instructor will then rotate the movement arm so it is aligned with the ulna of the forearm.

Shoulder Internal Rotation

Patient is seated with upright posture and the measured arm is laterally abducted away from the body with the elbow bent at 90 degrees, the elbow in line with the shoulder and wrist in line with the elbow and the palm facing towards the floor. The patient should maintain this position as they let their hand rotate up downwards to the floor by allowing their elbow to pivot.

The instructor is oriented laterally to the patient on the same side of the patient as the moving arm. After the patient rotates their arm, place the axis of the goniometer so it is oriented with the olecranon process of the elbow and the stationary arm runs parallel to the floor. The instructor will then rotate the movement arm so it is aligned with the ulna of the forearm.

Supine Upper

Shoulder Flexion

The patient should be oriented in the supine position with the knees bent and arms straight down at their sides. Instruct the patient to keep the palm facing the body as they keep their arm straight, and lift it overhead and backwards as far as possible while keeping the shoulder, elbow and wrist in alignment.

The instructor should be oriented laterally to the patient on the same side as the moving arm. After the patient flexes their arm overhead, place the axis at the lateral aspect of the glenohumeral joint with the stationary arm aligning with the spine. The instructor should then move the movement arm until it aligns with the midline of the humerus.

Shoulder Extension

The patient should be oriented in the prone position, head turned away from the working arm, legs straight, and arms straight down at their sides. Instruct the patient to keep the palm facing the body as they keep their arm straight, and extend it backwards up towards the ceiling as far as possible while keeping the shoulder, elbow and wrist in alignment.

The instructor should be oriented laterally to the patient on the same side as the moving arm. After the patient extends their arm, place the axis at the lateral aspect of the glenohumeral joint with the stationary arm aligning with the spine. The instructor should then move the movement arm until it aligns with the midline of the humerus.

Shoulder Abduction

The patient should be oriented in the supine position, with the knees bent and arms straight down at their sides. Instruct the patient to keep the arm straight as they drag it laterally away from the midline of their body and as close to overhead as possible while keeping the wrist, elbow and shoulder in alignment.

The instructor should be oriented laterally to the patient on the same side as the moving arm. After the patient is done, place the axis hovering over the anterior lateral aspect of the glenohumeral joint and the stationary arm parallel to the spine. The instructor should then move the movement arm until it aligns with the midline of the humerus.

Shoulder External Rotation

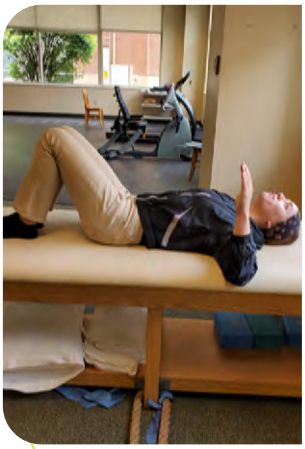
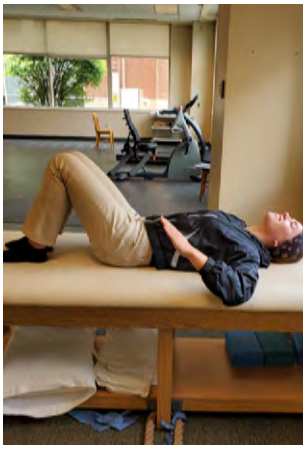
The patient should be oriented in the supine position, with the knees bent and arms laterally extended out at the sides. The patient should bend their arms at the elbow to form a 90 degree angle where the elbow is in line with the shoulder. Instruct the patient to keep the shoulder against the table as they pivot from the elbow to rotate the back of the hand up and back towards the table.

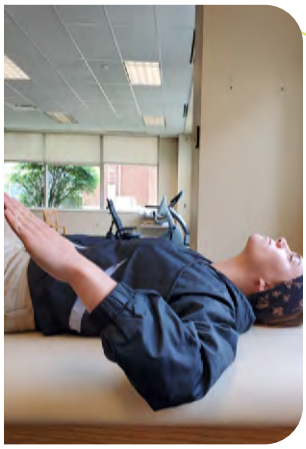
The instructor should be oriented laterally to the patient on the same side as the moving arm. After the patient is done, the axis is placed on the lateral epicondyle of the elbow, with the stationary arm aligning perpendicular to the floor. The instructor should then move the movement arm until it aligns with the midline of the ulna.

Shoulder Internal Rotation

The patient should be oriented in the supine position, with the knees bent and arms laterally extended out at the sides. The patient should bend their arms at the elbow to form a 90 degree angle where the elbow is in line with the shoulder. Instruct the patient to keep the shoulder against the table as they pivot from the elbow to rotate the front of the hand down towards the table.

The instructor should be oriented laterally to the patient on the same side as the moving arm. After the patient is done, the axis is placed on the lateral epicondyle of the elbow, with the stationary arm aligning perpendicular to the floor. The instructor should then move the movement arm until it aligns with the midline of the ulna.



Supine Lower

Hip Flexion

The patient should be oriented in the supine position with both legs fully extended. Instruct the patient to flex the hip by bringing the knee to the chest without the use of their arms.

The instructor is oriented laterally to the patient on the same sides as the working leg. The axis of the goniometer is oriented laterally on the greater trochanter of the femur and the stationary arm runs parallel to the spine. Once the patient has moved the moving limb, move the movement arm until it aligns with the femur.

Hip Extension

The patient should be oriented in the prone position with both legs fully extended. Instruct the patient to extend the hip by lifting the working leg up as high as possible.

The instructor is oriented laterally to the patient on the same sides as the working leg. The axis of the goniometer is oriented laterally on the greater trochanter of the femur and the stationary arm runs parallel to the spine. Once the patient has moved the moving limb, move the movement arm until it aligns with the femur.

Hip Abduction

The patient should be oriented in the supine position with both legs fully extended. Instruct the patient to abduct the hip by lifting up the leg and sliding it laterally away from the midline of the body as far as possible.

The instructor is oriented laterally to the patient on the same sides as the working leg. The axis of the goniometer is oriented superior to the anterior superior iliac spine (ASIS) of the pelvis and the stationary arm runs opposite in direction to the ASIS. Once the patient has moved the moving limb, move the movement arm until it aligns with the femur and patella.

Hip Adduction

The patient should be oriented in the supine position with both legs fully extended and the non-tested leg abducted laterally away from the midline of the body. Instruct the patient to adduct the hip by lifting up the leg and sliding it medially towards and across the midline of the body as much as possible.

The instructor is oriented laterally to the patient on the same sides as the working leg. The axis of the goniometer is oriented superior to the ASIS of the pelvis and the stationary arm runs opposite in direction to the ASIS. Once the patient has moved the moving limb, move the movement arm until it aligns with the femur and patella.

Knee Flexion

The patient should be oriented in the supine position with both legs fully extended. Instruct the patient to slide the back of the heel along the ground as much as possible until they can no longer bend their knee.

The instructor should be oriented laterally to the patient on the same side as the working leg. The axis of the goniometer is oriented on the lateral epicondyle of the femur and the stationary arm aligns with the greater trochanter of the femur. Once the patient has moved the moving limb, the instructor should move the movement arm parallel to the lateral aspect of the fibula.

Knee Extension

The patient should be oriented in the supine position with both legs fully extended. Instruct the patient to press the back of the knee down into the ground as much as possible by locking out their knee.

The instructor should be oriented laterally to the patient on the same side as the working leg. The axis of the goniometer is oriented on the lateral epicondyle of the femur and the stationary arm.

STATIC POSTURAL ANALYSIS TEST

Purpose: To determine postural deviations and muscle imbalances.

Equipment: None

Procedure

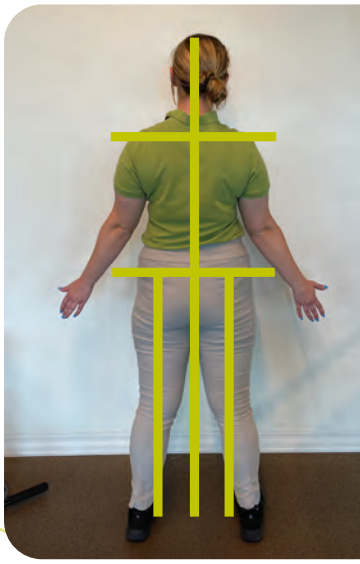
Start by having the patient remove their shoes. Against a wall or a postural grid, have your patient close their eyes and march in place for approximately 5-10 seconds. The patient will then stop marching and stand completely still as you make observations of their posture from an anterior, lateral and posterior viewpoint.

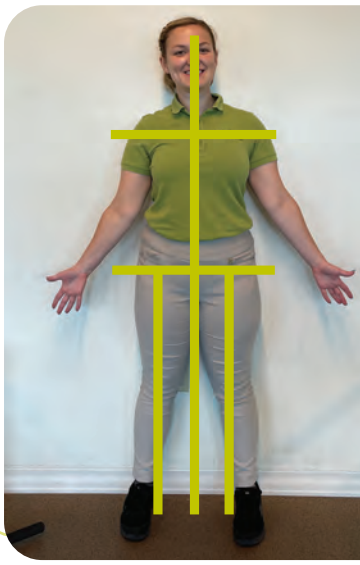
Note: *Patients with disabilities that confine them to a wheelchair, a walker/cane or severe balance issues may need to alter their stance, or in situations where someone is confined to a wheelchair, you may not be able to complete a full assessment (some parts still may be applicable). For those who require a walker, it is recommended to wear a gait belt and be near them, or if they are able to stand where they can grab on to a wall or their walker in case of balance issues*

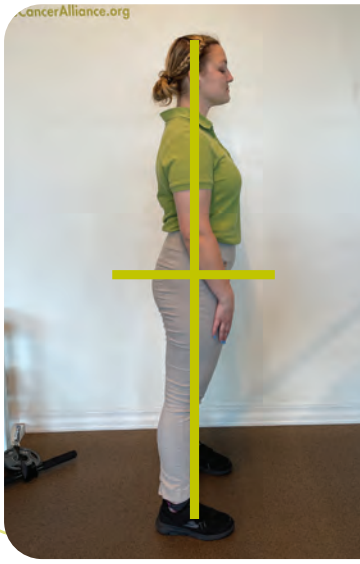
1. Start by looking at the patient from an anterior view.
   - Shoulders should be level, and you should not see elevation or depression in their shoulder.
   - Hips should be level, and you should not notice a "hip hike or hip drop".
   - Look for the position of the hands, with thumbs pointing towards each other, it could indicate rounded shoulders.
   - There should be no noticeable bow leg or knock knee.
   - Knees should be facing towards the front, not far out to the side or inwards.
   - Look at the arches of the feet and the ankles. If flat footed, this could indicate they may have pronation and higher arches could indicate supination.

2. Looking posteriorly at their body:
   - Make sure the head is not tilted from side to side.
   - Look for depression or elevation in the shoulders.
   - You cannot diagnose but palpate the spine to note any scoliosis.
     ** Always ask patients if they have ever been diagnosed with scoliosis.*
   - There should be no winging of the shoulder blades. A condition that typically results from damage to the long thoracic nerve.
   - Note the position of the hips. Is one side higher than the other?
   - The patients arches should not be excessively raised or flat.

3. Looking laterally:
   - Note head position. Ears should be between their collarbone and not excessively far forward.
   - Shoulders should not be excessively rounded.
   - Look for any spinal curvatures.
   - Have the patient place their hands on their hips. Note the location of their ASIS (Anterior Superior Illiac Spine) and PSIS (Posterior Superior Illiac Spine). Make sure the hands are not too far forward or fingers pointing straight up. This could indicate tilt issues at the hip.
   - Knees should not be hyperextending.







POSTURAL ASSESSMENT

Maple Tree CANCER ALLIANCE

Patient Name _____ **Date** _____

Was a postural assessment conducted? ☐ Yes ☐ No

☐ Evaluation was performed, but no deviations or imbalances were found.

Check all deviations and/or imbalances found during assessment.

☐ Forward Head	☐ Lateral tilt	☐ Hyperextended
☐ Elevated	☐ Anterior tilt	☐ Supinated
☐ Winged	☐ Posterior tilt	☐ Pronated
☐ Kyphosis	☐ Medial rotation	
☐ Scoliosis	☐ Lateral rotation	
☐ Rounded/protracted	☐ Knocked knee	
☐ Lordosis	☐ Bow legs	

Comments _____

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FOUR STAGE BALANCE TEST

Purpose

The purpose of this test is to assess standing balance in patients. Using this test, the patient's risk for falling can be assessed, allowing for the exercise oncology specialist to develop an exercise prescription to improve balance. This, in turn, helps to ensure that the patient can more safely perform both exercises as well as activities of daily living by reducing the risk of fall-related injuries.

Equipment

The only equipment necessary is a stopwatch to measure time (in seconds) to monitor the patient so that they maintain the four stances.

Procedure

This Test consists of 4 stances, each getting progressively harder than the last.

Using a stopwatch, record the number of seconds the patient is able to maintain the desired stance. The patient may progress to the next stage either after balance has been lost, or the stance has been maintained for a full 10 seconds. The patient may use his or her arms to help maintain their balance.

Begin the test by demonstrating to the patient how to perform stage one. During stage one, the subject will stand with feet parallel, and will try to maintain the stance for 10 seconds. When the patient is ready, instruct them to perform the stage. Use the stopwatch to count how long the stance is maintained, or 10 seconds.

Next, demonstrate to the patient how to perform stage two. During stage two, the subject will stand in a posture so that with parallel feet, the big toe of one foot is touching the instep of the other and will try to maintain the stance for 10 seconds. When the patient is ready, instruct them to perform the stage. Use the stopwatch to count how long the stance is maintained, or 10 seconds.

Next, demonstrate to the patient how to perform stage three. During stage three, the subject will stand heel to toe, and will try to maintain the stance for 10 seconds. When the patient is ready, instruct them to perform the stage. Use the stopwatch to count how long the stance is maintained, or 10 seconds.

Next, demonstrate to the patient how to perform stage four. During stage four, the subject will stand on one foot, and will try to maintain the stance for 10 seconds. When the patient is ready, instruct them to perform the stage. Use the stopwatch to count how long the stance is maintained, or 10 seconds. *Do not perform this stage if patient has leg amputation, lymphedema/swelling, or severe pain in the balance leg or foot.

Assessment

Stage one (parallel feet) is the most important stage as it is the most relevant indicator of fall risk. For all stages, record the time the patient maintained the stances. In the exercise prescription form on google docs, the results of the first stage will be recorded.

Classifications will be as follows:

> 9 seconds = normal
< 8 seconds = very slightly abnormal
< 6 seconds = mildly abnormal
< 4 seconds = moderately abnormal
< 2 seconds = severely abnormal

Goals

During the 12-week phase, the fitness goals from assessment to reassessment should be to increase the patient's stance durations by +2 seconds.

Notes

- The patient can have their arms out for balance or leave them at their side.
- Once a patient completes 10 seconds, stop the test regardless of ability to keep going. 10 seconds is the maximum time.

Source: Centers for Disease Control and Prevention STEADI program, 2017

EXERCISE PRESCRIPTION

GOAL SETTING

Once the fitness assessment has been completed and reviewed, the EOI develops an individualized exercise prescription for the patient, addressing recommendations pertaining to the frequency, intensity, duration, mode and progression of exercise.

Ideally, for an individual undergoing cancer treatment, the prescription will include a whole-body workout that targets all the major muscle groups. The table below illustrates the appropriate goals for the 12-week initial assessment.

Appropriate Goals for the 12-Week Initial Assessment

Body Fat %	-1% to -2%
BMI	-1 to -2 points reduction in overall score
Predicted VO_2 Peak	+3 to +4 ml/kg/min
Get Up and Go	Decrease in overall time/improved step pattern
3-Minute Step Test	Heart rate that returns to normal quicker than previously scored
Treadmill Time	+2 to +3 minutes
R Handgrip	Average Category or Higher
L Handgrip	Average Category or Higher
Modified Curl Up Test	+6 - 9 Repetitions
60 Second Squat Test	Average Category or Higher
30 Second Dominant Arm Curl Test	Average or Above Average Category
Modified Sit and Reach	+0.5 to +1 inch
Chair Sit and Reach	Average or Above Average Rating

MAPLE TREE PATIENT PHASE SYSTEM

After completing an initial assessment and goal setting, patients are assigned a phase of rehabilitation based on their treatment status and placement on the cancer continuum. Periodic follow-up assessments will allow patients to track their recovery and provide valuable information in the formulation of an individualized exercise prescription.

0 PHASE 0: Prehabilitation

Who: Cancer survivors who have been diagnosed but not yet started treatment. Phase duration is up to 6 weeks prior to the start of the treatments and/or surgery.

Goals: To obtain baseline measurements and to improve functional capacity prior to treatments to reduce treatment-related side effects.

What type of training is provided? Low-to-moderate intensity, one-on-one training.

1 PHASE 1: Active Treatment

Who: Cancer survivors who are currently undergoing chemotherapy and/or radiation treatments, or have a recurrence of cancer requiring additional chemotherapy and/or radiation. Patients will remain in this phase during cancer treatment, or for 12 weeks.

Goals: To attenuate treatment-related side effects of chemotherapy and/or radiation treatment and protect immune function.

What type of training is provided? Low intensity, one-on-one training.

NOTE: Due to varying lengths of treatment, patient may stay in Phase 1 until the cessation of chemotherapy/ radiation before moving onto Phase 2.

2 PHASE 2: Pre-Survivorship

Who: Cancer survivors who have completed Phase 1, or clients who have had surgery and/or hormonal treatment, and have not received chemotherapy or radiation. Patients will remain in this Phase for 12 weeks.

Goals: To reduce the physical and functional limitations created by cancer treatment.

What type of training is provided? Low-to-moderate intensity, one-on-one training that incorporates foundational, technique-oriented exercises.

3 PHASE 3: Survivorship

Who: Cancer survivors who have completed active cancer treatment.

Goals: To improve physiological and psychological values beyond baseline. Clients should be back to functional health after completing this phase.

What type of training is provided? Moderate intensity, one-on-one training. Typically this takes place in the community setting.

Phase	Description	Exercise Intensity
0	Prehabilitation; patient has not started treatments and/or surgery	40% - 50%
1	Patient currently in chemo/radiation	30% - 45%
2	Patient completed chemo/radiation, or only received surgery and/or hormonal therapy	40% - 60%
3	Patient successfully completed Phase 2	50% - 85%

PLANNING THE PROGRAM

The overall goal of the exercise program should be to minimize the general de-conditioning and toxicities that often accompany cancer treatment. In general, the exercise prescription should include a slow progression and demonstrate adaptability to changes in the patient's health status, which frequently will change from day-to-day during treatment.

Research indicates that individuals undergoing cancer therapy benefit from low-to-moderate intensity aerobic and resistance exercise[1]. Based on available data, the table below presents some general guidelines a EOI may follow when designing an exercise program[2].

Typically, previously active cancer patients may continue their exercise regimen, although intensity may need to be decreased during treatment. Progression should consist of increases in frequency and duration rather than intensity[3].

1 Swartz, 2009
2 Schmitz et al., 2010; Physical Activities Guidelines Advisory Committee, 2008; Haskell et al., 2007; Schneider & Carter, 2003)
3 Physical Activities Guidelines Committee, 2008; Schneider & Carter, 2003

	Aerobic Training	Strength Training	Flexibility Training
Frequency	3-5 days/wk	2-3 days/wk	2-7 days/wk
Duration	20-60 min/session	1-3 sets, 8-12 reps per exercise	10-30 seconds per stretch
Mode	Walking, cycling, cross trainers, swimming	Free weights, machines, resistance bands, resistance balls	Static stretching

12-WEEK INTENSITY PHASE PLAN

Maple Tree Cancer Alliance utilizes a 12-week intensity plan that will give the EOI a week-by-week breakdown of the patient's expected intensity based on their current Phase. For each week the EOI make small incremental jumps (i.e. 1% or 2%) in the patient's exercise intensity. For example, a patient in Phase 1 should begin week 1 at 30% and should progress to 32%, 33%, 35%, 37%, 38%, each week until 45% is reached during week 12. In other words, the first week should always start out on the lowest intensity level for the Phase, and the final week should end at the highest intensity for that Phase. A patient in Phase 2 starts out at 40%, but should end week twelve at 60%.

Note: A patient in Phase 1 may be required to remain in Phase 1 for longer than 12 weeks based on the treatment length. If a patient is on a treatment cycle that lasts more than 15 weeks, or is on a known chemotherapy drug that would last very long term (one year plus), the EOI, together with the oncologist, must evaluate if/when the patient is able to advance to Phase 2.

Once this task is complete, the EOI will need to determine the patient's target heart rate. The calculation is as follows:

(MAX HR – Resting HR) x Intensity (for that week) + Resting HR

EXERCISE PRESCRIPTION

Maple Tree CANCER ALLIANCE

Patient Name _____ **Date of Birth** (MM/DD/YR) _____

Date _____ ☐ **Male** ☐ **Female**

Height (in) _____ **Weight** (lb) _____

Fitness Variable	**Score**	**Rating**	**12-Week Goal**
Body Composition			
Cardiovascular Endurance			
Muscular Endurance			
Muscular Strength			
Flexibility			
Balance			

Intensity Calculations

Phase of Patient _____

Week of Training	**Target Intensity**	**Target Heart Rate**
Week 1		
Week 2		
Week 3		
Week 4		
Week 5		
Week 6		
Week 7		
Week 8		
Week 9		
Week 10		
Week 11		
Week 12		

Comments _____

EXERCISE PROGRAMMING

PRE-EXERCISE GUIDELINES

Prior to each exercise session, the EOI must assess the patient's readiness to exercise. Resting heart rate and blood pressure should be measured, and general information regarding the patient's overall health status should be obtained. Depending on the information attained from the patient, the exercise intervention may need to be adjusted for that day.

Contraindications to exercise are:

- Onset of nausea following exercise initiation
- Vomiting within the last 24 hours
- Leg pain
- Decreased heart rate and blood pressure with increased workload
- Chest pain
- Difficult or shallow breathing
- Difficult or shallow breathing
- Unusual muscle weakness
- Numbness in the extremities
- Chemotherapy treatment within the last 24-hours
- Irregular pulse during exertion
- Disorientation and confusion
- Dizziness

Borg Ratings of Perceived Exertion (RPE) Scale:

0	Rest
1	Really Easy
2	Easy
3	Moderate
4	Sort of Hard
5	Hard
6	...
7	Really Hard
8	...
9	Really, Really Hard
10	Maximal

SUPERVISED EXERCISE TRAINING SESSION

All exercise sessions must be recorded in a patient log book. Each session must include the following components:

Warm Up: Each session should begin with a 5 to 10-minute warm-up that stimulates blood flow to the working muscles. The warm-up should involve some mild stretching and light aerobic activity.

Aerobic Exercise: During the aerobic component of exercise, it is important to frequently monitor blood pressure and heart rate. If the patient is on a medication that effects heart rate, the Borg Scale of Exertion[1] may be used to monitor intensity. Based on this scale, a light-to-moderate intensity (RPE of 3-5) should be encouraged. If dizziness, nausea, or chest pain occurs, all exercise should be stopped. Frequent short breaks are sometimes encouraged to accommodate therapy-related fatigue.

Resistance Training: The type of resistance exercise performed will depend on the patient's range of motion, tissue removal, and wound healing. ACSM recommends at least 48 hours of rest between each resistance training session[2]. Therefore, it may be advisable to plan a whole-body approach to resistance training, where all major muscle groups are targeted in one day. If the patient is unwilling or unable to participate in traditional modes of strength training, Yoga or Pilates may serve as an alternative form of strength exercise.

Cool Down: Exercise should be followed by static stretching and range of motion exercises for all major muscle groups.

1 Borg, 1973
2 Schneider & Carter, 2003

EXERCISE LOG

Maple Tree CANCER ALLIANCE

Date _____ **Trainer Name** _____

Patient Name _____

Patient Phase & Week Number _____ **Patient Intensity for the Week** _____

Pre-Exercise Comments _____

_____

_____

Pre-Exercise Heart Rate (bpm) _____ **Pre-Exercise Blood Pressure** _____

CARDIOVASCULAR EXERCISE

Exercise	Duration	Intensity	
		Heart Rate	RPE
Warm Up			
Cool Down			

Form continued on next page >>

EXERCISE LOG

Maple Tree CANCER ALLIANCE

RESISTANCE EXERCISE

Exercise	Reps	Sets	Weight/Resistance	Intensity Heart Rate RPE	Comments

Flexibility Comments _____

_____

_____

Post Exercise Heart Rate (bpm) _____ **Post Exercise Blood Pressure** _____

Post Session Comments _____

_____

_____

_____

_____

_____

EXERCISE NORMS

Exercise Norms

Please note that cancer-specific population norms do not exist. Therefore these norms are for an apparently healthy population. As such, the goal is to achieve a category of 'average' or above. For the individuals who score higher than 'average' the goal will be (at minimum) to maintain, particularly while undergoing cancer treatment.

Body Composition Norms (Percent)

Male

	Age				
Percentile	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**
90	7.1	11.3	13.6	15.3	15.3
80	9.4	13.9	16.3	17.9	18.4
70	11.8	15.9	18.1	19.8	20.3
60	14.1	17.5	19.6	21.3	22.0
50	15.9	19.0	21.1	22.7	23.5
40	17.4	20.5	22.5	24.1	25.0
30	19.5	22.3	24.1	25.7	26.7
20	22.4	24.2	26.1	27.5	28.5
10	25.9	27.3	28.9	30.3	31.2

Female

	Age				
Percentile	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**
90	14.5	15.5	18.5	21.6	21.1
80	17.1	18.0	21.3	25.0	25.1
70	19.0	20.0	23.5	26.6	27.5
60	20.6	21.6	24.9	28.5	29.3
50	22.1	23.1	26.4	30.1	30.9
40	23.7	24.9	28.1	31.6	32.5
30	25.4	27.0	30.1	33.5	34.3
20	27.7	29.3	32.1	35.6	36.6
10	32.1	32.8	35.0	37.9	39.3

Muscular Strength Norms (KG)

Male

Age	15-19	20-29	30-39	40-49	50-59	60-69
Above Avg.	103-112	113-123	113-122	110-118	102-109	98-101
Average	95-102	106-112	105-112	102-109	96-101	86-92
Below Avg.	84-94	97-105	97-104	94-101	87-95	79-85
Poor	≤83	≤96	≤96	≤93	≤86	≤78

Female

Age	15-19	20-29	30-39	40-49	50-59	60-69
Above Avg.	64-70	65-70	66-72	65-72	59-64	54-59
Average	59-63	61-64	61-65	59-64	55-58	51-53
Below Avg.	54-58	55-60	56-60	55-58	51-54	48-50
Poor	≤53	≤54	≤55	≤54	≤50	≤47

Cardiovascular Fitness Norms

Male, VO_2max (ml*kg-1*min-1)

Age	20-29	30-39	40-49	50-59	60-69
Low	≤ 38	≤ 34	≤30	≤ 25	≤ 21
Fair	39-43	35-39	31-35	26-31	22-26
Average	44-51	40-47	36-43	32-39	27-35
Good	52-56	48-51	44-47	40-43	36-39
High	57-62	52-57	48-53	44-48	40-44
Superior	63+	58+	54+	49+	45+

Female, VO_2max (ml*kg-1*min-1)

Age	20-29	30-39	40-49	50-65
Low	≤ 28	≤ 27	≤ 25	≤ 21
Fair	29-34	28-33	26-31	22-28
Average	35-43	34-41	32-40	29-36
Good	44-48	42-47	41-45	37-41
High	49-53	48-52	46-50	42-45
Superior	54+	53+	51+	46+

3-Minute Step Test Norms (One Minute Recovery Heartbeat in BPM)

Male

Age	18-25	26-35	36-45	46-55	56-65	65+
Excellent	50-76	51-76	49-76	56-82	60-77	59-81
Good	79-84	79-85	80-88	87-93	86-94	87-92
Above Avg.	88-93	88-94	92-88	95-101	97-100	94-102
Average	95-100	96-102	100-105	103-111	103-109	104-110
Below Avg.	102-107	104-110	108-113	113-119	111-117	114-118
Poor	111-119	114-121	116-124	121-126	119-128	121-126
Very Poor	124-157	126-161	130-163	131-159	131-154	130-151

Female

Age	18-25	26-35	36-45	46-55	56-65	65+
Excellent	52-81	58-80	51-84	63-91	60-92	70-92
Good	85-93	85-92	89-96	95-101	97-103	96-101
Above Avg.	96-102	95-101	100-104	104-110	106-111	104-111
Average	104-110	104-110	107-112	113-118	113-118	116-121
Below Avg.	113-120	113-119	115-120	120-124	119-127	123-126
Poor	122-131	122-129	124-132	126-132	129-135	128-133
Very Poor	135-169	134-171	137-169	137-171	141-174	135-155

Partial Curl-Up Norms (Number of Repititions)

Male

	Age				
Percentile	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**
90	75	75	75	74	53
80	56	69	75	50	33
70	41	46	67	45	26
60	31	36	51	35	19
50	27	31	39	27	16
40	24	26	31	23	9
30	20	19	26	19	6
20	13	13	21	13	0
10	4	0	13	0	0

Female

	Age				
Percentile	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**
90	70	55	50	48	50
80	43	43	43	30	30
70	37	34	33	23	24
60	32	28	28	16	19
50	27	21	25	9	13
40	21	15	20	2	9
30	17	12	14	0	3
20	12	0	5	0	0
10	5	0	0	0	0

Source: ACSM's Guidelines for Exercise Testing and Prescription (7th ed.). Lippincott Williams & Wilkins. 2006

60-Second Squat Test Norms (Number of Repititions

Male

Age	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**
Excellent	> 49	> 45	> 41	> 35	> 31	> 28
Good	44-49	40-45	35-41	29-35	25-31	22-28
Above Avg.	39-43	35-39	30-34	25-38	21-24	19-21
Average	35-38	31-34	27-29	22-24	17-20	15-18
Below Avg.	31-34	29-30	23-26	18-21	13-16	11-14
Poor	25-30	22-28	17-22	13-17	12-Sep	7-10
Very Poor	< 25	< 22	< 17	< 9	< 9	< 7

Female

Age	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**
Excellent	> 43	> 39	> 33	> 27	> 24	>23
Good	37-43	33-39	27-33	22-27	18-24	17-23
Above Avg.	33-36	29-32	23-26	18-21	13-17	14-16
Average	29-32	25-28	19-22	14-17	10-12	11-13
Below Avg.	25-28	21-24	15-18	10-13	7-9	5-10
Poor	18-24	13-20	7-14	5-9	3-6	2-4
Very Poor	< 18	< 20	< 7	< 5	< 3	<2

3-Minute Step Test Norms (One Minute Recovery Heartbeat in BPM)

Male

Age	60-64	65-69	70-74	75-79	80-84	85-89	90-94
Below Avg.	<16	<15	<14	<13	<13	<11	<10
Average	16-22	15-21	14-21	13-19	13-19	11-17	10 -14
Above Avg.	> 22	> 21	> 21	> 19	> 19	> 17	> 14

Female

Age	60-64	65-69	70-74	75-79	80-84	85-89	90-94
Below Avg.	< 13	< 12	< 12	< 11	< 10	< 10	< 8
Average	13-19	12-18	12-17	11-17	10-16	10-15	8-13
Above Avg.	> 19	> 18	> 17	> 17	> 16	> 15	> 13

Flexibility Norms

Sit-and-Reach, Female (Inches)

	Age		
Percentile	≤ 35 yr	36-49 yr	≥ 50 yr
99	70	55	50
95	18.7	19.2	15.7
90	17.9	17.4	15.0
80	16.7	16.2	14.2
70	16.2	15.2	13.6
60	15.8	14.5	12.3
50	14.8	13.5	11.1
40	14.5	12.8	10.1
30	13.7	12.2	9.2
20	12.6	11.0	8.3
10	10.1	9.7	7.5
05	8.1	8.5	3.7
01	2.6	2.0	1.5

Sit-and-Reach, Male (Inches)

	Age		
Percentile	≤ 35 yr	36-49 yr	≥ 50 yr
99	24.7	18.9	16.2
95	19.5	18.2	15.8
90	17.9	16.1	15.0
80	17.0	14.6	13.3
70	15.8	13.9	12.3
60	15.0	13.4	11.5
50	14.4	12.6	10.2
40	13.5	11.6	9.7
30	13.0	10.8	9.3
20	11.6	9.9	8.8
10	9.2	8.3	7.8
05	7.9	7.0	7.2
01	7.0	5.1	4.0

Sit-and-reach scores measured to the nearest 0.25 inch
Source: Hoeger (1998). Lifetime Physical Fitness and Wellness, (5th ed.).

Flexibility Norm Rankings

99-90 = Superior, 80-70 = Excellent, 60-50 = Good, 40-30 = Fair, 20-10 = Low, 05-01 = Very low

Chair Sit-and-Reach, Female (Inches)

Age	60-64	65-69	70-74	75-79	80-84	85-89	90-94
Below Avg.	< -0.5	< -.05	< -1.0	< -1.5	< -2.0	< -2.5	< -4.5
Average	-0.5- 5.0	-0.5- 4.5	-1.0 -4.0	-1.5- 3.5	-2.0- 3.0	-2.5- 2.5	-4.5- 1.0
Above Avg.	> 5.0	> 4.5	> 4.0	> 3.5	> 3.0	> 1.5	> 1.0

Chair Sit-and-Reach, Male (Inches)

Age	60-64	65-69	70-74	75-79	80-84	85-89
Below Avg.	< -2.5	< -3.0	< -3.5	< -4.0	< -5.5	< -5.5
Average	-2.5-4.0	-3.0-3.0	-3.5-2.5	-2.0-3.0	-2.5-2.5	-5.5-0.5
Above Avg.	> 4.0	> 3.0	> 2.5	> 2.0	> 1.5	> 0.5

Get Up and Go Scoring

1 Normal

2 Very slightly abnormal

3 Mildly abnormal

4 Moderately abnormal

5 Severely abnormal

ADDITIONAL RESOURCES

THERABAND EXERCISE GUIDE

In addition to general wellness and fitness programs, elastic resistance is recommended for use in a variety of impairments:

- Resistance training for postural impairments, motor function impairments, muscle performance impairments
- Stretching exercises for muscle length impairments
- Balance training for balance and gait impairments
- Cardio training for cardiorespiratory impairment
- Functional and sport specific training for functional limitations

TheraBand Exercise Benefits

Increase strength
Increase power
Improve balance and proprioception
Prevent falls
Improve posture
Decrease pain
Improve gait
Increase grip strength
Improve cardiovascular fitness
Decrease blood pressure
Decrease disability and Improves function

Instructions

Exercises may be performed seated or standing. Each exercise should be performed for 2 sets of 15 at a resistance that provides fatigue near the end of the second set of exercises. Perform a warm-up of stretches followed by the band exercises. Be sure to keep proper alignment of spine during each of the exercises outlined.

TheraBand Elbow Flexion (Bilateral) in Sitting

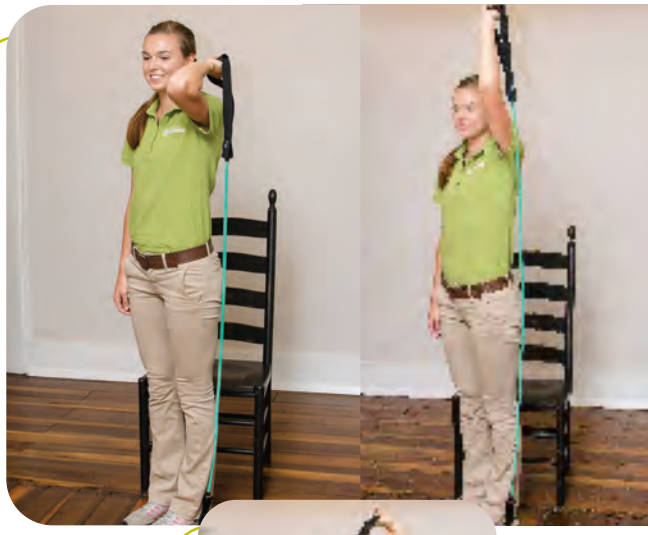
Wrap the middle of the band around both feet and grasp each end of the band with palms facing forward. Keep elbows at the side. Keeping wrists straight, bend elbow, bringing the hands to shoulders. Slowly return to the starting position.

TIP: *Keep the back straight! Don't slouch or lean forward.*

TheraBand Shoulder Bench Press Sitting

Begin with band wrapped around the upper back. Grasp both ends of band with elbows bent and palms facing inward. Push band forward, extending the elbows to shoulder level. Slowly return to starting position.

TIP: *Keep the back and neck straight. Don't shrug shoulders. Don't hold breath.*



TheraBand Elbow Extension Sitting

Stabilize one end of band in opposite hand with elbow straight. Grasp band with elbow bent. Keep elbow behind the side. Straighten the elbow, pulling the band backward. Hold steady with opposite hand. Slowly return to the starting position. Repeat on other arm.

TIP: *Keep the stabilizing arm straight.*

TheraBand Shoulder Seated Row

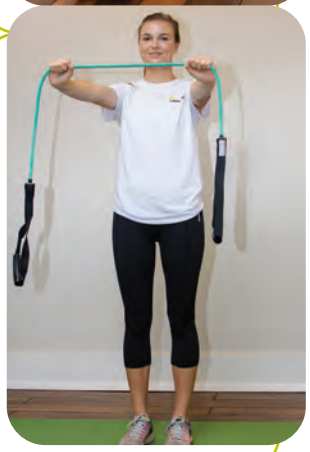
Extend the legs and wrap middle of band around feet. Be sure band is secure by wrapping the middle around the feet so it won't slip. Grasp both ends of band with elbows straight. Pull band upward and back, bending elbows. Slowly return to starting position.

TIP: *Keep the knees and back straight.*

TheraBand Shoulder Horizontal Abduction

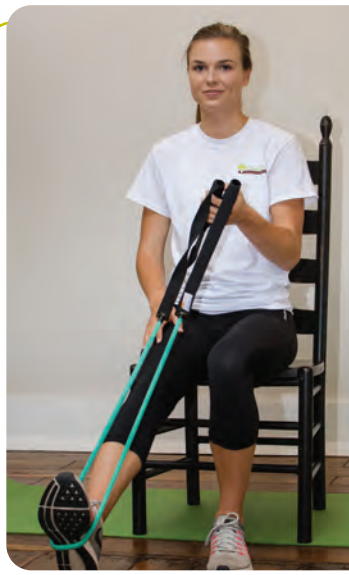
Grasp the ends of the band in front at shoulder height, and take up the slack. Pull the band outward, keep the elbows straight and pinch the shoulder blades together. Slowly return.

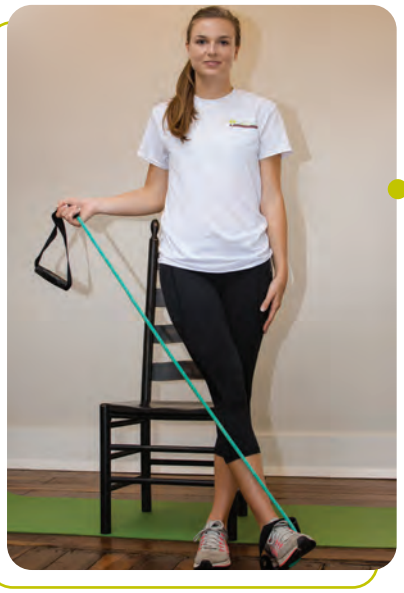
TIP: *Keep the lower back straight. Don't hold breath, and relax after each repetition.*



TheraBand Knee Extension

Sit on the edge of a sturdy chair with feet together. Begin by looping the center of the band around the ankle of the exercising leg. Bring the ends of the band underneath the foot of the opposite leg to stabilize and grasp the ends by the knee. Slowly extend the leg so the knee is straight against the band. Hold 1 to 2 seconds and slowly return.





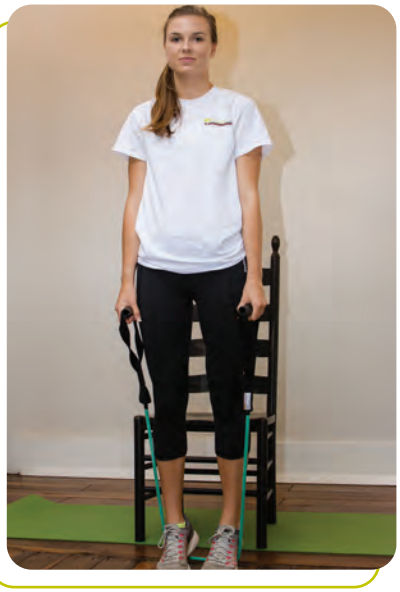
TheraBand Hip Adduction

Securely attach one end of the band to a sturdy object. Attach the band above the ankle. Keeping the knee straight, bring the leg inward toward the opposite leg. Hold and slowly return. Use a sturdy object nearby for balance if needed.

TheraBand Knee Mini-Squats

Begin with center of band under feet. Grasp ends of bands with hands by sides. Keep tension in the band with elbows straight. Keeping the elbows straight, slowly bend the knees while leaning forward slightly at the hips. Slowly return to starting position.

TIP: *Keep the back straight.*



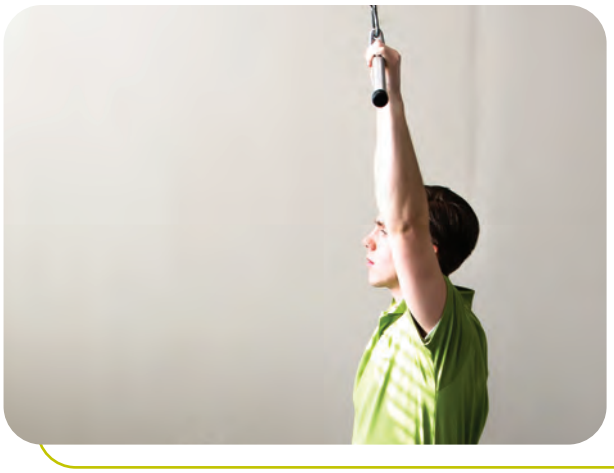
SAMPLE WEIGHTED EXERCISES FOR MAJOR MUSCLE GROUPS

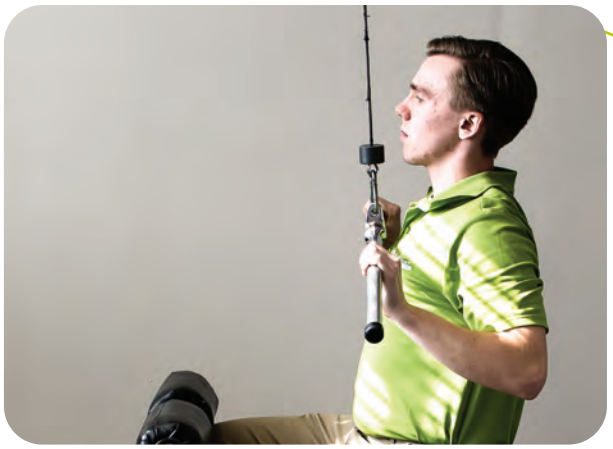
CHEST | CHEST PRESS

CHEST | DIPS

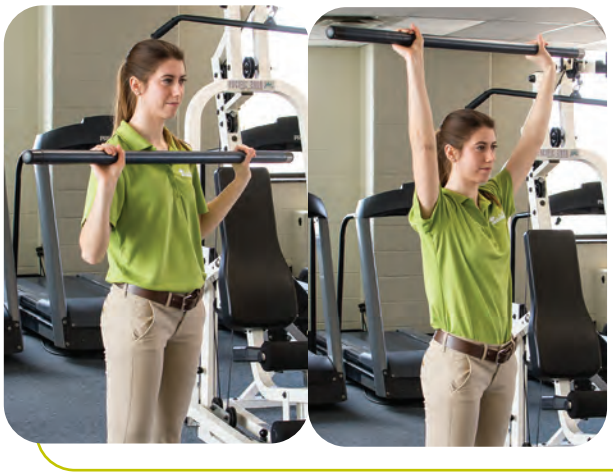
BACK | BENT OVER ROW

BACK | LATERAL PULLDOWN

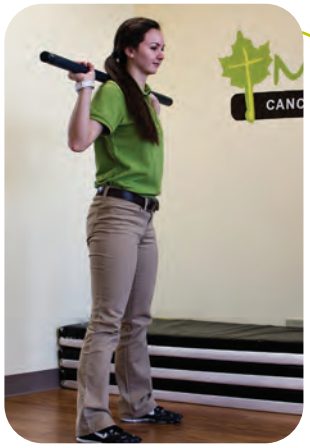




ARMS | OVERHEAD PRESS & SKULL CRUSHERS



LOWER BODY | SQUATS



APPROVED EQUIPMENT FOR EXERCISE TRAINING & ASSESSMENTS

ASSESSMENT TESTING

- Omron Bio-electrical Impedance Analysis (BIA)
- Baseline Medical skinfold calipers – Body Composition
- MyoTape tape measure (cloth and steel) – Circumference
- Baseline hand grip Dynamometer – Muscular Strength
- Precor treadmill – Cardiovascular Endurance
- Rouge Fitness12" step box – Cardiovascular Endurance
- ProCoach stopwatch – Cardiovascular Endurance
- Rouge Fitness 4 lb. and 8 lb. dumbbell or kettle bell – Muscular Endurance
- Baseline flexibility box – Flexibility
- Rouge Fitness flat bench – Muscular Endurance

EXERCISE EQUIPMENT

- Rouge Fitness TheraBands (various sizes, styles, and strengths)
- Eleiko kettlebells (various weights)
- Ivanko dumbbells (various weights)
- Eleiko barbell (various lengths)
- Rouge Fitness flat and incline benches
- Rogue Fitness exercise balls (various sizes)
- Rogue Fitness medicine balls (various weights)
- Eleiko Plated weights (various weights)
- Rouge Fitness conditioning ropes
- Rogue Fitness BOSU balls
- Exercise mats
- Rumble Roller foam rollers
- Rouge Fitness Plyometric boxes (various heights)
- York Barbell commercial grade crossover machines
- Cybex commercial grade exercise machines (variety for upper and lower body)
- Rogue Fitness power racks
- TRX devices
- Rouge Fitness rubber flooring

APPENDIX 1

EXERCISE ONCOLOGY INSTRUCTOR CERTIFICATION EXAM STUDY GUIDE

Cancer Physiology and Diagnosis

- Knowledge of basic cancer physiology
- Understanding risk factors associated with a cancer diagnosis and prognosis
- Knowledge of cancer invasion and metastasis
- Understand the difference between major types of cancer including symptoms, risk, mortality and basic physiology *(Lung, prostate, leukemia)*
- Knowledge of breast cancer physiology and treatment *(HER2/neu, lumpectomy vs mastectomy, lymph node removal)*
- Understanding the differences in common cancer terminology *(tumors, cysts)*
- Lipoma, carcinoma, adenocarcinoma, myeloma, DCIS, oncogene
- Knowledge on the cancer staging system (TNM) and broad classifications of cancer type
- Understanding characteristics of cancer cells

Exercise Physiology

- Understand the physiological differences in aerobic vs anaerobic exercise training
- Knowledge on different physiologic forms of exercise (isokinetic, isometric, isotonic exercises) and the corresponding effect on different body systems
- Knowledge on the principles of exercise
- Knowledge of the body's energy sources and supply to muscles and tissues when exercising
- Components of a muscle contraction (force, strength, lactic acid accumulation)
- Understanding which systems benefit the most from exercise and how
- Cellular respiration
- Autonomic nervous system responses
- Benefits of regular exercise
- Knowledge of physiological difference seen in acute vs. chronic adaptations to exercise
- Understand the difference between fast twitch vs. slow twitch muscle fibers

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The Physiologic Effects of Exercise with a Cancer Diagnosis

- Knowledge of physiologic outcomes that may be improved by exercise training among cancer survivors
- Knowledge of symptoms, side effects, and psychological attributes that may be improved among cancer survivors
- Knowledge of physiologic systems as they pertain to exercise training
- Knowledge of exercise guidelines for cancer risk and survival
- Knowledge of exercise intensity and immune system functioning in cancer patients

Cancer Treatment and Side Effects

- Knowledge on the delivery and effectiveness of common cancer treatments such as chemotherapy and radiation
- Knowledge on the different techniques used for cancer treatment
- Knowledge on common side effects experienced with common cancer treatments *(Neuropathy, fatigue)*
- Common forms of chemotherapy treatment
- Biologic therapies *(immunotherapies)*
- Knowledge on how the immune system functions while undergoing invasive cancer treatments

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MTCA Guidelines

- Knowledge of exercise intensities and corresponding phase system
- Knowledge on phasing system in terms of time and heart rate intensity calculations

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Exercise Prescription and Programming

- Knowing the importance of evaluating current fitness level
- Understanding important considerations to keep in mind when making a patient's exercise prescription
- Knowledge on how to exercise properly to avoid injury
- Knowledge on common exercise examples for major muscle groups
- Knowledge on the use of plyometrics and yoga training with cancer patients
- Importance of warm-up and cool-down
- Knowledge of how cancer and its treatments may alter balance, agility, speed, flexibility, endurance and strength in order to appropriately prescribe exercise for your patient

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Fitness and Clinical Exercise Testing

- Cardiopulmonary exercise evaluation tests
- Muscular fitness tests
- Knowledge of metabolic equivalents and VO_2max
- Knowledge of how the heart rate changes and adapts with certain areas such as blood pressure medications and chemotherapy drugs
- Knowledge of the components of fitness that are tested
- Selecting most appropriate exercise testing modality understanding the combined effects of aging and cancer-treatment on exercise capacity and movement

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Clinical and Medical Considerations

- Knowledge on when to discontinue exercise with a patient
- Special considerations for patients with osteoarthritis and increased risk of bone fractures
- Knowledge of the long term side effects of cancer treatment or survivorship obstacles for patients who have experienced childhood cancer
- Special considerations for breast cancer patients (non-weight bearing, lymphedema, reduced range of motion)
- Understanding signs and symptoms of lymphedema

APPENDIX 2

EXERCISE ONCOLOGY INSTRUCTOR RULES AND RESPONSIBILITIES

The Exercise Oncology Instructor is responsible for the implementation of individualized exercise programs. In addition, the responsibilities of the Exercise Oncology Instructor include:

- Secure all patient information by ensuring all patient data is reviewed at the location of operations.
- Maintain confidentiality by not sharing sensitive patient information with anyone other than the staff of Maple Tree Cancer Alliance.
- Being responsible for the upkeep of the facility by turning off all lights, locking all doors prior to exiting facility, making sure no trash remains, and returning patient paperwork to the appropriate location.
- Clean weight area by returning weights to the weight racks after use. Machines should be checked regularly for defects and kept clear of any dust and debris. Any other equipment that is not fixed to the floor should be safely and securely stored away for the next instructor.
- Protect patient immunity by cleaning equipment daily, as well as before/after use. Use a cleaning solution that is not abrasive to the skin and will disinfect the area.

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