# Cancer Exercise Specialist®

HANDBOOK

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**Module Three**

**14th Edition**

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



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# CONTENTS

## CHAPTER ONE

# *MUSCLE BALANCE AND EVALUATION*

### Program Design

**Objective:** to learn how to conduct a postural assessment and understand the balance of agonists and antagonists in order to sequentially determine individualized programming based on:

- Range of Motion Limitations
- Correcting Postural Deviations
- Acute & Chronic Treatment Side-Effects
- Lymphedema Identification, Prevention, & Management

**Goal:** to correct muscle imbalances and ROM limitations by determining the proper combinations of strength training exercises and stretching while taking precautions to avoid lymphedema, pain, and other undesirable mental and physical side-effects.

## POSTURE

Good posture involves training the body to stand, walk, sit and lie in positions where the least strain is placed on supporting muscles and ligaments during movement or weight-bearing activities. It is the result of alignment of all of the joints in the body at any given moment in time (Kendall, McCreary, and Provance 1993). From a ***biomechanical perspective,*** imbalance between agonists and antagonists in standing posture changes alignment and negatively affects the position of the parts of the body above and below the "faulty" area. From a ***functional perspective,*** the neurological, muscular, and articular systems form an inseparable unit. The central nervous system (CNS) regulates the muscles ability to produce and control motion and stabilize and protect the joints. When there is a dysfunction resulting from injury, pathology, or chronic overuse, you will most likely observe changes in muscle function.

Poor posture leads to adaptive patterns of movement and balance; thus causing undue stress on the musculoskeletal system, resulting in wear and tear on the joints and increased likelihood of injury. Once the body begins to compensate for poor habits or injury, the body begins to know this as its new "norm." This leads to patterns of muscle tightness and weakness.

For example, for every inch the head moves forward from neutral posture, the weight carried by the lower neck increases by the additional weight of the entire head. (Liebenson C, ed. Rehabilitation of the Spine. Baltimore: Williams and Wilkins, 1996:177).

According to the late Dr. Vladamir Janda, a Czech neurologist, there are two basic causes of muscle imbalance; structural and functional. Our standards of care in orthopedic medicine are based primarily on a structural approach. They rely on the visualization of structure through modalities such as X-ray, MRI, and/or surgery. When you hear the term ***"structural lesion,"*** it is referring to damage to physical structures such as bones or ligaments that can be diagnosed through these sophisticated tests and procedures. The structural lesions can be repaired with the proper combination of immobilization, surgery (when necessary), and rehabilitation. What happens, however, when these diagnostic tests are inconclusive? We find ourselves as both clients and practitioners at a loss. It is frustrating on many different levels as we try to "fix" something that we are being told does not exist. This is where the term "functional lesion" comes in to play. A ***"functional lesion"*** is an impairment in the ability of the structure to perform its normal tasks; movement, strength, flexibility, etc... Our dilemma is that this type of lesion is not as easy to treat because the analysis of the problem is not as cut and dry as it is with a structural lesion. As practitioners it is our job to get to the root of the problem and determine the source of origination of the functional lesion. We must analyze the particular dysfunction by looking at the interactions of all the structures and systems that may contribute to the problem. MRIs, X-rays and surgery are designed to "diagnose" and "cure" the problem, but they overlook an important part of the problem; the source. If we do not identify the source of the problem, it stands to reason, that it cannot be cured or rehabilitated.

When we use the term "muscle balance," we are referring to the equality of muscle strength between the agonist and antagonist muscles.

***Agonists are the muscles that act as prime movers whereas antagonists are muscles that act in direct opposition to prime movers. Synergists are muscles that assist the prime movers during functional movement patterns. Stabilizers are muscles that support or stabilize the body while the prime movers and the synergists perform the movement patterns.***

Without this balance it would be impossible to properly execute movement and function. Muscle balance can also be viewed as the strength and balance between contralateral (right vs. left) muscle groups. If your client is right-side dominant, the strength in their right quadricep may be significantly greater than that of the left quadricep. This can create a chain reaction of problems from the hip to the ankle as the body tries to compensate for and adapt to the imbalance. Sometimes it is an injury itself that can cause a muscle imbalance while other times the muscle imbalance leads to the injury. There are two ways to look at muscle imbalances. The first is ***biomechanical,*** caused by repetitive movements and postural deviations that put undue stress on the joints. As our bodies try and adapt to repetitive motions and/or postural imbalances, there will most likely be adaptations in muscles length, strength, and flexibility. As a muscle becomes dominant over its fellow synergists, joint motion will change and can lead to abnormal stress on a particular joint.

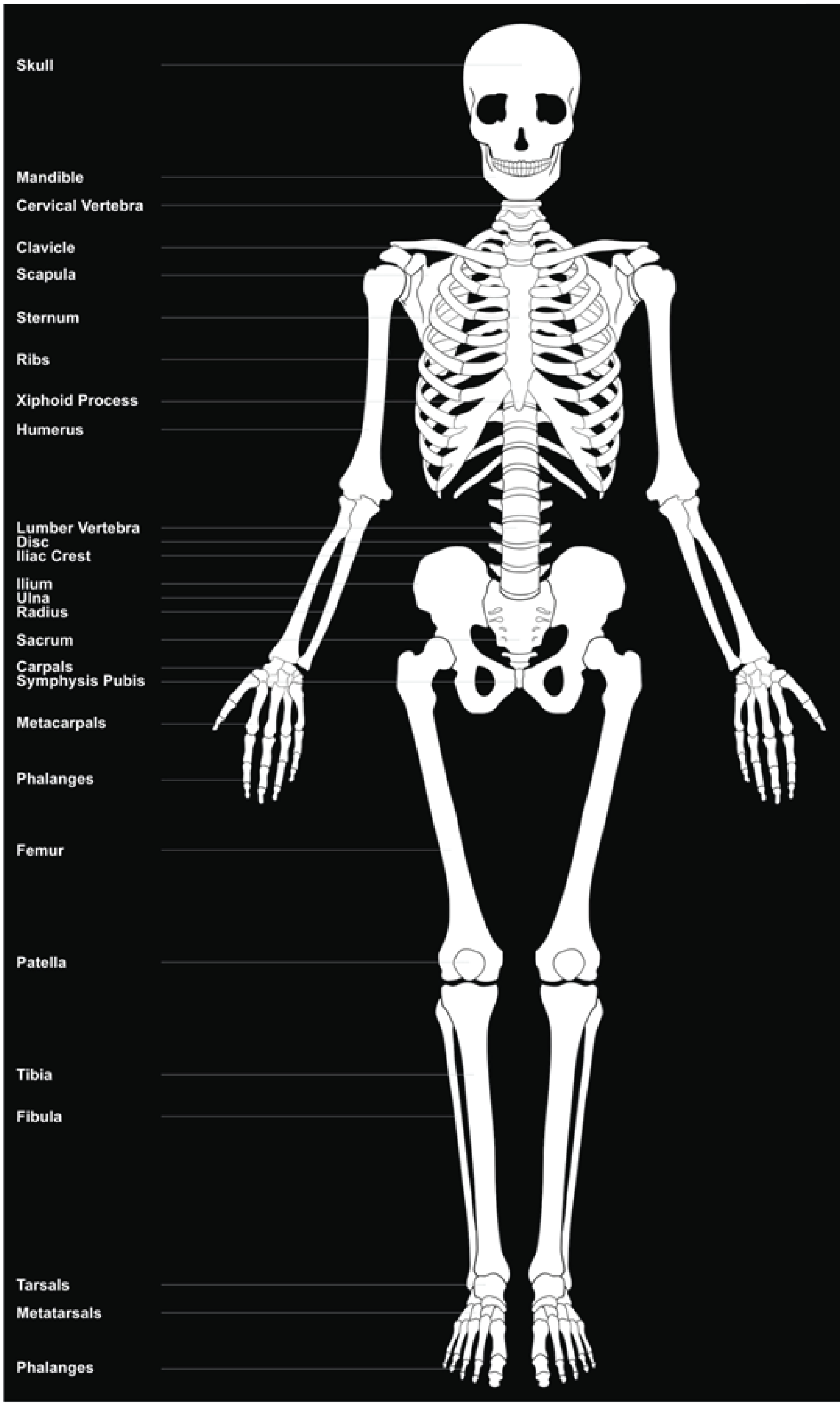
The second is ***neurological.*** They are not, however, exclusive of one another as both may contribute to the imbalance. Janda believed that many chronic musculoskeletal conditions are the result of faulty motor learning that prevents the motor system from properly reacting or adapting to different changes within the body. The result of this is seen in poor reflexive or mechanical performance. All systems in the human body function automatically except for the motor system. Therefore, Janda believed that chronic musculoskeletal pain and muscle imbalance are a functional pathology (impaired function of the structures rather than damage to the structures) of the CNS. He stated that muscle imbalances often begin after an injury or pathology leads to pain and inflammation. Muscle imbalances may also arise from alterations in proprioceptive input resulting from abnormal joint position or motion. ***Proprioception*** is one form of afferent information that uses mechanoreceptors to provide information about static and dynamic positions, movements, and sensations that relate to muscle force and movement. This afferent information is delivered within the CNS and is used to manipulate and monitor movement. These two conditions can ultimately lead to muscles that become hypertonic (tight), or inhibited (weak). As the body tries to create a new homeostasis, the imbalance becomes "normal" to the CNS and results in a new pattern of movement.

The necessary ingredient for muscle balance is the functional integration of the sensory and motor systems. Sensory information is elicited in motor response through the central and peripheral nervous systems. It receives information from receptors to determine things such as the body's position in space, limb orientation, information about the environment, temperature, texture, and other external factors. Sensory information is critical in order to protect the body from harm. ***Afferent information*** refers to sensory input to the CNS that plays several roles in creating motor responses (Holm, Inhahl, and Solomonow 2002). These include triggering a reflex response, determining the extent of programmed, voluntary responses, and integrating feedback for automatic motor output to maintain balance for standing and walking.

Postural stability, or balance, is the ability of the body to maintain its center of gravity within its base of support and limits of stability. It is the result of processing and output of information from the PNS and CNS. Balance of agonists and antagonists is necessary in order for ligaments to provide adequate joint stability and equalize pressure distribution. There are two types of stability that we will refer to; ***dynamic and static.*** Dynamic stability is the result of muscular contraction. It is also referred to as ***functional joint stabilization.*** Static stability comes from passive structures such as bony congruities, ligaments, and joint capsules.

***"He who treats the site of the pain is often lost," Karl Lewis.***

***Tensegrity*** is the inherent stability of structures based on synergy between tension and compression components. In other words, the body rearranges itself in response to changes in load. The principle of a "***kinetic chain***" suggests that each part of the body is interconnected. For example, forces in the foot and ankle can affect body parts such as the knees, the hips, and the lower back. Therefore, if something is out of alignment, or functioning improperly, the body will rearrange itself to compensate for the inadequacy.




*Postural chains* are the position of one joint in relation to the other when the body is in an upright position. We refer most often to the postural chain that occurs throughout the spine. The postural position of the cervical, thoracic, and lumbar spine is looked at in relation to musculoskeletal pain. We emphasize proper positioning in these areas during exercise to promote safe movement and reduce the risk of injury. Because these regions are connected through the vertebral column, changes in one region can cause a chain reaction leading to changes in another region.

### Here are some examples:

- Poor sitting posture encourages a posterior pelvic tilt. This reduces the normal lordotic curve of the spine. It also reverses the normal kyphotic curve of the spine and encourages the forward position of the head that is often associated with poor posture.
- The rib cage is an important structure to consider because of its direct influence on the position of the thoracolumbar spine. Those who are weak in the diaphragm and deep spinal stabilizers will often elevate the lower rib cage during inspiration as a compensation for breathing. The repetitive and continuous elevation of the ribs leads to posterior rotation of the ribs on the vertebrae at the costovertebral joint (articulations that connect the heads of the ribs with the bodies of the thoracic vertebrae) and to relative anterior rotation of the vertebrae on the ribs. Ideal posture is sacrificed in an attempt to maintain respiratory integrity.
- An anterior pelvic tilt is associated with tight hip flexors, whereas a posterior pelvic tilt is associated with tight hamstrings.
- Foot pronation causes tibial internal rotation, which causes knee valgus (knock-knees), and hip internal rotation.

*Muscular chains* are groups of muscles that work together to influence each other through movement patterns.

*Myofascial chains* rely on the integrity of the muscle fascia as a vital link to multiple muscles acting together for movement; as well as connecting the extremities through the trunk.

*Neuromuscular chains* provide our bodies with critical reflexes for function and protection. These reflexes serve as the basis for all human movement patterns.

*Sensorimotor chains* are linked neurologically through afferent (input) and efferent (output) systems for function. They are both reflexive and adaptive and provide local and global dynamic stabilization of the joints.

Now that we have a basic understanding of the principles of "chains" and how they work together both in compensation and adaptation, we are going to get even more specific. The CNS is responsible for regulating two groups of muscles within the body; ***Tonic and Phasic.***

Neurodevelopmental movement patterns can be broken down into these two groups. These terms are not used in the physiological description of muscle fiber (slow twitch vs. fast twitch). Tonic muscles are dominant and are involved in repetitive or rhythmic activities as well as the upper and lower extremities' withdrawal reflexes. Their main responsibility is flexion. Phasic muscles tend to be predominant in extension and typically serve as postural stabilizers, working against gravity. These systems do not function independently. They work synergistically in posture, gait, and coordination of movement. Therefore, when we refer to muscle balance, we are really referring to the interaction between the tonic and phasic systems.

In essence these systems are the "default" motor program of human movement dating back to the beginning of time. The proper balance of the two systems would be seen in someone with "normal" gait and posture. When you watch someone walk you will notice the contralateral movement pattern between the upper and lower body. The right arm and leg will be in flexion at the same time and the same will apply to the left side. With leg extension you will see arm extension on the opposite side. This can be noted in creeping, crawling, swimming, and walking. For you to be skilled at assessing one's posture you must understand which muscles are more prone to tightness vs. which muscles are more prone to weakness.

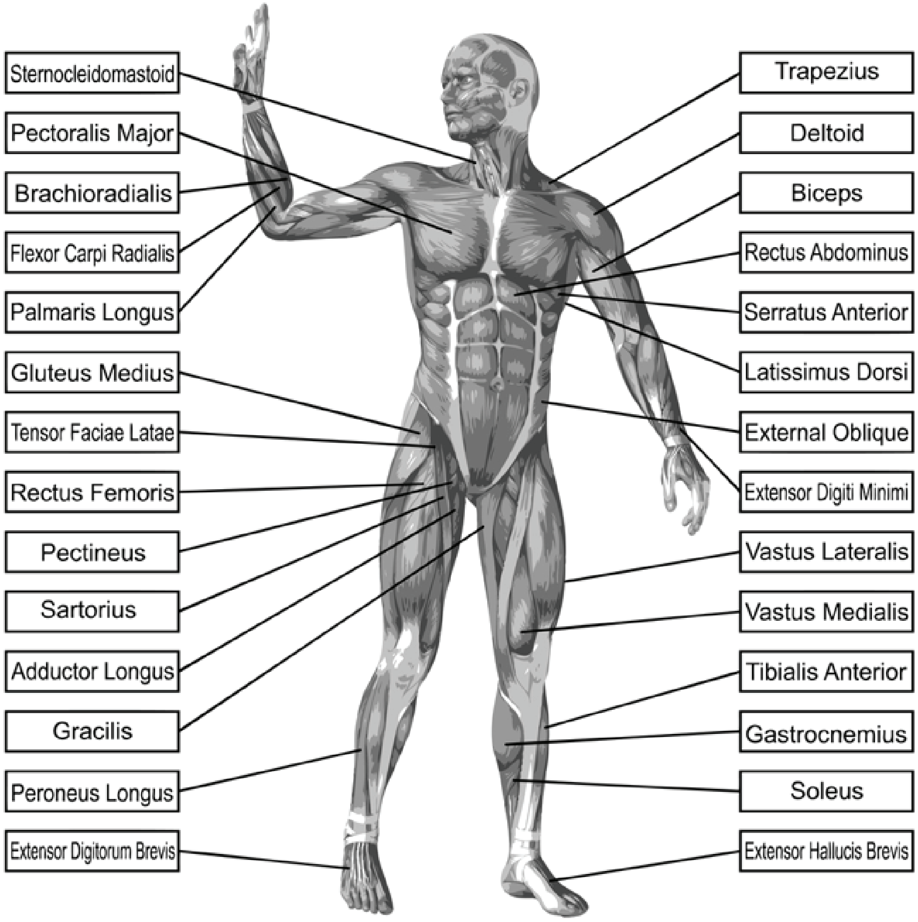
*Keep in mind that some muscles may exhibit both characteristics, but will typically be one or the other.*

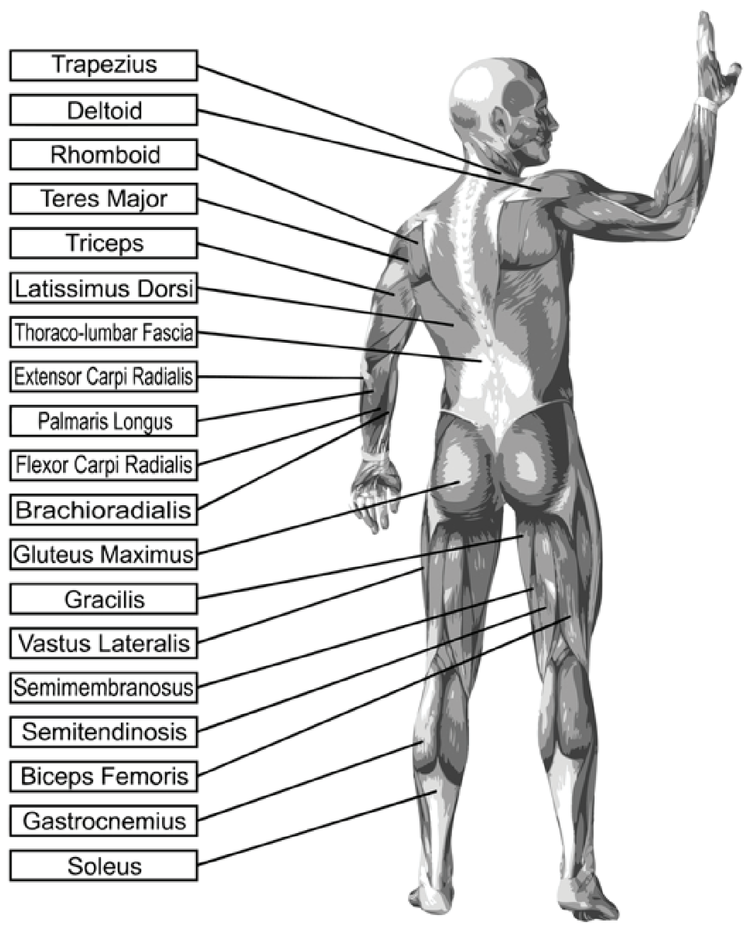
### TABLE 1.0 - TONIC AND PHASIC MUSCLES OF THE UPPER BODY

| TONIC (TIGHT) MUSCLES OF UPPER BODY | PHASIC (WEAK) MUSCLES OF UPPER BODY |
|---|---|
| Pectoralis major/minor | Middle and lower trapezius |
| Levator scapulae | Rhomboids |
| Scalenes | Serratus anterior |
| Upper trapezius | Deep cervical flexors |
| Sternocleidomastoid | Scalenes |
| Latissimus dorsi | Extensors and supinators |
| Flexors and pronators | |

### TABLE 1.1 - TONIC AND PHASIC MUSCLES OF THE LOWER BODY

| TONIC (TIGHT) MUSCLES OF LOWER BODY | PHASIC (WEAK) MUSCLES OF LOWER BODY |
|---|---|
| Quadratus lumborum | Rectus abdominis |
| Thoracolumbar paraspinals | Gluteus maximus/medius/minimus |
| Piriformis | Vastus medialis/lateralis |
| Iliopsoas | Tibialis anterior |
| Rectus femoris | Peroneals |
| IT band | |
| Hamstrings | |
| Hip adductors | |
| Soleus | |
| Tibialis posterior | |


Sternocleidomastoid
Pectoralis Major
Brachioradialis
Flexor Carpi Radialis
Palmaris Longus
Gluteus Medius
Tensor Faciae Latae
Rectus Femoris
Pectineus
Sartorius
Adductor Longus
Gracilis
Peroneus Longus
Extensor Digitorum Brevis
Trapezius
Deltoid
Biceps
Rectus Abdominus
Serratus Anterior
Latissimus Dorsi
External Oblique
Extensor Digiti Minimi
Vastus Lateralis
Vastus Medialis
Tibialis Anterior
Gastrocnemius
Soleus
Extensor Hallucis Brevis


Trapezius
Deltoid
Rhomboid
Teres Major
Triceps
Latissimus Dorsi
Thoraco-lumbar Fascia
Extensor Carpi Radialis
Palmaris Longus
Flexor Carpi Radialis
Brachioradialis
Gluteus Maximus
Gracilis
Vastus Lateralis
Semimembranosus
Semitendinosis
Biceps Femoris
Gastrocnemius
Soleus

## PAIN AND MUSCLE IMBALANCE

If we injure ourselves, it is safe to assume that the particular injury will heal itself in a reasonable amount of time.

**When someone comes to you with chronic musculoskeletal pain it may suggest that the problem lies within the muscle, or group of muscles. More often than not, it will not stem from the bones, joints, and ligaments. Most muscle pain is the result of a muscle spasm and the resulting ischemia (inadequate circulation to a local area due to blockage of the blood vessels in the area) from the prolonged muscle contraction.**

This will ultimately lead to fatigue and result in a decreased ability to meet normal postural and movement demands. In the acute phase of pain the muscles may respond by altering movement patterns to compensate for the injured area. As time passes, the CNS will adapt this altered movement pattern. Our bodies have a protective adaptation to pain in which the flexor response is activated to protect the injured area. Not only will this affect movement patterns, it will also result in decreased range of motion. These altered movement patterns will ultimately lead to altered joint position which will cause more stress on the joints. This can also be caused by ***altered reciprocal inhibition.*** This is the process by which a tight muscle causes decreased neural drive and, therefore, optimal recruitment of its functional antagonist is not achieved. Altered reciprocal inhibition may lead to synergistic dominance. This is the process in which a ***synergist compensates*** for a prime mover to maintain ***force production*** (the force generated by a muscle action).

***It is paradoxical that the muscle imbalance may be the source of the pain or it may be the result of the pain.***

Vladamir Janda observed three distinct stereotypical patterns of muscle tightness/weakness that cross between the dorsal and ventral sides of the body. The first, and perhaps most common is ***upper-crossed syndrome.*** Tightness in the levator scapulae and upper trapezius on the dorsal side crosses with the tightness of the pectoralis major/minor. Weakness of the deep cervical flexors on the ventral side crosses with weakness of the middle and lower trapezius. This pattern of muscle imbalance creates joint dysfunction that results in forward head, cervical lordosis, elevated and protracted (rounded) shoulders, winged scapulae, and thoracic kyphosis. This combination wreaks havoc on the glenohumeral joint by decreasing joint stability, which then leads to increased activation by the levator scapulae and upper trapezius, in an effort to maintain the integrity of the joint.

Individuals who present with upper-crossed syndrome typically exhibit rotator cuff impingement, shoulder instability, biceps tendinitis, thoracic outlet syndrome, and headaches.

*Lower-crossed syndrome* manifests when the tightness in the thoracolumbar extensors on the dorsal side crosses with the tightness of the iliopsoas and rectus femoris. Weakness of the deep abdominal muscles ventrally crosses with weakness of the gluteus maximus/medius. Look for increased lumbar lordosis, lateral lumbar shift and leg rotation, and knee hyperextension. There are two variations of LCS; anterior tilt and posterior tilt. The client with an anterior pelvic tilt will usually present with slight hip and knee flexion and hyperlordosis of the lumbar spine and hyperkyphosis of the upper lumbar and lower thoracolumbar areas. Those with a posterior pelvic tilt present with locked out knees, hypolordosis (flat back), thoracic hyperkyphosis and head protraction. More than likely they will also have tight hamstrings and dynamic movement patterns may be affected. Individuals who present with lower-crossed syndrome typically exhibit anterior knee and low back pain, posterior tibialis (shin-splints), and plantar fasciitis.

*Layer syndrome* is the combination of LCS and UCS where clients display impairment with motor skills and have a poorer prognosis because of the longer duration of their impairment. You are more likely to see this in the elderly.

Chronic muscle imbalance can lead to altered patterns of movement. There are several factors that can affect muscle balance:

- **Repetitive movement -** can result in overuse or injury and can lead to a change in elasticity of the muscle. It may be as simple as bad posture and lack of regular daily activity. Muscle that is repeatedly placed in a shortened position (psoas complex during sitting, or pectorals following a mastectomy/radiation), will eventually adapt to that new position and it will become its new "norm."

- **Acute injury -** an individual may alter their movement patterns to avoid pain, or to perform an activity out of desire or necessity. Because of the newly established "norm," an individual may need to re-train their body back to their more normal motor pattern. Injury can also result in tissue that becomes ***hypomobile*** (restricted) from splinting or self-immobilization due to pain.

- **Surgery -** scar tissue can alter tissue alignment and pull on the fascia. This will alter muscle and joint function. It is critical to assess ROM and posture and develop a corrective strategy to return to a normal motor pattern and correct imbalances.

## POSTURAL ANALYSIS TEST PROTOCOL

*Purpose: to determine muscle imbalances; which may cause unnecessary stress on the bones, joints, ligaments, and muscles.*

*Equipment: none*

**Procedures:** a thorough postural analysis is essential to get a clear understanding of symmetry, contour, and tone of the muscles as they are observed in static posture. The postural analysis is done with the participant wearing minimal clothing, standing erect (naturally) with the arms hanging downward at their sides, and bare feet. Have client march in place with their eyes closed for a few seconds, making sure that they are standing **naturally**. Have them stop marching, hold their position, and open their eyes. Ask them to stand as still as they can so that you can conduct the assessment. If you are working with a client who has difficulty with balance, it is okay to have them stand near a wall or countertop, or have a chair near by them to give them a sense of security.

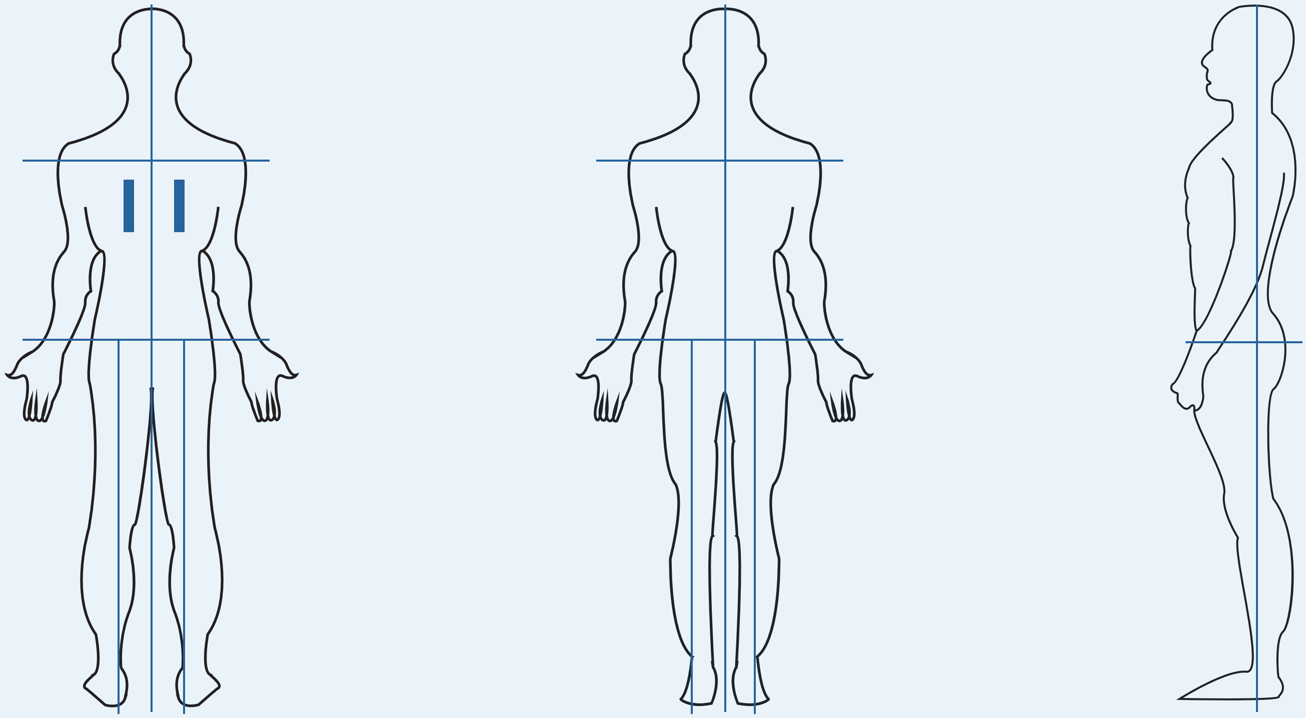
Begin by looking posteriorly at spinal curves; excessiveness, scoliosis, leg-length discrepancy, or other orthopedic deviations. From there you should evaluate the pelvis; as this is where most dysfunctions of the lumbar spine, SI joint, and lower limbs will originate. Not only can the pelvic tilt affect lumbar lordosis, it can also influence the orientation of the head and other parts of the body.

**The position of the pelvis should be evaluated by locating the iliac crests and the anterior and posterior iliac spines. Locating the posterior/anterior superior iliac spine:**

The ilium is the most superior part of the innominate bone and articulates the pelvis with the spinal column through the sacrum. At the most anterior and posterior aspects of the ilium are bony prominences known as the anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS). The ridge of bone that runs between the ASIS and PSIS, and is a major source of muscle attachments, is known as the crest of the ilium or iliac crest. Place your hands on your clients' hips and feel for the iliac crests. While you are doing so, follow the crest to its anterior and posterior ends and those will be the ASIS and PSIS.

After identifying the aforementioned structures, there are several things you will want to look for:

- Lateral tilt
- Rotation
- Anterior tilt
- Posterior tilt



### LOOKING AT THE SUBJECT FROM THE BACK:

- Head should be erect and not tilted to either side
- Shoulders should be level and one should not be higher than the other
- Shoulder blades should not be “winged” and they should be at the same height
- Curvatures of the spine are minimal (no scoliosis)
- Hips should be at the same level; one should not be higher than the other
- Legs are vertical
- Arches of the feet should not be excessively flat or raised, but should appear normal
- Heels should be equal distance apart
- Body weight should appear to be evenly distributed on both feet

### LOOKING AT THE SUBJECT FROM THE FRONT:

- Head should be erect and should not be tilted to either side
- Shoulders should be level and one should not be higher than the other
- Arms and hands should face toward the body. If there is considerable round shoulderedness, it will cause the hands to rotate so that the palms face backward
- Hips should be at the same level; one should not be higher than the other
- Legs are vertical and kneecaps should face forward and be centered
- Toes should be in a straight line
- Feet should be turned out at about ten degrees
- Arches of the feet should not be excessively flat, or raised, but should appear normal
- Heels should be equal distance apart
- Body weight should appear to be evenly distributed over the feet

### LOOKING AT THE SUBJECT FROM THE SIDE:

- Head should be erect and should not be pulled back or extended forward
- Shoulders should be level and should not be rounded
- Curvatures of the spine should be minimal
- Arms and hands should face towards the body
- Chest should be lifted and should not appear depressed or protruding
- Abdominals should be flat
- Knees should not be over flexed or hyperextended, but should appear straight
- Toes should be in a straight line

## CONDUCTING A VIRTUAL POSTURAL ASSESSMENT

Conducting a virtual assessment certainly poses its challenges, but is still a valuable tool for corrective exercise programming. There are a number of variables that can add to, or subract from, the accuracy of your assessment:

- Lighting
- Distracting background
- Camera or computer quality
- Ability of client to follow instructions
- Ability to move camera or computer to catch different angles/perspectives

To make your job easier and more effective, you might ask your client to have someone there with them that can help palpate, move the camera/computer, adjust lighting, etc.

In order to get the client's entire body in the screen you will probably lose clarity of the picture. This can make it very difficult to identify certain muscle imbalances. For this reason, you will need to break the body into top and bottom as well as front, back, left side, and right side.

You will start the process in the same exact fashion as you would in-person (as described on the previous page). I suggest that you have your client's camera/computer focused on their lower body to begin with. After you have gathered all of the essential findings, you can ask them to adjust the view to the top half of their body. If they are adjusting it themselves, you will need to ask them to march in place again each time.

When assessing the hips, it will be incredibly helpful to have an assistant with the client to help palpate the iliac crests, ASIS's, and PSIS's (this can be very difficult to see virtually). If they do not have anyone that can assist, you can describe to your clients how to "find" the top of their hips (iliac crests), the bony protrusions in the front (ASIS's) and the bony protrusions in the back (PSIS's). It will probably take a few tries to get it right. Have them use their index finger to point to these areas while trying to keep the rest of their hand from blocking your view.

Although most people will not want to go shirtless (men) or wear just a sportsbra (women), this may be your only hope of being able to see any alterations in scapular movement or winged scapula. If they have an assistant with them, you can ask them to gently run their hands across their shoulder blades to see if they can "grab" them at all. If they have significant winged scapula, this will be easy to identify.

***If you are trying desperately to find an imbalance (anywhere on their body), but just can't be certain, it is probably not significant enough to worry about!***

Alterations in scapular positioning at rest and in movement, called scapular dyskinesis, are associated with various diseases of the shoulder, such as impingement syndrome, rotator cuff tear, instabilities and adhesive capsulitis.[229]

There is evidence suggesting that scapular positioning is abnormal in patients with shoulder impingement syndrome,[222] symptoms of impingement,[223, 224] a traumatic shoulder instability[225], multidirectional shoulder joint instability,[226] and shoulder pain after neck dissection in cancer patients.[227, 228] As no longitudinal study has yet been reported, it is not known if abnormal scapular positioning is a cause or consequence of shoulder pain or a secondary phenomenon caused by shoulder pain.

It can also be quite difficult to determine if the client has pronated or supinated feet. Asking the assistant to bring the camera/computer closer to the subject, trying different angles, can be very helpful.

Remember that this is not going to be perfect. You are going to do the best that you can do! Even a mediocre postural assessment is going to be better than none.

## TABLE 1.2
## MUSCLE IMBALANCES AND THEIR POTENTIAL CAUSES

| POSTURAL DEVIATION | TIGHT MUSCULATURE | WEAK MUSCULATURE |
|---|---|---|
| Forward Head | SCM, Levator Scapulae, Scalenes, Suboccipitals, Upper Trapezius | Deep Cervical Flexors (Longus Coli/Capitus), Lower Trapezius, Rhomboids |
| Elevated Shoulder | Upper Trapezius, Levator Scapulae | Lower Trapezius, Rhomboids, Serratus Anterior, Rotator Cuff |
| Shoulder Protraction | Pectoralis Major/Minor, Latissimus Dorsi | Rhomboids, Middle/Lower Trapezius |
| Winged Scapula | Rhomboid, Pectoralis Minor | Serratus Anterior, Middle/Lower Trapezius |
| Anterior Tilt (increased lumbar lordosis) | Adductors, Iliopsoas, Rectus Femoris, Erector Spinae, Latissimus Dorsi | Gluteus Maximus/Medius, Hamstrings, Biceps Femoris, Transverse Abdominis, Internal Obliques, Multifidi, Rectus Abdominis |
| Posterior Tilt (increased lumbar flexion-flattened lumbar curve) | External Obliques, Rectus Abdominis, Hamstrings | Hip Flexors, Quadriceps |
| Iliac Crest Inequality | *Leg length discrepancy<br>Quadratus Lumborum, Hip Flexors, Rectus Abdominus, External Obliques, Soleus, Gastrocnemius | Gluteus Maximus/Medius/Minimus, Hamstrings, Adductor Complex |
| Medially Rotated Hip | Gluteus Medius/Minimus, Tensor Fasciae Latae, Adductors Brevis and Longus, Superior Portion of the Adductor Magnus | Externus and Internus Obturators, Piriformis, Superior and Inferior Gemelli, Quadratus Femoris |
| Laterally Rotated Hip | Externus and Internus Obturators, Piriformis, Superior and Inferior Gemelli, Quadratus Femoris | Gluteus Medius/Minimus, Tensor Fasciae Latae, Adductors Brevis and Longus, Superior Portion of the Adductor Magnus |
| Knee Hyperextension | Quadriceps, Soleus | Hamstrings, Gastrocnemius, Popliteus |
| Laterally Rotated Patella | Tensor Fasciae Latae, Gluteus Minimus, Piriformis | Adductor Complex, Medial Hamstring, and Gluteus Medius/Maximus, Vastus Medialis, Anterior/Posterior Tibialis |
| Medially Rotated Patella | Adductor Complex, Biceps Femoris, TFL, and Vastus Lateralis | Gluteus Medius/Maximus, Hip External Rotators, Vastus Medialis, Medial Hamstring |
| Feet Internally Rotate | Tensor Fasciae Latae | Gluteus Medius/Minimus |
| Feet Externally Rotate | Soleus, Biceps Femoris, Lateral Gastrocnemius, Tensor Fasciae Latae | Medial Gastrocnemius, Medial Hamstring, Gluteus Medius/Maximus, Gracilis, Popliteus, Sartorius |
| Flat Foot | Gastrocnemius, Peroneals | Gluteus Medius, Anterior/Posterior Tibialis |
| Feet Supinate | Plantar Fascia, Gastrocnemius, Soleus, Achilles, Tibialis Anterior | Extensor Digitorum Longus, Extensor Hallucis Longus |
| Feet Pronate | Peroneals, Gastrocnemius, Soleus, IT Band, Hamstring, Adductor Complex, Hip Flexor Complex, Tensor Fascia Latae, Biceps Femoris | Posterior Tibialis, Anterior TIbialis, Gluteus Medius/Maximus, Vastus Medialis, Hip External Rotators |

Lateral stabilization of the pelvis is required to maintain proper gait. The stability of the pelvis comes from the gluteus medius, gluteus maximus, and TFL. A single-leg stance test for balance can be analyzed to screen for muscle imbalances and risk of injury.

**Have your client raise one hip to 45-90° while bending the knee to 90°. Observe the quality of their movement.**

1) Is there any shifting while trying to attain the desired stance? Is there any unevenness in their pelvis or shoulders?

2) The client should be able to hold this stance without any compensation for at least 15 seconds.

3) If you notice any of the following while trying to attain stance position, there may be possible dysfunction.

    - Excessive shifting of the pelvis
    - Inability to hold the stance for 15 seconds
    - Elevated contralateral shoulder
    - Elevated contralateral hip
    - Medial rotation of the femur

If the knee is medially rotating, it may be that the TFL and medial hip rotators are dominant to the inhibited and weaker gluteus medius/minimus, and hip lateral rotators. We can generalize this by saying that the adductors are dominant to the abductors. In this case, choose exercises that focus on strengthening the hip abductors and avoid hip adduction until the medial rotation seems to be corrected. The reverse would apply if the femur was laterally rotated.

At this point you should do the Modified Thomas Test and the Trendelenberg test to confirm your findings and help you to determine the correct balance of stretching vs. strengthening exercises. The modified Thomas test allows you to assess the lower extremity muscles that are especially prone to tightness. They include the iliacus and psoas major, and the rectus femoris and TFL-ITB. If the hip flexors are tight it will limit hip extension and may cause an anterior pelvic tilt. Coupled with the tight hip flexors, you will most likely find weak gluteus maximus. A positive Trendelenburg test can occur when there is presence of a muscular dysfunction (weakness of the gluteus medius or minimus) or when someone is experiencing pain. The body is not able to maintain the center of gravity on the side of the stance leg.

## MODIFIED THOMAS TEST

Have your client sit on the very edge of the table or exercise bench with the coccyx touching the table and one foot on the floor **(FIGURE 1A).** Help them to carefully roll onto their back while helping to support their midthoracic spine and keeping their knees drawing into their chest. Make sure that their spine is in neutral (not arched) and that their pelvis is in posterior rotation to fix the origin of the hip flexors. They should maintain this position during the evaluation.

While maintaining hip flexion, passively lower the clients' leg until you detect resistance in the leg being tested **(FIGURE 1B).** Once you determine the resting position, look at the thigh from the side to see if it is parallel (180°) to the table or exercise bench, or if it is less than 180°. The greater the hip flexion in the leg being tested, the tighter the iliacus and psoas muscles will be.

Now look at the angle of the knee. The normal angle should be 90°. If the angle is greater than 90°, it is most likely due to tightness in the rectus femoris. With both the hip flexors and the quadriceps, the degree of the angle will reflect the amount of tightness in that area.

Position yourself at the end of the table or exercise bench, facing your client **(FIGURE 1C)**. Is the femur in a straight line with the patella centered? If the tested leg and respective patella are laterally rotating, it suggests that there is tightness in the TFL-ITB. This can be further confirmed when you passively move the tested leg into neutral and there is an increase in hip flexion.

FIGURE 1A

FIGURE 1B

FIGURE 1C

## MODIFIED 30-SECOND SIT TO STAND TEST

Sit-to-stand tests measure a clinically relevant function and are widely used in older adult populations. The modified 30-second sit-to-stand test overcomes the floor effect of other sit-to-stand tests observed in physically challenged older adults.

This is an important test of the client's functional ability to perform essential activities like getting up from the toilet, out of bed, and out of a chair.

**Purpose:** to assess functional lower extremity strength and endurance, transitional movements, balance, and fall risk.

**Equipment:** a chair with a straight back without arm rests (seat 17" high), and a stopwatch.

### Instruct your client to:

1) Sit in the middle of the chair.

2) Place their hands on their opposite shoulders – crossed at the wrists.

3) Keep their feet flat on the floor.

4) Keep their back straight, and arms against their chest.

5) On "Go," rise to a full standing position, then sit back down again. Repeat this for 30 seconds.

### On the word "Go," begin timing.

1) If the client must use his/her arms to stand, stop the test. Record "0" for the number and score.

2) Count the number of times the patient comes to a full standing position in 30 seconds.

3) If the patient is over halfway to a standing position when 30 seconds have elapsed, count it as a stand.

4) Record the number of times the patient stands in 30 seconds.

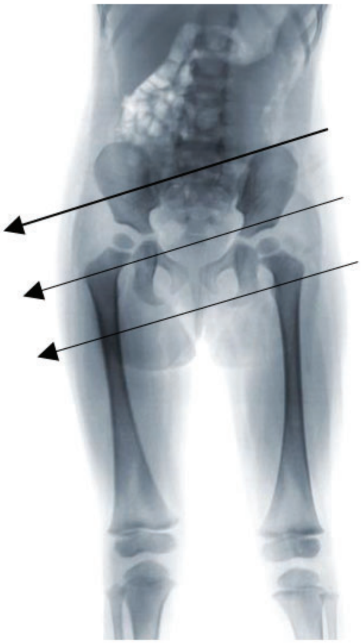
### Below Average Scores

| AGE | MEN | WOMEN |
|---|---|---|
| 60-64 | <14 | <12 |
| 65-69 | <12 | <11 |
| 70-74 | <12 | <10 |
| 75-79 | <11 | <10 |
| 80-84 | <10 | <9 |
| 85-89 | <8 | <8 |
| 90-94 | <7 | <7 |

** A below average score indicates a risk for falls.*

## TRENDELENBURG TEST

A physical examination finding associated with various hip abnormalities (those associated with abduction muscle weakness or hip pain or congenital hip dislocation, hip rheumatoid arthritis/osteoarthritis) in which the pelvis sags on the side opposite the affected side during single leg stance on the affected side. During gait, compensation occurs by leaning the torso toward the involved side during stance phase on the affected extremity.



If you have a client who you suspect has a hip abductor weakness, and also presents with foot over-pronation, a baseline gluteus medius strength assessment is necessary.

Have the client stand on one foot for 30 seconds. Look at frontal plane pelvis alignment. If you notice a drop in the hip on the contralateral side of the stance leg, that would be a ***positive Trendelenburg test.*** The muscle weakness is present on the side of the stance leg.

***A Trendelenburg sign can occur when there is presence of a muscular dysfunction (weakness of the gluteus medius or minimus) or when someone is experiencing pain.*** The body is not able to maintain the center of gravity on the side of the stance leg. Normally, the body shifts the weight to the stance leg, allowing the shift of the center of gravity and consequently stabilizing or balancing the body. However, in this scenario, when the client lifts the opposing leg, the shift is not created and the client cannot maintain balance, leading to instability.

## RECOMMENDED EXERCISES FOR POSITIVE TRENDELENBURG TEST:

### Single Leg Squat

- Beginning in a single leg stance, instruct your client to lower to a 45 degree of knee flexion
- Have them hold this position for 5 seconds while trying to maintain frontal plane hip and knee alignment
- Repeat 5-10 times

### Clams

- Have client lie on their side, with head propped up
- Legs should be bent, feet stacked on top of one another, and circular band should be positioned above knees
- Instruct your client to raise the top leg, pulling against the band, and hold at the top for 1-3 seconds
- Have them lower their leg slowly back to starting position and then repeat 12-15 times
- Repeat 12-15 times on other side

### Pelvic Drop

- Have the client stand on the "stance" leg on a small step
- Allow the foot on the opposite leg to drop below the height of the step, causing the pelvis to drop
- Instruct them to exhale as they bring the foot up to the level of the step and level out the pelvis
- Repeat 10 times

## OVERHEAD SQUAT ASSESSMENT (OHSA) TEST PROTOCOL

*Purpose: to assess dynamic flexibility, core strength, balance, and overall neuromuscular control.*
*Equipment: none*

### Procedures:

Position

- Have your client remove their shoes and socks.
- Instruct them to stand with their feet shoulder-width apart and pointing straight ahead.
- Ask them to raise their arms overhead, with elbows fully extended. If your client is unable to do this, or if it is causing any pain, you can conduct the test with their arms crossed over their chest. You will only be able to analyze their lower body under these circumstances.

Movement

- Instruct them to squat as if they were going to sit in a chair and then return to starting position *slowly.*
- Have them repeat the process for 5 repetitions while you observe them from the anterior, lateral, and posterior positions.
  - From the front you can view their feet, ankles, and knees. Their feet should point straight forward with the knees tracking in line with the foot. You can also look at the achilles tendons from the back. They should be almost perpendicular to the floor (FIGURE 2C).
  - From the side you can view their lumbo-pelvic hip complex, shoulder, and cervical spine. The tibia and arms should stay in line with the torso (FIGURE 2A and 2B).
  - From behind you can view the foot and ankle complex, knee valgus and varus (FIGURE 2D and 2E), and the lumbo-pelvic hip complex. It is normal for the foot and ankle complex to demonstrate slight pronation, but the arch should remain *visible*. The feet should continue to point straight ahead and the heels should remain in contact with the floor. There should be no shifting from side to side in the lumbo-pelvic hip complex.

FIGURE 2A

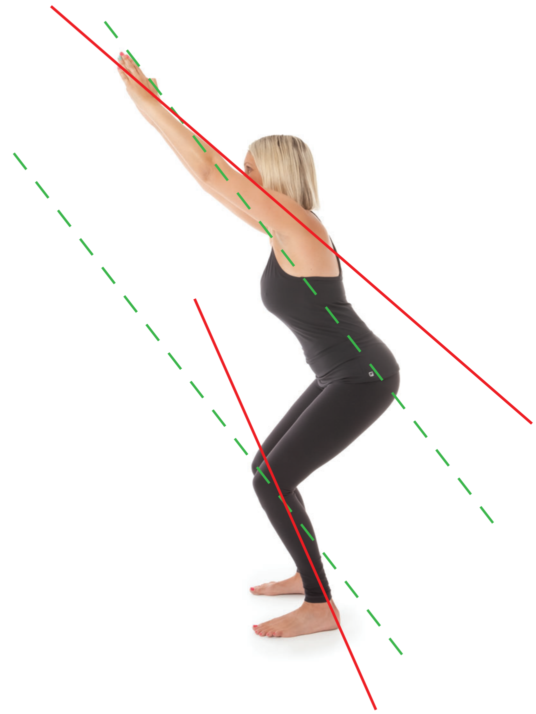


FIGURE 2B

*Optimal Positioning*
*Client Positioning*

FIGURE 2C

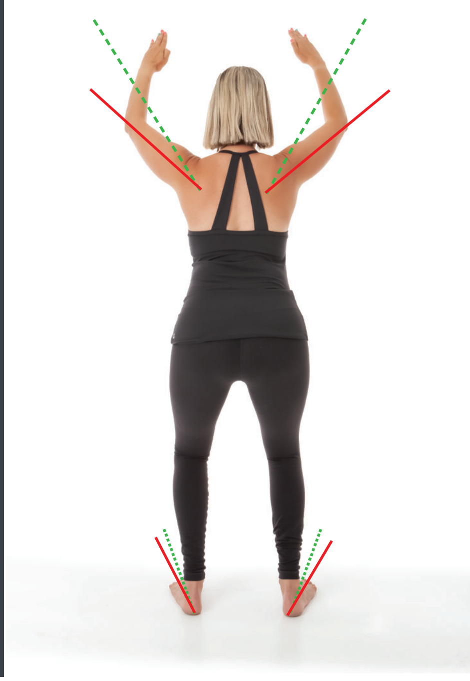
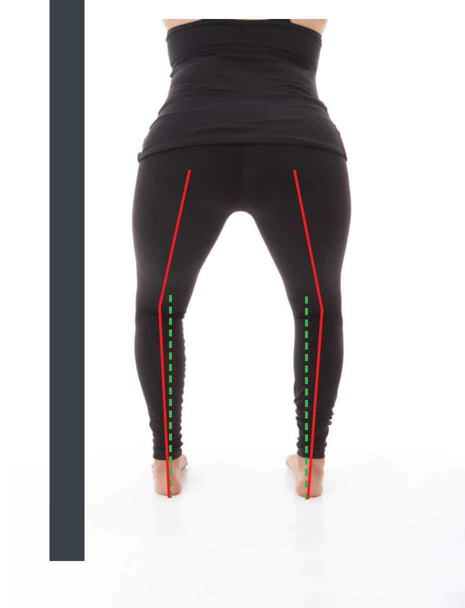


FIGURE 2D

FIGURE 2E



## AFTER WATCHING THEIR MOVEMENT PATTERN YOU CAN DERIVE THE FOLLOWING:

## LOOKING AT YOUR CLIENT FROM THE FRONT

**LPHC – Lumbo pelvic hip complex*

| CHECKPOINT | COMPENSATION | OVERACTIVE MUSCLES | UNDERACTIVE MUSCLES |
|---|---|---|---|
| Foot | Foot turns out | Soleus, Lateral Gastrocnemius, Bicep Femoris (short head), Tensor Fascia Latae | Medial Gastrocnemius, Medial Hamstring, Gluteus Medius/Maximus, Gracilis, Popliteus |
| Knee | Moves inward | Adductor Complex, Bicep Femoris (short head), Tensor Fascia Latae, Vastus Lateralis, Lateral Gastrocnemius | Gluteus Medius/Maximus, Vastus Medialis Oblique (VMO), Medial Hamstring, Medial Gastrocnemius |
| Knee | Moves outward | Piriformis, Biceps Femoris, Tensor Fascia Latae, Gluteus Minimus/Medius | Adductor Complex, Medial Hamstring, Gluteus Maximus |

### Looking at your client from the side

| CHECKPOINT | COMPENSATION | OVERACTIVE MUSCLES | UNDERACTIVE MUSCLES |
|---|---|---|---|
| LPHC | Excessive forward lean | Soleus, Gastrocnemius, Hip Flexor Complex, Abdominal Complex (rectus abdominus, external oblique) | Anterior Tibialis, Gluteus Maximus, Erector Spinae |
| LPHC | Low back arches | Hip Flexor Complex, Erector Spinae, Latissimus Dorsi | Gluteus Maximus, Hamstrings, Intrinsic Core Stabilizers (transverse abdominis, multifidus, internal oblique, transversospinalis, pelvic floor muscles |
| LPHC | Low back rounds | Hamstrings, Adductor Magnus, Rectus Abdominus, External Obliques | Gluteus Maximus, Erector Spinae, Intrinsic Core Stabilizers (transverse abdominis, multifidus, internal oblique, pelvic floor muscles, transversospinalis) |
| Upper body | Arms fall forward | Latissumus Dorsi, Pectoralis Major/Minor, Teres Major, Coracobrachialis | Mid/Lower Trapezius, Rhomboids, Rotator Cuff, Posterior Deltoid |
| Upper body | Forward head | Levator Scapula, Sternocleidomastoid, Scalenes | Deep Cervical Flexors |
| Upper body | Shoulder elevation | Upper Trapezius, Sternocleidomastoid, Levator Scapulae | Mid/Lower Trapezius, Rhomboids, Rotator Cuff |

### Looking at your client from the back

| CHECKPOINT | COMPENSATION | OVERACTIVE MUSCLES | UNDERACTIVE MUSCLES |
|---|---|---|---|
| Foot | Foot flattens | Peroneals, Lateral Gastrocnemius, Bicep Femoris (short head), Tensor Fascia Latae | Anterior Tibialis, Posterior Tibialis, Medial Gastrocnemius, Gluteus Medius |
| LPHC | Heel rises | Soleus | Anterior Tibialis |
| LPHC | Asymmetrical weight shift | Adductor Complex, Tensor Fascia Latae (same side), Piriformis, Bicep Femoris, Gluteus Medius (opposite side) | Gluteus Medius (same side), Adductor Complex (opposite side) |

## TABLE 1.3
## BIOMECHANICS

| MUSCLE STRUCTURE | ORIGIN | INSERTION | MOVEMENT |
|---|---|---|---|
| Pectoralis Major | Clavicular head: anterior surface of medial half of clavicle; Sternocostal head: anterior surface of sternum, superior six costal cartilages, and aponeurosis of external oblique muscle | Lateral lip of intertubercular groove of humerus | Adducts and medially rotates humerus; draws scapula anteriorly and inferiorly; Acting alone: clavicular head flexes humerus and sternocostal head extends it; Ball and socket joint |
| Pectoralis Minor | 3rd to 5th ribs near their costal cartilages | Medial border and superior surface of coracoid process of scapula | Stabilizes scapula by drawing it inferiorly and anteriorly against thoracic wall |
| Deltoid | Lateral third of clavicle, acromion, and spine of scapula | Deltoid tuberosity of humerus | Anterior part: flexes and medially rotates arm; Middle part: abducts arm; Posterior part: extends and laterally rotates arm |
| Serratus Anterior | Superolateral surfaces of upper 8 or 9 ribs at the side of chest | Vertebral border of scapula | Draws scapula forward and upward; abducts scapula and rotates it; stabilizes vertebral border of scapula |
| Rectus Abdominis | Pubic crest and symphysis pubis | Ribs (5th, 6th, & 7th), Xiphoid Process | Rectus Abdominis controls the tilt of the pelvis and curvature of the lower spine. It also tilts pelvis forward improving the mechanical positioning of the erector spinae. |
| External Obliques | External surfaces of ribs 5-12 | Anterior iliac crest and abdominal aponeurosis to linea alba | Flexes vertebral column (draws thorax downwards); rotates vertebral column (torso); laterally flexes vertebral column; compresses abdomen |
| Internal Obliques | Anterior iliac crest , lateral half of the inguinal ligament, and thoracolumbar fascia | Costal cartilages of ribs 8-12, abdominal aponeurosis to linea alba | Flexes vertebral column(draws thorax downwards); rotates vertebral column(torso) |
| Transverse Abdominis | Anterior iliac crest , lateral half of the inguinal ligament, and thoracolumbar fascia and cartilages of ribs 6-12 | Abdominal aponeurosis to linea alba, xiphoid process and pubic symphysis | Compresses the abdomen |
| Multifidis | Posterior surface of the sacrum, Articular processes of the lumbar vertebrae, Transverse processes of the thoracic vertebrae, Articular processes of C3-7 | Each part of the muscle inserts into the spinous process 2-4 vertebrae higher than its origin | Extension, lateral flexion and rotation of the spine |
| Quadratus Lumborum | Posterior iliac crest and Iliolumbar ligament | Twelfth rib and transverse processes of L1-L4 | Laterally flexes (side-bends) trunk |
| Pectineus | Upper front of the pubic bone | Upper medial shaft of the femur, inferior to the lesser trochanter | Hip adduction and Hip flexion |
| Iliopsoas | Inner surface the Ilium base of the sacrum, vertebral column (lateral surface) of thoracic vertebrae (T-12), lumbar vertebrae (L1-5) and intervertebral discs | Femur-lesser trochanter and shaft below lesser trochanter, tendon of psoas major & femur | Hip flexion and spine rotation |

| MUSCLE STRUCTURE | ORIGIN | INSERTION | MOVEMENT |
|---|---|---|---|
| Biceps Brachii | Short head: tip of coracoid process of scapula; long head: supraglenoid tubercle of scapula | Tuberosity of radius and fascia of forearm via bicipital aponeurosis | Supinates forearm and, when it is supine, flexes forearm |
| Brachialis | Distal half of anterior surface of humerus | Coronoid process and tuberosity of ulna | Major flexor of forearm - flexes forearm in all positions |
| Brachioradialis | Proximal 2/3 of lateral supracondylar ridge of humerus | Lateral surface of distal end of radius | Flexes forearm |
| Supinator | Lateral epicondyle of humerus, radial collateral and annular ligaments, supinator fossa and crest of ulna | Lateral, posterior and anterior surfaces of proximal 1/3 of radius | Supinates forearm (i.e., rotates radius to turn palm anteriorly) |
| Pronator Teres | Medial epicondyle of humerus and coronoid process of ulna | Middle of lateral surface of radius | Pronates and flexes forearm (at elbow) |
| Pronator Quadratus | Distal 1/4 of anterior surface of ulna | Distal 1/4 of anterior surface of radius | Pronates forearm; deep fibers bind radius and ulna together |
| Palmeris Longus | Medial epicondyle of humerus | Distal half of flexor retinaculum and palmar aponeurosis | Flexes hand (at wrist) and tightens palmar aponeurosis |
| Flexor Carpi Ulnaris | Humeral head: medial epicondyle of humerus; Ulnar head: olecranon and posterior border ulna | Pisiform bone, hook of hamate bone, and 5th metacarpal bone | Flexes and adducts hand (at wrist) |
| Flexor Carpi Radialis | Medial epicondyle of humerus | Base of 2nd metacarpal | Flexes and abducts hand (at wrist) |
| Vastus Lateralis | Superior portion of intertrochanteric line, anterior and inferior borders of greater trochanter, superior portion of lateral lip of linea aspera, and lateral portion of gluteal tuberosity of femur | Lateral base and border of patella; also forms the lateral patellar retinaculum and lateral side of quadriceps femoris tendon | Extends the knee |
| Rectus Femoris | Straight head from anterior inferior iliac spine; reflected head from groove just above acetabulum | Base of patella to form the more central portion of the quadriceps femoris tendon | Extends the knee |
| Vastus Medialis | Inferior portion of intertrochanteric line, spiral line, medial lip of linea aspera, superior part of medial supracondylar ridge of femur, and medial intramuscular septum | Medial base and border of patella; also forms the medial patellar retinaculum and medial side of quadriceps femoris tendon | Extends the knee |
| Vastus Intermedius | Superior 2/3 of anterior and lateral surfaces of femur; also from lateral intramuscular septum of thigh | Lateral border of patella; also forms the deep portion of the quadriceps tendon | Extends the knee |
| Adductor Longus | Anterior surface of body of pubis, just lateral to pubic symphysis | Middle1/3 of linea aspera, between the more medial adductor magnus and brevis insertions and the more lateral origin of the vastus medialis | Adducts and flexes the thigh, and helps to laterally rotate the hip joint |
| Adductor Brevis | Anterior surface of inferior pubic ramus, inferior to origin of adductor longus | Pectineal line and superior part of medial lip of linea aspera | Adducts and flexes the thigh, and helps to laterally rotate it |

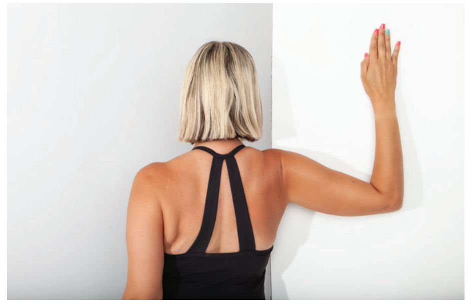
| MUSCLE STRUCTURE | ORIGIN | INSERTION | MOVEMENT |
|---|---|---|---|
| Adductor Magnus | Inferior pubic ramus, ischial ramus, and inferolateral area of ischial tuberosity | Gluteal tuberosity of femur, medial lip of linea aspera, medial supracondylar ridge, and adductor tubercle | Powerful thigh adductor; superior horizontal fibers also helps flex the thigh, while vertical fibers help extend the thigh |
| Tibialis Anterior | Lateral condyle of tibia, proximal 1/2 - 2/3 or lateral surface of tibial shaft, interosseous membrane, and the deep surface of the fascia cruris | Medial and plantar surfaces of 1st cuneiform and on base of first metatarsal | Dorsiflexor of ankle and invertor of foot |
| Tibialis Posterior | Posterior aspect of interosseous membrane, superior 2/3 of medial posterior surface of fibula, superior aspect of posterior surface of tibia, and from intramuscular septum between muscles of posterior compartment and deep transverse septum | Splits into two slips after passing inferior to plantar calcaneonavicular ligament; superficial slip inserts on the tuberosity of the navicular bone and sometimes medial cuneiform; deeper slip divides again into slips inserting on plantar surfaces of metatarsals 2 - 4 and second cuneiform | Principal invertor of foot; also adducts foot, plantar flexes ankle, and helps to supinate the foot |
| Extensor Digitorum Longus | Lateral condyle of fibula, upper 2/3 - 3/4 of medial fibular shaft surface, upper part of interosseous membrane, fascia cruris, and anterior intramuscular septum | Splits into 4 tendon slips after inferior extensor retinaculum, each of which insert on dorsum of middle and distal phalanges as part of extensor expansion complex | Extend toes 2 - 5 and dorsiflexes ankle |
| Peroneus Tertius | Arises with the extensor digitorum longus from the medial fibular shaft surface and the anterior intramuscular septum (between the extensor digitorum longus and the tibialis anterior) | Dorsal surface of the base of the fifth metatarsal | Works with the extensor digitorum longus to dorsiflex, evert and abduct the foot |
| Peroneus Longus | Head of fibula, upper 1/2 - 2/3 of lateral fibular shaft surface; also anterior and posterior intra-muscular septa of leg | Plantar posterolateral aspect of medial cuneiform and lateral side of 1st metatarsal base | Everts foot and plantar flexes ankle; also helps to support the transverse arch of the foot |
| Peroneus Brevis | Inferior 2/3 of lateral fibular surface; also anterior and posterior intramuscular septa of leg | Lateral surface of styloid process of 5th metatarsal base | Everts foot and plantar flexes ankle |
| Levator Scapulae | Posterior tubercles of transverse processes of C1 - C4 vertebrae | Superior part of medial border of scapula | Elevates scapula and tilts its glenoid cavity inferiorly by rotating scapula |
| Trapezius | Medial third of superior nuchal line; external occipital protuberance, nuchal ligament, and spinous processes of C7 - T12 vertebrae | Lateral third of clavicle, acromion, and spine of scapula | Elevates, retracts and rotates scapula; superior fibers elevate, middle fibers retract, and inferior fibers depress scapula; superior and inferior fibers act together in superior rotation |
| Lattisimus Dorsi | Spinous processes of inferior 6 thoracic vertebrae, thora-columbar fascia, iliac crest, and inferior 3 or 4 ribs | Floor of intertubercular groove of humerus | Extends, adducts, and medially rotates humerus; raises body toward arms during climbing |
| Supraspinatus | Supraspinous fossa of scapula | Superior facet on greater tuberosity of humerus | Initiates and assists deltoid in abduction of arm and acts with other rotator cuff muscles |

| MUSCLE STRUCTURE | ORIGIN | INSERTION | MOVEMENT |
|---|---|---|---|
| Infraspinatus | Infraspinous fossa of scapula | Middle facet on greater tuberosity of humerus | Laterally rotate arm; helps to hold humeral head in glenoid cavity of scapula |
| Teres Major | Dorsal surface of inferior angle of scapula | Medial lip of intertubercular groove of humerus | Adducts and medially rotates arm |
| Teres Minor | Superior part of lateral border of scapula | Inferior facet on greater tuberosity of humerus | Laterally rotate arm; helps to hold humeral head in glenoid cavity of scapula |
| Subscapularis | Subscapular fossa of scapula | Lesser tuberosity of humerus | Medially rotates arm and adducts it; helps to hold humeral head in glenoid cavity of scapula |
| Rhomboids | Minor: nuchal ligament and spinous processes of C7 and T1 vertebrae; Major: spinous processes of T2 - T5 vertebrae | Medial border of scapula from level of spine to inferior angle | Retract scapula and rotate it to depress glenoid cavity; fix scapula to thoracic wall |
| Triceps Brachii | Long head: infraglenoid tubercle of scapula; Lateral head: posterior surface of humerus, superior to radial groove; Medial head: posterior surface of humerus, inferior to radial groove | Proximal end of olecranon process of ulna and fascia of forearm | Chief extensor of forearm; long head steadies head of abducted humerus |
| Gluteus maximus | Gluteal surface of ilium, lumbar fascia, sacrum, sacrotuberous ligament | Gluteal tuberosity of the femur, iliotibial tract | External rotation and extension of the hip joint, supports the extended knee through the iliotibial tract, chief antigravity muscle in sitting |
| Gluteus Medius | Gluteal surface of ilium, under gluteus maximus | Greater trochanter of the femur | Abduction of the hip; preventing adduction of the hip. Medial rotation of thigh. |
| Gluteus Minimus | Gluteal surface of ilium, under gluteus medius. | Greater trochanter of the femur | Works in concert with gluteus medius: abduction of the hip; preventing adduction of the hip. Medial rotation of thigh. |
| Biceps Femoris | Common tendon with semitendinosus from superior medial quadrant of the posterior portion of the ischial tuberosity | Primarily on fibular head; also on lateral collateral ligament and lateral tibial condyle | Flexes the knee, and also rotates the tibia laterally; long head also extends the hip joint |
| Semimembranosus | Superior lateral quadrant of the ischial tuberosity | Posterior surface of the medial tibial condyle | Extends the thigh, flexes the knee, and also rotates the tibia medially, especially when the knee is flexed |
| Semitendinosus | From common tendon with long head of biceps femoris from superior medial quadrant of the posterior portion of the ischial tuberosity | Superior aspect of medial portion of tibial shaft | Extends the thigh and flexes the knee, and also rotates the tibia medially, especially when the knee is flexed |
| Gracilis | Inferior margin of pubic symphysis, inferior ramus of pubis, and adjacent ramus of ischium | Medial surface of tibial shaft, just posterior to Sartorius | Flexes the knee, adducts the thigh, and helps to medially rotate the tibia on the femur |

| MUSCLE STRUCTURE | ORIGIN | INSERTION | MOVEMENT |
|---|---|---|---|
| Gastrocnemius | Medial head from posterior nonarticular surface of medial femoral condyle; Lateral head from lateral surface of femoral lateral condyle | The two heads unite into a broad aponeurosis which eventually unites with the deep tendon of the soleus to form the Achilles tendon, inserting on the middle 1/3 of the posterior calcaneal surface | Powerful plantar flexor of ankle |
| Soleus | Posterior aspect of fibular head, upper 1/4 - 1/3 of posterior surface of fibula, middle 1/3 of medial border of tibial shaft, and from posterior surface of a tendinous arch spanning the two sites of bone origin | Eventually unites with the gastrocnemius aponeurosis to form the Achilles tendon, inserting on the middle 1/3 of the posterior calcaneal surface | Powerful plantar flexor of ankle |
| Extensor Carpi Ulnaris | Lateral epicondyle of humerus and posterior border of ulna | Base of 5th metacarpal | Extends and adducts hand at wrist joint |
| Extensor Carpi Radialis Longus | Lateral supracondyle ridge of humerus | Base of 2nd metacarpal | Extend and abduct hand at wrist joint |
| Extensor Carpi Radialis Brevis | Lateral epicondyle of humerus | Base of 3rd metacarpal | Extend and abduct hand at wrist joint |
| Erector Spinae | Spinous processes of T9-T12 thoracic vertebra | Spinous processes of T1 and T2 thoracic vertebrae and the cervical vertebrae | |
| Temporalis | Temporal lines, temporal fossa and temporal fascia | Tips and medial surface of coronoid process of the mandible | Elevates and retracts mandible at temporomandibular joint to close jaw |
| Frontalis | Galea apneurotica | Skin around eyebrows and nose | Raises eyebrows and wrinkles forehead as it draws scalp back |
| Orbicularis oculi | Frontal bone; medial palpebral ligament; lacrimal bone | Ateral palpebral raphe | Closes eyelids |
| Masseter | Zygomatic arch and maxilla | Coronoid process and ramus of mandible | elevation (as in closing of the mouth) and retraction of mandible |
| Sternocleidomastoid | Manubrium sterni, medial portion of the clavicle | Mastoid process of the temporal bone, superior nuchal line | Acting alone, tilts head to its own side and rotates it so the face is turned towards the opposite side. Acting together, flexes the neck, raises the sternum and assists in forced inspiration. |

## CORRECTING ROUND SHOULDER SYNDROME – STRETCH PECS AND LATS

## CORRECTING ROUND SHOULDER SYNDROME – STRENGTHEN MID/LOWER TRAPS, TERES MINOR, INFRASPINATUS, AND RHOMBOIDS



## MINIMIZING FORWARD HEAD – STRENGTHEN DEEP CERVICAL FLEXORS (LONGUS COLI/CAPITUS)

## CORRECTING POSTERIOR TILT – STRETCH EXTERNAL OBLIQUES, RECTUS ABDOMINIS, AND HAMSTRINGS









## CORRECTING ANTERIOR TILT – STRETCH ADDUCTORS, ILIOPSOAS, RECTUS FEMORIS, ERECTOR SPINAE, AND LATS

## CORRECTING ANTERIOR TILT – STRENGTHEN GLUTES, HAMSTRINGS, BICEPS FEMORIS, TRANSVERSE ABDOMINIS, INTERNAL OBLIQUE, MULTIFIDI, AND RECTUS ABDOMINIS

**CHAPTER TWO**

# *CARDIORESPIRATORY FITNESS IN ADULT CANCER CLIENTS*

## Cardiorespiratory Testing

**Objective:** to determine the level of the patient's cardiorespiratory fitness through exercise testing and to know when to refer the patient to their primary caregiver for further testing of cardiotoxicity. This will help you to:

- Understand cardiopulmonary function
- Understand absolute and relative contraindications for exercise testing
- Understand how and when to perform cardiorespiratory testing

**Goal:** to design an exercise program that is safe and effective for the clients' individual needs that takes into consideration any pre-existing medical conditions and their current/previous level of conditioning.

## WHAT IS CARDIORESPIRATORY FITNESS?

In recent years, exercise has become part of the standard of care during the treatment, recovery, and survivorship of cancer clients. Formalized exercise guidelines have been established by several national and international agencies such as the American Cancer Society, the European Respiratory Society, and the American Thoracic Society/American College of Chest Physicians.

*As exercise professionals, cardiorespiratory testing can help us to:*

- Create individualized exercise programming for clients with cancer
- Determine whether your programming is effective in promoting positive change

Cardiopulmonary function is the interrelationship between the lungs, the heart, and the blood system. Its primary function is the regulation of blood flow between the heart and lungs through the pulmonary artery. During exercise, it allows the body to receive freshly oxygenated blood to the active skeletal muscles. There are two inter-related cardio-centered systems in the human body; cardiovascular and cardiorespiratory. The cardiovascular system regulates the flow of blood throughout the body while the cardiorespiratory system describes the function of the heart in relationship to the entire breathing process from the nose and throat to the lungs.

The efficiency of heart function depends on the strength of the heart muscle. We know that chemotherapy and radiation can have a detrimental effect on both the heart and lungs. Several chemotherapy drugs may cause cardiac toxicity, but the most common cause of cardiac toxicity in cancer clients is treatment with chemotherapy drugs called anthracyclines. Adriamycin® ( Doxorubicin) is a frequently prescribed anthracycline. Anthracyclines may be used to treat leukemia, lymphoma, multiple myeloma and breast cancer.

Cardiac toxicity may cause arrhythmias or it can develop into heart failure. Heart failure means that the heart cannot pump with enough force to supply the body with blood containing essential oxygen and nutrients. Heart failure develops over time as the pumping action of the heart grows weaker.

*Cardiac toxicity is diagnosed with a number of examinations and tests:*

**Heart sounds –** an extra sound other than the normal heart beat is called a murmur, and may be a sign that the heart is damaged.

**Chest X-ray –** provides a one-dimensional picture of the heart and lungs. An enlarged heart on a chest x-ray may indicate that the heart muscle is damaged.

**Electrocardiogram (ECG) –** ECG machine records the electrical activity of the heart. This test is used to measure the rate and regularity of the heartbeat.

**Echocardiogram –** uses sound waves to create a picture of the heart. It shows how well the heart is filling with blood and pumping it to the rest of the body.

**Multi Gated Acquisition (MUGA) scan –** takes specialized pictures of the heart after a radioactive substance is injected into a vein. The contraction and relaxation of the heart and blood supply to the heart can be visualized from the pictures.

If your client presents with any of the following, they should notify their doctor immediately as these may be signs of cardiac toxicity:

- Excessive fatigue
- Shortness of breath on exertion worsening to shortness of breath at rest
- Discomfort lying on their back
- Swelling of their ankles

## CONTRAINDICATIONS FOR EXERCISE TESTING

### Absolute

- Acute myocardial infarction within (3-5 days)
- Unstable angina
- Uncontrolled arrhythmias causing symptoms or hemodynamic compromise
- Syncope
- Active endocarditis
- Acute myocarditis
- Symptomatic severe aortic stenosis
- Uncontrolled heart failure
- Acute pulmonary embolus or pulmonary infarction
- Thrombosis of lower extremities
- Uncontrolled asthma
- Pulmonary edema
- Room air desaturation at rest ≤ 85%
- Respiratory failure
- Acute noncardiopulmonary disorder that may affect exercise performance or be aggravated by exercise (i.e. infection, renal failure, thyrotoxicosis)
- Mental impairment leading to inability to cooperate
- Evidence of extensive metastases

### Relative

- Left main coronary stenosis or its equivalent
- Moderate stenotic valvular heart disease
- Severe untreated arterial hypertension at rest (>200 mm Hg systolic, >120 mm Hg diastolic)
- Tachyarrhythmias or bradyarrhythmias
- High-degree atrioventricular block
- Hypertrophic cardiomyopathy
- Significant pulmonary hypertension
- Advanced or complicated pregnancy
- Electrolyte abnormalities
- Orthopedic impairment that compromises exercise performance
- Untreated anemia

*Adapted from American Thoracic Society/American College of Chest Physicians, 2003, "ATS/ACCP Statement on cardiopulmonary exercise testing." American Journal of Respiratory and Critical Care Medicine 167(2):211-77.*

## CARDIORESPIRATORY TESTING METHODS

As fitness professionals, we are taught to compare our clients' test results to age-matched norms. This method will be ineffective for cancer clients because there are so many factors affecting their performance that the average, healthy individual, does not contend with. These may include cancer-related fatigue, shortness of breath, dizziness, balance issues, anemia, peripheral neuropathy, pain, and chemotherapy/radiation-induced cardiomyopathy.

Prior to beginning any exercise testing or programming with a client, it is imperative that you receive a medical clearance from their primary oncologist or general practitioner. Their attending physician should prescribe an initial, medically supervised, cardiovascular screening and/or stress test. Exercise constitutes a physiologic stress that may pose a greater risk to people with cancer than to people without pathology or impairment. The space for testing must be sufficient to minimize injury should the patient fall or have an arrest. All fitness professionals should have current CPR certification.

The initial appointment with your client should consist of a thorough evaluation of their entire health/medical history, balance, postural assessment, range of motion (flexibility), girth measurements (lymphedema), resting heart rate, resting blood pressure, and cardiorespiratory fitness. The average cancer patient may be older than your typical client and, therefore, present with a wide range of orthopedic and other health issues that need to also be taken into consideration.

Advise your client to avoid caffeinated beverages (coffee, tea, soda, energy drinks…), smoking, or exercising, prior to their assessment. Make sure that you familiarize yourself with any medication that they are taking that may have an effect on their heart rate and exercise response.

There are two types of cardiorespiratory tests that can be done; maximal and submaximal. The decision to use a maximal or submaximal exercise test depends on the reasons for the test, risk level of the client, and availability of necessary equipment and medical supervision. Maximal tests require participants to exercise to the point of volitional fatigue, which might entail the need for medical supervision.

Personal trainers commonly rely on submaximal exercise tests because maximal exercise testing is not always feasible in health club or studio setting. The submaximal test will predict cardiorespiratory fitness based on the workload achieved at a predetermined submaximal heart rate. Submaximal testing can be challenging with cancer clients because of various cancer therapies and medications that can affect heart rate.

Objective goals can also be quite effective in determining the appropriate exercise prescription for a given client. A normal exercise response might be the reduction of the resting and/or working heart rate of an individual over time. Typically, we are able to gradually increase the intensity and duration of an exercise as the client adapts to their previous level. If you do not see a notable improvement in exercise response, that should alert you to the fact that there may be an underlying problem. At this point, gently suggest that the client be evaluated by their attending physician to rule out any heart and/or lung damage.

Be very delicate with your approach, so as not to alarm your client, although they are usually well aware of the risks associated with their treatments. You want them to know that you are looking out for their best interests.

Accurate measurement of heart rate is critical for valid submaximal testing. You can certainly use manual palpation, however, there is a greater risk of error if you are not an experienced evaluator. Try using a heart rate monitor as it can reduce a significant source of error in the test. In addition to the medications and treatments that your clients are taking/undergoing, there are several other factors that can affect the outcome. The submaximal heart rate can also be affected by heat and humidity as well as the aforementioned; smoking, caffeine, and exercise prior to the testing.

The two standard tests that are used are the treadmill test and the cycle ergometer. While walking is a more natural activity than cycling is for most people, it can pose additional challenges for the cancer patient whose balance and coordination may be affected by treatment. The safety of our client is the highest priority and should be considered when choosing the testing modality. A cycle ergometer will, of course, require less coordination and balance than a treadmill.

Make sure that when you re-evaluate your client every 8-12 weeks that the same method of testing is used, under the same circumstances (time of day, environment, etc.)

**Bruce Protocol –**is a maximal exercise test where the patient works to complete exhaustion as the treadmill speed and incline is increased every three minutes. The length of time on the treadmill is the test score and can be used to estimate the VO2 max value. During the test, heart rate, blood pressure and ratings of perceived exertion are often also collected. **For clients undergoing treatment, or lower functioning clients, use the Modified Bruce Protocol**.

**Modified Bruce Protocol –** starts at a lower workload than the standard test, and is typically used for elderly or sedentary clients. Standard **Bruce Protocol** test has 7 three minute stages. First stage starts at a speed of 1.7 miles per hour (mph) and a gradient of 10%. Each subsequent stage has an increment of 0.7 to 0.8 mph in speed and 2% in gradient. The first two stages of the Modified Bruce Test are performed at a 1.7 mph and 0% grade and 1.7 mph and 5% grade, and the third stage corresponds to the first stage of the Standard Bruce Test protocol as listed above.

| |
|---|
| Stage 1 = 1.7 mph at 0% Grade |
| Stage 2 = 1.7 mph at 5% Grade |
| Stage 3 = 1.7 mph at 10% Grade |
| Stage 4 = 2.5 mph at 12% Grade |
| Stage 5 = 3.4 mph at 14% Grade |
| Stage 6 = 4.2 mph at 16% Grade |
| Stage 7 = 5.0 mph at 18% Grade |

The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines specify indications for termination of exercise testing. **Absolute indications for termination of testing include the following:**

- Drop in systolic blood pressure (SBP) of more than 10 mm Hg from baseline, despite an increase in workload, when accompanied by other evidence of ischemia (shortness of breath, extreme fatigue, dizziness, lightheadedness, fainting, chest pain, heart palpitations, swelling in the legs, feet, or abdomen)
- Moderate-to-severe angina (chest pain)
- Increasing nervous system symptoms (eg, lack of coordination, dizziness, close to fainting)
- Signs of poor perfusion (blue or purple colored skin or paleness)
- Patient’s desire to stop
- Sustained ventricular tachycardia (faster than normal heart rate)

## RESULTS:

**ACTIVE AND SEDENTARY MEN** (Foster et al. 1984)

From the total walk/run time an estimate of the athlete's VO2 max can be calculated as follows:

- **VO2 max = 14.8 - (1.379 × T) + (0.451 × $T^2$) - (0.012 × $T^3$)**

"T" is the total time of the test expressed in minutes and fractions of a minute (13 minutes 15 seconds = 13.25 minutes)

**ACTIVE AND SEDENTARY WOMEN** (Pollock et al. 1982)

From the total walk/run time an estimate of the athlete's VO2 max can be calculated as follows:

- **VO2 max = 4.38 × T - 3.9**

"T" is the total time of the test expressed in minutes and fractions of a minute.

### *Maximal oxygen uptake norms for men (ml/kg/min)*

| RATING | 18-25 AGE (YEARS) | 26-35 | 36-45 | 46-55 | 56-65 | 65+ |
|---|---|---|---|---|---|---|
| excellent | > 60 | > 56 | > 51 | > 45 | > 41 | > 37 |
| good | 52-60 | 49-56 | 43-51 | 39-45 | 36-41 | 33-37 |
| above average | 47-51 | 43-48 | 39-42 | 36-38 | 32-35 | 29-32 |
| average | 42-46 | 40-42 | 35-38 | 32-35 | 30-31 | 26-28 |
| below average | 37-41 | 35-39 | 31-34 | 29-31 | 26-29 | 22-25 |
| poor | 30-36 | 30-34 | 26-30 | 25-28 | 22-25 | 20-21 |
| very poor | < 30 | < 30 | < 26 | < 25 | < 22 | < 20 |

### *Maximal oxygen uptake norms for women (ml/kg/min)*

| RATING | 18-25 AGE (YEARS) | 26-35 | 36-45 | 46-55 | 56-65 | 65+ |
|---|---|---|---|---|---|---|
| excellent | > 56 | > 52 | > 45 | > 40 | > 37 | > 32 |
| good | 47-56 | 45-52 | 38-45 | 34-40 | 32-37 | 28-32 |
| above average | 42-46 | 39-44 | 34-37 | 31-33 | 28-31 | 25-27 |
| average | 38-41 | 35-38 | 31-33 | 28-30 | 25-27 | 22-24 |
| below average | 33-37 | 31-34 | 27-30 | 25-27 | 22-24 | 19-21 |
| poor | 28-32 | 26-30 | 22-26 | 20-24 | 18-21 | 17-18 |
| very poor | < 28 | < 26 | < 22 | < 20 | < 18 | < 17 |

**YMCA Submax Cycle Protocol –** is a multistage protocol that involves a progressive increase in workload based on the patient's heart rate response during exercise. Their VO2max can be calculated by putting the workloads and heart rates for the final two stages of the protocol into the multistage VO2max prediction equation. Cycle ergometer testing offers some advantages over Modified Bruce Protocol treadmill testing. A cycle ergometer is easy to transport, less expensive, and easier to calibrate and maintain than a treadmill. In addition, heart rate and blood pressure measurements are less difficult to obtain during exercise on the cycle. One of the major advantages of using a cycle for testing cancer clients is that the exercise is non-weightbearing and less stressful on the lower body. This is a huge plus for clients who are overweight, have orthopedic limitations, peripheral neuropathy of the feet, or struggle with balance and coordination. The biggest disadvantage is localized muscle fatigue in the legs that can limit the ability of the patient to perform exercise at higher submaximal intensities.

### EQUIPMENT NEEDED:

- Bicycle Ergometer
- Metronome set at 50 or 100 bpm to help subject with cadence
- Stopwatch to time test duration (and heart rate if a monitor is not available)
- Heart-rate monitor
- Weigh scale (for use in obtaining relative O2 consumption)
- Logbook

Adjust the seat height so the patient's leg is straight when their heel is in contact with the pedal on the down stroke or lowest point of rotation. Their knee should be slightly bent when the ball of their foot is placed on the pedal at the same low point of rotation. **Record the seat position on the data sheet so that it may be used for re-testing.** The YMCA test is meant to establish the relationship between heart rate and workrate. In order to maintain the validity of the test, the two heart rates used (steady state HR from the last two workrates) in the estimation of maximal exercise capacity must be greater than 110 bpm and less than 85 percent of age-predicted maximal heart rate. The YMCA uses an upper limit of 150 bpm, which encompasses most age groups likely to be tested.

**All subjects** begin at 150 kg.m/min and progress according to their heart rate response at the first workrate. The metronome is set to either 100 bpm (two beats/pedal cycle) or 50 bpm (one beat/pedal cycle) to maintain a constant pedal rate throughout the test, or the client maintains a 50-rpm pedal rate using the bike's speedometer. Let the patient decide whether to use the metronome but many subjects find it difficult to maintain such a low pedaling frequency even with cadence readout from the bike, so the metronome helps somewhat.

1) In order to familiarize clients with the 50-rpm pedal rate, start the metronome (if desired) and have them pedal with very little or no resistance.

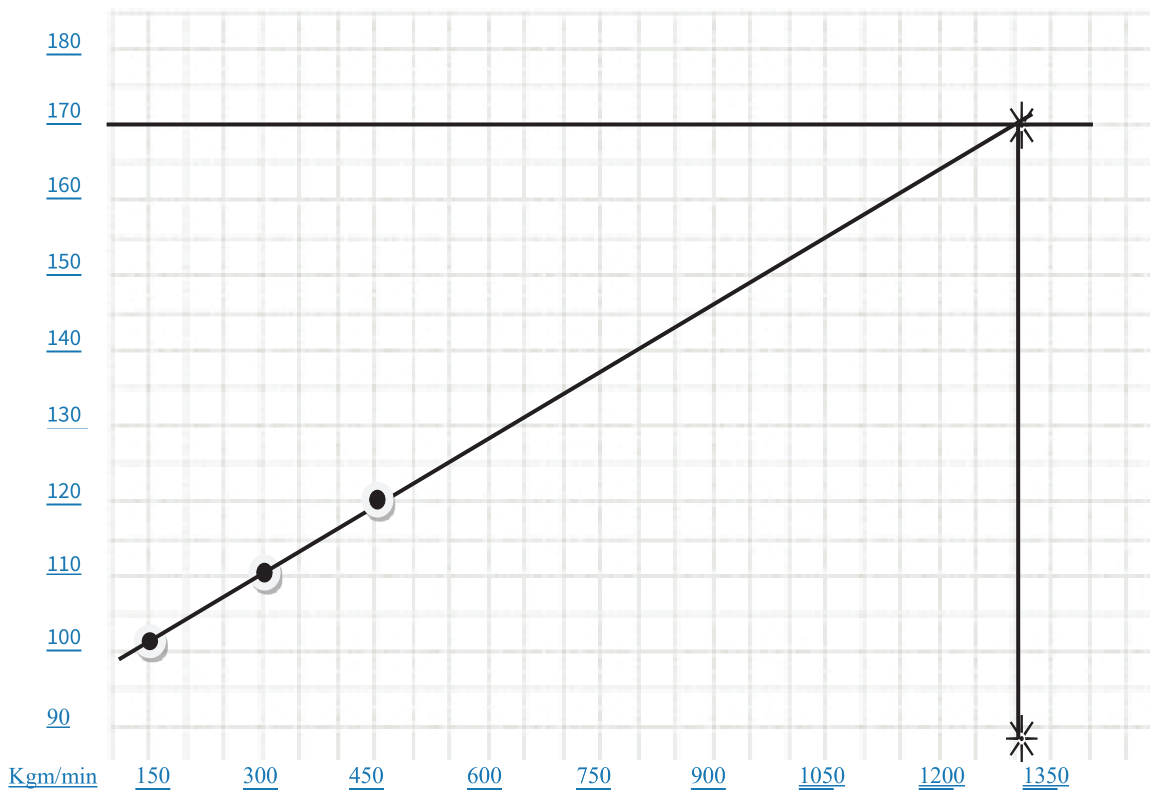
2) Start the test by setting the first workrate to 0.5 KP (150 kg.m/min) and then starting the time clock. Take heart rate reading near the end of the second and third minutes of the first stage. **A steady-state heart rate must be achieved before** progressing to the next stage (if the difference between the second-minute heart rate and the third-minute heart rate is greater than 5 bpm, the heart rate has not yet reached a steady stage and a fourth minute should be added). It may even take five minutes for the heart rate to stabilize, especially in less conditioned subjects.

3) **Be conservative** in the progression of the workrate in order to avoid driving heart rate too high. There is no need to hurry the test; each workrate (and hence steady state heart rate) is timed independently of others, so be careful to measure and record all data accurately.

4) Repeat the heart-rate monitoring guidelines used in the first stage for subsequent stages. **Continue the test until two steady-state heart rates between 110-150 bpm have been recorded for two different stages.** End the test by releasing all but 0.5-1.0 kg of resistance on the ergometer, allowing the client time to cool down (the heart rate should drop below 100 before the client stops cycling).

**Interpretation -** the objective of the YMCA submax bicycle test is to obtain two separate workloads resulting in steady state heart rate values between 110 bpm and the subject's 85% MHR. Steady state is determined by the last two heart rates being within 6 bpm apart. This establishes linearity between heart rate and workload for the person being tested. To establish the line of best fit on the graph, at least two points are needed. Once the test is completed, the heart rates should be plotted against the respective workload in the graph (see sample below). A straight line should be drawn through the points and extended to the subject's predicted max heart rate (220-age). The point where the diagonal line intersects the horizontal predicted max heart rate line will represent the maximal working capacity.

A perpendicular line will then be drawn from this point to the base where the maximal physical workload capacity can be read in kgm/min. This can then be used to predict a person's maximal oxygen uptake.




*Sample MHR 170*

## CARDIOMYOPATHY

Some people  have cardiomyopathy without ever having signs or symptoms, while others may not have signs or symptoms in the early stages of the disease.

Signs and symptoms of heart failure usually occur as cardiomyopathy worsens and the heart weakens. These signs and symptoms include:

- Trouble breathing when active or resting. Some people might also need to sleep sitting up or with many pillows under their head to help them breathe
- Fatigue
- Swelling in the legs, ankles, or feet
- Coughing, which may be worse when lying down at night
- Sudden weight gain
- Abdominal bloating
- Feeling dizzy, weak, or lightheaded
- Heart palpitations

Other signs and symptoms may include dizziness; light-headedness; fainting during physical activity; arrhythmias (irregular heartbeats); chest pain, especially after physical exertion or heavy meals; and heart murmurs. (Heart murmurs are extra or unusual sounds heard during a heartbeat.)

Your client may be taking any of the following medications:

- **Aldosterone blockers –** balance electrolytes in the body and help muscle and nerve tissues work properly. Abnormal electrolyte levels may be a sign of dehydration, heart failure, high blood pressure, or other disorders.
- **Antiarrhythmics –** help to prevent arrhythmias
- **ACE inhibitors and angiotensin II receptor blockers –** lower blood pressure
- **Anticoagulants –** prevent blood clots from forming. Blood thinners often are used to prevent blood clots from forming in people who have dilated cardiomyopathy.
- **Corticosteroids –** reduce inflammation
- **Diuretics (water pills) –** remove excess sodium from the body and reduce the amount of fluid in the blood
- **Beta blockers, calcium channel blockers, and digoxin –** slow your heart rate. Beta blockers and calcium channel blockers also are used to lower blood pressure

## CLASSIFICATION OF CARDIOMYOPATHY:

**Restrictive Cardiomyopathy –** develops when the ventricles become stiff and rigid but the walls of the heart do not thicken. As a result, the ventricles do not relax and don't fill with the normal blood volume. As the disease progresses, the ventricles do not pump as well and the heart muscle weakens. Over time, restrictive cardiomyopathy can lead to heart failure and problems with the heart valves.

**Dilated cardiomyopathy (DCM) –** develops when the ventricles enlarge and weaken. The condition usually starts in the left ventricle and over time can affect the right ventricle. The weakened chambers of the heart don't pump effectively, causing the heart muscle to work harder. Over time, the heart loses the ability to pump blood effectively. Dilated cardiomyopathy can lead to heart failure, heart valve disease, irregular heart rate, and blood clots in the heart. For people who are on medication, with stable symptoms and who do not have heart failure or arrhythmias, exercise can play an important role in recovery as well as enhanced quality of life. It can help to improve symptoms and is not likely to affect the underlying condition. Exercise prescription will depend on the person's individual symptoms.

**Hypertrophic cardiomyopathy (HCM) –** happens when the heart muscle enlarges and thickens without an obvious cause. Usually the ventricles, the lower chambers of the heart, and septum (the wall that separates the left and right side of the heart) thicken. The thickened areas create narrowing or blockages in the ventricles, making it harder for the heart to pump blood. Hypertrophic cardiomyopathy also can cause stiffness of the ventricles, changes in the mitral valve, and cellular changes in the heart tissue.

If you detect an arrhythmia during exercise testing, please refer your client to their doctor before any further exercise or testing is done. The individual may be considered for an ICD (implantable cardioverter defibrillator). An ICD uses electrical pulses or shocks to help control life-threatening arrhythmias.

**Arrhythmogenic right ventricular dysplasia –** is a rare type of cardiomyopathy that occurs when the muscle tissue in the right ventricle is replaced with fatty or fibrous tissue. This can lead to disruptions in the heart's electrical signals and causes arrhythmias. Arrhythmogenic right ventricular dysplasia usually affects teens or young adults and can cause sudden cardiac arrest in young athletes.

## UNCLASSIFIED CARDIOMYOPATHY:

**Left ventricular noncompaction –** occurs when the lower left chamber of the heart, which helps the heart pump blood, does not develop correctly. Instead of the muscle being smooth and firm, the cardiac muscle in the left ventricle is thick and appears spongy. The abnormal cardiac muscle is weak and has an impaired ability to pump blood because it either cannot completely contract or it cannot completely relax.

**Takotsubo cardiomyopathy –** also known as Takotsubo syndrome, is a temporary condition where your heart muscle becomes suddenly weakened or 'stunned'. The left ventricle, one of the heart's chambers, changes shape and enlarges. Though rare, this condition is more common in post-menopausal women.

**** Make sure to obtain proper medical clearance and adhere to doctors' recommendations.***

****Intensive or competitive exercise is not recommended for anyone with cardiomyopathy.***

## CAUSES OF CARDIOMYOPATHY IN CANCER PATIENTS:

Some cancer treatments may cause cardiomyopathy, especially if there is an existing history of a heart condition.

- Previous heart conditions or diseases that may have caused damage to the heart, such as coronary heart disease and hypertension
- Anthracyclines are a type of chemotherapy medication. They include Adriamycin® (Doxorubicin) and Rubex,® Cerubidine® (Daunorubicin), Ellence® (Epirubicin), and Idamycin® (Idarubicin). The risk of cardiomyopathy increases with higher doses of these drugs.
- Herceptin® (Trastuzumab) is a type of chemotherapy medication used to treat breast cancer and can cause cardiomyopathy. In many cases, once the patient stops taking it, the cardiomyopathy should partially or fully go away.
- Radiation treatment to the chest can also increase the risk of developing cardiomyopathy

## LIFESTYLE CHANGES FOR MANAGING CARDIOMYOPATHY:

- Avoid smoking and tobacco products
- Your client should weigh themselves every day. If their weight increases by 2 pounds in 1 day or 4 pounds in 1 week, have them call their healthcare provider. This might mean that they have fluid build-up and their diuretic dose may need to be increased.
- Keep sodium to less than 2 grams per day when possible, and avoid processed foods, such as canned soups, frozen meals, and cold cuts
- Be as physically active as possible
- Find ways to manage stress levels such as massage, acupuncture, yoga, reflexology, and meditation/mindfulness
- Avoid the use of recreational drugs and alcohol. Decrease alcohol intake to no more than 1 drink per day for females and 2 drinks per day for males.
- Get 7 to 8 hours of sleep nightly

*These recommendations are provided by Memorial Sloan Kettering Cancer Center*

## H.I.T.T. TRAINING FOR CANCER PATIENTS

In a 2019 study entitled "High-intensity interval training in the therapy and aftercare of cancer patients: a systematic review with meta-analysis," by Mugele et al., the authors identified 1453 studies, out of which 12 articles were included. The average duration of interventions was 6.7 ± 3.0 weeks, with 2.8 ± 0.5 sessions per week.[344] The meta-analysis for VO2peak showed superiority of HIIT compared to usual care (MD 3.73; 95% CI 2.07, 5.39; $p < 0.001$) but not moderate-intensity training (MD 1.36; 95% CI - 1.62, 4.35; $p = 0.370$).[344] Mugele et al. concluded that there was no difference between HIIT compared with moderate-intensity aerobic training for changes in cardiorespiratory fitness, lean mass, and patient-reported outcomes.[344] HIIT may be a time-efficient intervention for certain cancer patients throughout all stages of treatment and recovery.[344]

According to Klika et al., in their 2021 paper entitled "Exercise Oncology: High-Intensity Interval Training for Cancer Survivors," the cancer survivor should be able to complete 30 minutes of continuous exercise in a single session before starting HIIT.[345] Kilka states that after a general aerobic base training of 2 to 3 months, HIIT sessions may be incorporated into the exercise program.[345] HIIT should be recommended twice per week with approximately 48 hours between each HIIT session with each session 30 to 60 minutes in duration.[345] Each session should consist of a dynamic warm-up of 5 to 10 minutes at low to moderate intensity, followed by the interval conditioning phase of the session and culminating with a 10-minute cool-down period and/or stretching.[345]

When determining the intensity of the intervals, you must base it on the percentage of peak heart rate (measured), V˙O2peak (measured), or heart rate reserve whereby maximal heart rate is measured rather than estimated.[345] This should be assessed and monitored in a clinical/medical setting. Ranges for effective interval intensity are from 80% to 100% of peak heart rate (measured), 60% to 90% heart rate reserve when maximal heart rate and resting heart are available, and 60% to 90% of V˙O2peak (measured).[345] Kilka also states that the rating of perceived exertion has been used effectively to prescribe exercise intensity and should be between 7 and 9 on a modified Borg CR-10 scale or between 14 and 17 on the original 6 to 20 scale.[345] The rate of progression is based on client fitness, training response, and individual goals. Safety is number one when working with cancer patients who may have compromised immune systems, subclinical cardiomyopathy, and other comorbidities.[345] Cancer Exercise Specialists should monitor heart rate, blood pressure, and if available, oxygen saturation, during a client's first HIIT session to ensure a safe and appropriate response to exercise.[345] Warning signs to decrease and/or stop the workload are dizziness, ataxia, chest pain, and/or serious difficulty breathing.[345] Appropriate emergency equipment, including oxygen, should be available for cancer patients who are exercising in a commercial setting.[345]

**Conclusion:**
Based on the currently available evidence, HIIT training is safe, tolerable, and effective as part of a comprehensive cancer rehabilitation program.[345,346] Survivors who are relatively healthy after treatment may be able to add vigorous intensity to their training programs as a way to minimize workout duration.[345] An extensive medical and cancer history, as well as physician's clearance, should always be obtained before prescribing HIIT training to your clients.[345]

*It may be better to incorporate HITT training in a clinical/medical setting with appropriate emergency and testing equipment, conducted by a certified exercise physiologist.

## CHAPTER THREE

# *EXERCISE INTENSITY*

**Objective:** to understand the different stages and side-effects of treatment and how they affect exercise intensity and prescription.

- What is client's target heart rate?
- What level of intensity should they be striving for?
- Are they currently experiencing any side-effects of treatment?
- What are the recommended modifications/considerations?
- Under what circumstances should they avoid exercise, or cease exercise?

**Goal:** to create a safe and effective program using the Karvonen method to calculate target heart rate. Carefully consider any side-effects and contraindications while making exercise recommendations.

**Karvonen Method -** takes into account resting HR which is often higher in cancer patients.[181] However, any medication that affects heart rate, for example Beta-blockers, invalidates the formula. For these patients, subjective means of gauging intensity such as rate of perceived exertion (RPE) assessed by BORG Scale can be used. Moderate intensity activity is a level of effort of 12 or below on a 1–20 scale while vigorous intensity is a 14–16 on the same scale.[181]

**Table 3.0**

**Borg Rating of Perceive Exertion (RPE) Scale**

| | | |
|---|---|---|
| 6 - | Very, very light | How you feel when lying in bed or sitting in a chair relaxed. Little or no effort |
| 7 - | | |
| 8 - | Very light | |
| 9 - | | |
| 10 - | | |
| 11 - | Fairly light | |
| 12 - | | Target range: How you should feel with exercise or activity |
| 13 - | Somewhat hard | |
| 14 - | | |
| 15 - | Hard | |
| 16 - | | |
| 19 - | Very hard | How you felt with the hardest work you have ever done. |
| 18 - | | |
| 19 - | Very, very hard | |
| 20 - | Maximum exertion | Dont work this hard! |

**Example of a patient that is 60 years of age with a resting HR of 60.**

**[Maximum Heart Rate - Resting Heart Rate] x % Intensity)+ Resting Heart Rate**

**(Maximum Heart Rate) 220 - Age (60) = 160**

**Subtract Resting HR 160-60 = 100 x 50% (Intensity)**

**100 x 50% (50) + 60 (Resting HR) = 110**

**110 is the Target HR.**

Heart rate is currently the preferred method to establish exercise intensity, although many researchers have had success using the Borg rating of perceived exertion scale (1–20).[181] The current exercise guidelines for cancer patients suggest an intensity level of moderate-to-vigorous, which is defined as 40%–60% of maximal oxygen uptake reserve (VO2 reserve) or heart rate reserve (HRR).[181]

Effective aerobic conditioning programs incorporate some type of low level activity, followed by intermittent high intensity exercise in significantly shorter durations. Walking is typically the preferred modality of aerobic activity, but any modality may be considered with thought given to surgery and treatment side-effects and contraindications (i.e., cycling for prostate patients).[181] Aerobic training sessions are typically prescribed on alternating days throughout the week. This alternating level of high intensity/low intensity allows for significant overload and stimulus for adaptation while proving very safe and effective.[181] In the initial phase of conditioning at low intensity levels, it is not necessary to supervise the exercise sessions but during higher intensity exercise sessions your client may need supervision by a health professional.[181]

## TABLE 3.1

## ABSOLUTE CONTRAINDICATIONS AND RECOMMENDATIONS FOR EXERCISE

| CONTRADICTION | RECOMMENDATIONS |
|---|---|
| **External beam radiation** | No exercise within two hours – increased circulation may increase the effects of treatment. |
| **Non-intravenous chemotherapy** | No exercise within two hours |
| **Hematocrit < 25%** | No exercise |
| **Hemoglobin < 24% 8g/dl – anemic** | No exercise |
| **White blood cell count < 500 mm3** | No exercise |
| **Platelet count < 5,000 mm3<br><30,000 (only gentle active ROM)** | No resistance exercise – risk of internal hemorrhage |
| **Survivors with immunosuppressants should avoid public gyms until their white blood cell counts return to safe level (>500/mm3 )** | Avoid public gyms |
| **Bone marrow transplanted survivors within one year after transplantation** | Avoid exposure to public places with risk of microbial contamination. |
| **Adriamycin® (Doxorubicin) - chemotherapy regimen** | No exercise on the day of chemotherapy and only very low intensity exercise (heart rate is no greater than 15 to 20 beats above resting heart rate) for 24 to 48 hours after infusion. This is because Adriamycin can make the heart beat irregularly for about 24 hours afterward. |
| **PICC line** | Avoid resistance exercise of muscle in the area to avoid dislodgement of catheter.<br>Do not swim or play contact sports.<br>Avoid repetitive motions with affected arm. |
| **Fever** | No exercising - recommend that client see their doctor to eliminate the possibility of a systemic infection. |
| **Moderate/severe angina, dizziness or pre-syncope, cyanosis or pallor** | Discontinue exercise, monitor heart rate, and blood pressure. Have client sit or lie down and give them some water. Notify doctor and arrange patient transportation to hospital E.R. |
| **A drop in systolic blood pressure (10 mm. Hg. from baseline despite increases in workload, when accompanied by other indications of ischemia)** | Stop exercise and have client call their doctor |
| **Moderate to severe angina** | Stop exercise and have client call their doctor |
| **Increasing nervous system symptoms (i.e. ataxia, dizziness or near syncope). Signs of poor perfusion (cyanosis or pallor).** | Stop exercise and have client call their doctor |
| **Client's desire to stop** | Stop exercise and have client call their doctor |

## TABLE 3.2

## COMMON SIDE-EFFECTS, COMPLICATIONS, AND RECOMMENDATIONS FOR EXERCISE

| SIDE-EFFECT/COMPLICATION | RECOMMENDATIONS |
|---|---|
| **Blood glucose** | <100 or >250 Wait to exercise until blood glucose levels are in normal range |
| **Dehydration (vomiting/diarrhea within 24-36 hours)** | No exercising for 24-26 hours. The exception would be early or late dumping syndrome; if client has chronic vomiting or diarrhea. In this case, replenish electrolytes, rehydrate, and have them work at low intensity. |
| **Nausea** | Exercise at a level client can tolerate |
| **Fatigue** | Exercise at a level client can tolerate preferably 20-30 minutes 3-4 times per week |
| **Bone/joint pain** | Avoid high-impact activities, or those with a risk of falling (prevent fracture). Have client follow-up with doctor to eliminate the possibility of metastasis. |
| **Bone metastases (including lytic myelomatous lesions) – pelvis & proximal femur** | Caution regarding hip hyperflexion and hyperextension and high torque or rotational movements |
| **Bone metastases (including lytic myelomatous lesions) – spine** | Caution regarding axial loading. Avoid lumbar hyperflexion and hyperextension and high torque rotational movements. |
| **Bone metastases (including lytic myelomatous lesions) – ribs** | Caution regarding high torque or rotational movements through torso |
| **Bone metastases (including lytic myelomatous lesions) – shoulder** | Caution regarding extreme shoulder flexion, extension, abduction, and adduction |
| **Bone metastases (including lytic myelomatous lesions) – appendicular skeleton** | Modify or avoid for localized signs and symptoms |
| **Severe weight loss (greater than 35% of their weight)** | Low intensity exercise due to loss of muscle mass. Strength training will be beneficial in increasing lean muscle mass. |
| **Peripheral neuropathy** | If it is in the feet, avoid high-impact activities as well as those that require balance and coordination. If it is in the hands, use machines rather than hand weights. Modify activities that require balance to reduce risk of falling. |
| **Dizziness** | Avoid activities that require balance and coordination |
| **Increasing chest pain, fatigue, shortness of breath, wheezing, or claudication** | Reduce exercise intensity or facilitate active recovery (monitor heart rate & blood pressure) |
| **"Pitting" edema or awareness of "heaviness", "warmth", or increase in baseline girth measurements in area at risk for lymphedema** | Have client see doctor ASAP to evaluate for lymphedema |

## CANCER PATIENTS SHOULD CONTACT THEIR PHYSICIAN IF ANY OF THE FOLLOWING ABNORMAL RESPONSES DEVELOP:

- Fever
- Extreme or unusual tiredness or unusual muscular weakness
- Irregular heartbeat, palpitations, or chest pain
- Leg pain or cramps, unusual joint pain, unusual bruising or nosebleeds
- Sudden onset of nausea during exercise
- Rapid weight loss, severe diarrhea or vomiting
- Disorientation, confusion, dizziness, lightheadedness, blurred vision, or fainting
- Pallor or gray-colored appearance
- Night pain, or pain not associated with an injury

## CHAPTER FOUR

# *CORRECTING RANGE OF MOTION LIMITATIONS*

**Objective:** to understand how to use a goniometer to determine joint ROM and to choose the proper stretches/strength training exercises to help achieve the desired results.

- What are the three parts of a goniometer?
- What are the planes of the body and what joint motion occurs in each?
- What are the "norms" for the five planes of motion?
- Is the ROM limitation a strength or flexibility issue?
- What are the recommended modifications/considerations?

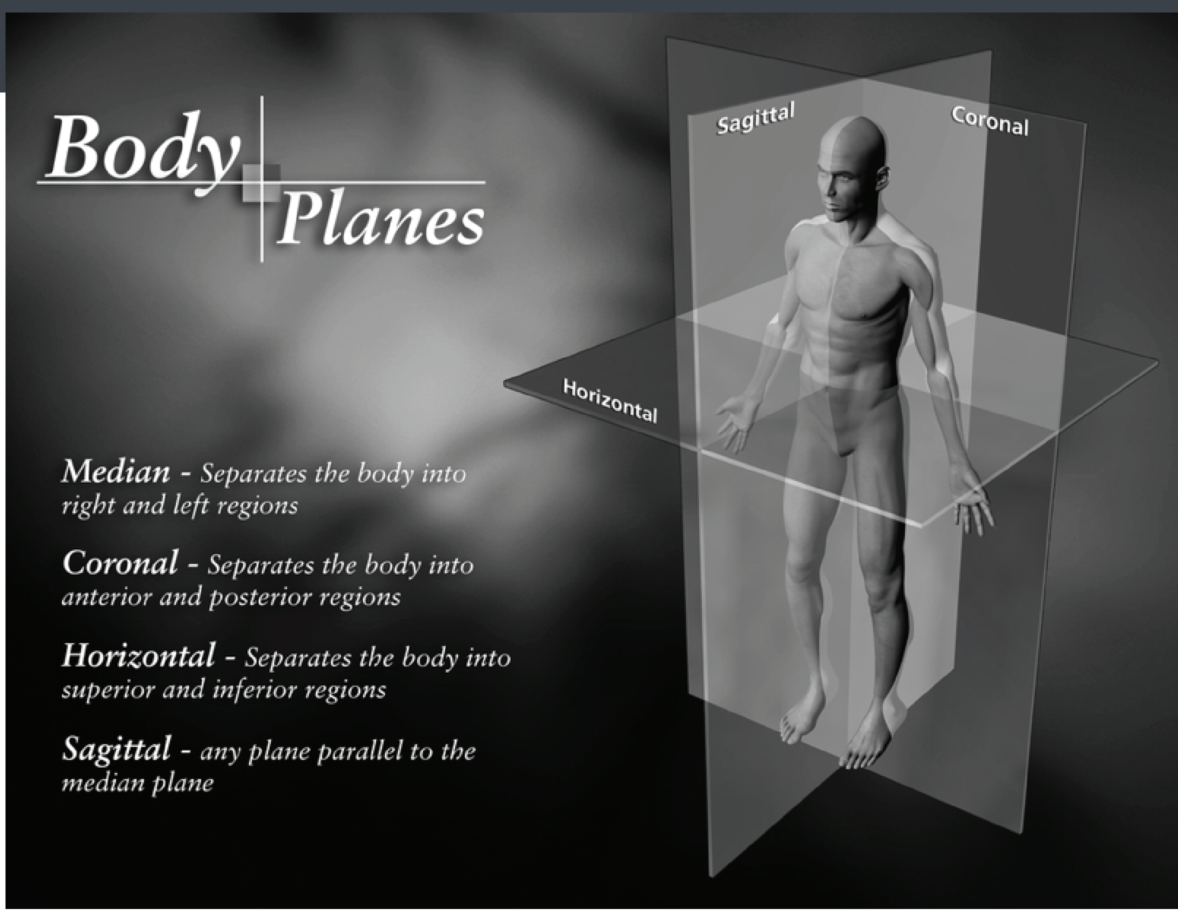
**Goal:** to determine whether ROM limitations are caused by scar tissue or hypertonic/hypertrophic muscles and to choose appropriate exercises that will help increase ROM and improve their ability to perform ADL's.

## CORRECTING RANGE OF MOTION LIMITATIONS

Following breast surgery/reconstruction shoulder range of motion limitations (ROM) are not uncommon. It is important to address these issues because they can lead to additional joint deterioration, and/or frozen shoulder, if not corrected. Conducting a ROM assessment with a goniometer will help determine which areas need attention. Before beginning a resistance training program, your client should have 90% or better of the lower end of the ROM norm. Remember that ROM measurements taken passively are ***typically*** a reflection of flexibility while measurements taken actively are ***typically*** a reflection of strength. This process is described in detail and norms for each plane of motion are listed in the shoulder ROM section of this book.

For example, if norms for flexion are 150-180, your client should be at no less than 135 degrees of passive ROM before they do any resistance training in flexion. If they are limited in passive ROM, it is likely that they will be limited in active ROM as well. It is a good idea to begin by taking the passive ROM measurements; as the results will dictate the next step. If they are limited in passive ROM, there isn't much need to take the active ROM measurement (other than for baseline purposes), as their focus will need to be on flexibility and ROM before they begin strength training. Flexibility limitations ***always*** outweigh strength limitations. You ***do not*** want a client to become stronger in a limited plane of motion.

Clients may begin resistance training in other planes of motion if they are 90% or better of the normal range in that plane. Therefore your client who only has 125 degrees of shoulder ROM in flexion, should not do a pullover, or other "shoulder flexion" exercise, with any type of resistance. They can, however, do exercises with resistance in the other planes of motion. It is important for you to consider which exercises take place in any given plane of motion. You can use this determination to make recommendations based on the need for improved flexibility or strength. Below you will find some examples of exercises to help correct ROM limitations for strength and flexibility. You can use any exercise you would like - with strength vs. flexibility in mind. They can be conventional strength training, Yoga, Pilates, water-based, etc. Keep in mind that these corrective exercises apply to ***anyone*** (not just breast cancer clients) who has a specific ROM deficiency. **The body and planes chart below** will help you to understand the planes of the human body, as well as which motions take place in each plane (axis). **Table 4.1** will give you ideas of sample strength training exercises in each plane.



## PLANES OF MOTION

There are three dimensions that all human movement occurs in. It is typically referred to in planes and axes. Three imaginary planes are positioned through the body; all intersecting at the body's center of mass. These planes are termed ***Median (Sagittal), Coronal (Frontal),*** and ***Horizontal (Transverse)***. If a movement occurs parallel to that plane, it is thought to occur predominantly in that plane. While this holds true to a certain extent, ***NO*** motion occurs strictly in one plane. Joint motion is the movement in a plane that occurs around an axis that runs perpendicular to that plane.

- **The Median (Sagittal) Plane –** this plane bisects the body into the right and left sides. Joint motion in this plane occurs around a frontal axis and includes ***flexion and extension.*** Flexion is the decrease in joint angle and extension is the increase in joint angle. Flexion and extension occur in many of the joints in the body, however they are referred to as ***plantarflexion*** and ***dorsiflexion*** when referring to the ankle.

- **The Coronal (Frontal) Plane –** this plane bisects the body into its front and back halves. Joint motion in this plane occurs around an anterior/posterior axis and includes ***abduction*** and ***adduction*** of the limbs, ***lateral flexion*** of the spine, and ***eversion and inversion*** of the foot. Abduction means to move away from the midline of the body, or increasing the joint angle. Adduction means movement toward the midline of the body, or decreasing the joint angle. Lateral flexion may refer to bending any part of the spine (cervical, thoracic, or lumbar) from side to side. Eversion and inversion refer to movement at the foot and ankle complex during pronation and supination.

- **The Horizontal (Transverse) Plane –** this plane bisects the body into top and bottom halves. Joint motion in this plane occurs around a longitudinal or vertical axis and includes ***internal and external rotation*** of the limbs, ***right and left rotation*** for the head and trunk, and radioulnar ***pronation and supination.*** When referring to transverse plane motions of the foot, we use the terms abduction and adduction. Abduction is when the toes are ***externally rotated*** (pointing outward) and adduction is when the toes are ***internally rotated*** (pointing inward).

## TABLE 4.1 - PLANES, JOINT MOTIONS, AND SAMPLE STRENGTHENING EXERCISES

| Plane | Joint Motion | Sample Strengthening Exercises |
|---|---|---|
| **Median (Sagittal)** | Flexion and Extension | Bicep Curls<br>Tricep Pushdowns<br>Tricep Kickbacks<br>Pullover<br>Frontal Shoulder Raises<br>Lunges<br>Squats<br>Chair Pose (Yoga)<br>Eagle Pose (Yoga)<br>High Lunge (Yoga)<br>Magic Circle at the Back (Pilates)<br>Magic Circle Overhead (Pilates)<br>Back Rowing (Pilates) |
| **Coronal (Frontal)** | Adduction and Abduction<br>Lateral Flexion<br>Eversion and Inversion | Snow Angel<br>Lateral Shoulder Raises<br>Side Lunges<br>Side-stepping with Band<br>Triangle Pose (Yoga)<br>Warrior II Pose (Yoga)<br>Mountain Pose (Yoga)<br>Saw (Pilates)<br>Small Arm Circles (Pilates)<br>Side Arm Series (Pilates) |
| **Horizontal (Transverse)** | Internal and External Rotation<br>Left and Right Spinal Rotation<br>Horizontal Adduction and Abduction | Cable rotation<br>Dumbbell rotation<br>Cow Face Pose (Yoga)<br>Half Lord of the Fishes Pose (Yoga)<br>Band at Side ER/IR (Pilates)<br>Back Rowing 45 Degrees (Pilates) |

## RANGE OF MOTION ASSESSMENT PROTOCOL

*Purpose: To determine the range of motion and measure the flexibility of a specific joint*

*Equipment: Goniometer*

## GONIOMETRIC MEASUREMENTS

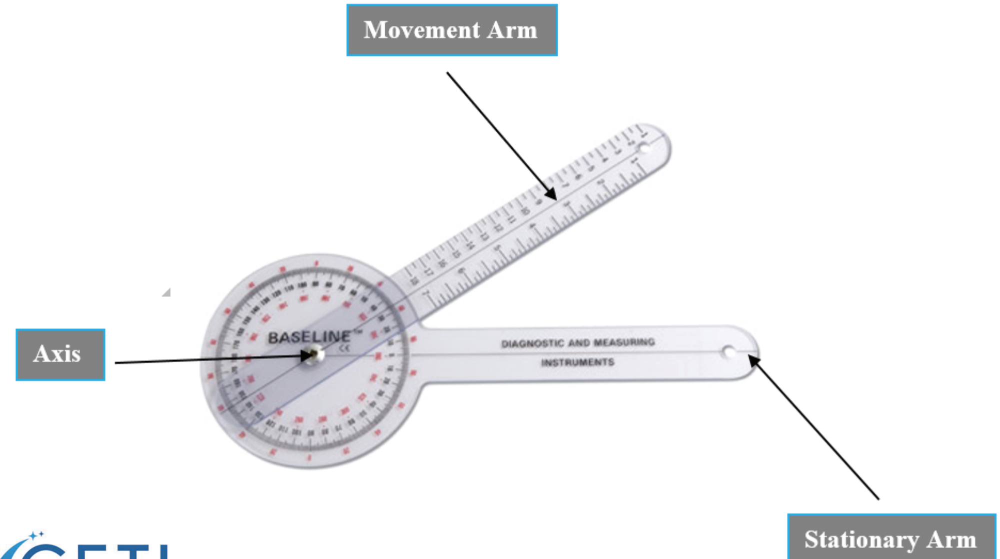
A goniometer is a device that is typically used by physical and occupational therapists to measure the range of motion around a joint. The word goniometer is derived from the Greek terms gonia and metron, which mean angle and measure, respectively. Goniometers can help the examiner to determine whether the restriction at a particular joint is primarily a function of strength (or lack of) or flexibility (or lack of - possibly from scar tissue). Measurements may be taken actively (when the client or patient moves the selected joint(s) through full ROM without any assistance from the examiner), or passively (where the examiner moves the joint(s) through full ROM without any assistance from the client/patient). A goniometer is usually made of transparent plastic. There are some goniometers that are made of metal. There are two "arms" of the goniometer: the stationary arm and the moveable arm. Each arm is positioned at specific points on the body and the center of the goniometer (axis of rotation) is aligned at the joint to be measured.

When first meeting with a client/patient, you should use a goniometer to obtain a baseline range of motion around a specific joint. These measurements can be compared to normative ROM data for each joint, thus helping to determine what the goal(s) of a particular exercise will be. Typically, measurements are taken again after 8-12 weeks to look for tangible signs of improvement.

## PROCEDURES:

### 1. HOW TO USE A GONIOMETER

- Identify stationary arm
- Identify movement arm
- How to read the angle



## 2) IDENTIFY FLEXIBILITY VS. STRENGTH

- **Flexibility –** for the purposes of our testing, this will refer to the amount of motion that is obtained while client is in supine position. This is not to say that these measurements are not affected at all by muscular strength (or lack thereof), however, they are a fairly accurate reflection of the client's limitations from scar tissue and adhesions vs. actual muscular strength.

- **Strength –** for the purposes of our testing, this will refer to the amount of motion that is obtained while client is in upright standing or sitting position (when unable to stand).

- Begin by taking supine measurements on both sides. Note the difference between the affected side (side with surgery or radiation) and the unaffected side.

- If ROM in the supine position is not 90% of the lowest end or the norms (ie; 150˚- 180˚ the client needs to have at least 135˚) before adding any resistance in that particular plane of motion, the focus will need to be on improving ROM through stretching and flexibility exercises before you even consider adding a load to any movement. To place an additional load on the muscles would strengthen them in that limited ROM and hinder their improvement.

**1)** Stationary arm - in line with body

Axis - at shoulder joint

Movement arm - in line with elbow/shaft of humerus

**2)** Have client in the supine position, with knees bent to flatten the lumbar spine. Arm should be extended at the side of the body **(Figure 1A).** This is the starting position. The arm is then raised forward and up overhead **(Figure 1B).** Palm will face in toward the body with thumb pointing upward and will end with palm still facing in, but thumb pointing down or backward.

Make sure to have client stabilize the scapula to prevent upward rotation and elevation of the scapula. If you notice excessive movement in their scapula, or see their lower back arch, have them back off a few degrees to the point where the compensation is no longer obvious.

### SHOULDER MOTION

Figure 1A

Figure 1B

### B. Abduction - ROM Norms: 150˚ - 180˚

Figure 2A

Figure 2B

1) Stationary arm - in line with body

   Axis - at armpit

   Movement arm - in line with elbow/shaft of humerus

2) Have client in the supine position, with knees bent to flatten the lumbar spine. Arm should be extended at the side of the body with palm facing upward **(Figure 2A)**. The arm is moved laterally away from the client's trunk, moving toward the head **(Figure 2B).** The palm stays facing upward throughout the motion.

   Make sure that the client does not rotate their arm (watch the elbow) and that their humerus does not come off of the table or floor when taking measurement. If either of those things are noted, have the client back off a few degrees to the point where the compensation is no longer obvious.

### C. Extension - ROM Norms: 40˚ - 60˚

Figure 3A

Figure 3B

1) Stationary arm - in line with body

   Axis - at shoulder joint

   Movement arm - in line with elbow/shaft of humerus

2) Have client lie on their side, making sure that their spine is in a straight line and their head is supported with a pillow **(Figure 3A).** This may be a more comfortable option for someone who has recently undergone surgery, or is otherwise uncomfortable in prone position. Keeping their arm level, and parallel to the table, have them extend it behind the midline of their body **(Figure 3B).** Make sure that their spine remains in a straight line.

   Make sure to have client stabilize the scapula to prevent anterior tilting of the lumbar spine and elevation of the trapezius. If you notice excessive movement in their trapezius, or see their back arch, have them back off a few degrees to the point where the compensation is no longer obvious.

### D. External Rotation - ROM Norms: 70˚- 90˚

Figure 4A

Figure 4B

1) Stationary arm - perpendicular to table or floor

   Axis - elbow joint (if taken while lying on the floor, the bottom of the stationary arm will be resting on the floor and axis of rotation will be slightly above the elbow.

   Movement arm - along shaft of ulna (forearm)

2) Have client in the supine position, with knees bent to flatten the lumbar spine. Have them bend their elbow to 90 degrees (at the shoulder joint). Their forearm should be perpendicular to the table, with their palm facing away from them (towards feet) and their fingers pointing straight up to the ceiling **(Figure 4A).** It is helpful to place a very small rolled up towel under their elbow to keep the upper arm level, and keep the elbow from dipping below the shoulder. The humerus should be supported by the table, and the elbow will be unsupported (the elbow will be supported if taking the measurement on the floor). Have them rotate their forearm backward toward floor **(Figure 4B).** At the beginning of the motion, stabilize the elbow joint in order to maintain 90˚.

   Make sure to have client stabilize the scapula to prevent upward rotation and elevation of the scapula. If you notice excessive movement in their scapula, or see their lower back arch, have them back off a few degrees to the point where the compensation is no longer obvious.

### E. Internal Rotation - ROM Norms: 40˚- 60˚

Figure 5A

Figure 5B

1) Stationary arm - perpendicular to table or floor

   Axis - elbow joint

   Movement arm - along shaft of ulna (forearm)

2) Have client in the supine position, with knees bent to flatten the lumbar spine. Have them bend their elbow to 90 degrees (at shoulder joint). Their forearm should be perpendicular to the table, with their palm facing away from them (towards feet) and their fingers pointing straight up to the ceiling **(Figure 5A).** It is helpful to place a very small rolled up towel under their elbow to keep the upper arm level, and keep the elbow from dipping below the shoulder. The humerus should be supported by the table, and the elbow will be unsupported (the elbow will be supported if taking the measurement on the floor). Have client rotate their arm forward **(Figure 5B).** Toward the end of the motion, use your hand to stabilize the clavicle and acromium process to prevent anterior tilting and protraction of the shoulder (you should be gently placing your hand on the AC joint and stopping their movement as soon as you feel a contraction beneath your fingertips).

   Make sure to have client stabilize the scapula to prevent anterior tilting of the lumbar spine. If you notice excessive movement in their clavicle/acromium process, or see their back arch, have them back off a few degrees to the point where the compensation is no longer obvious.

## F. Hip Flexion - ROM Norms: 100˚ - 120˚

Figure 6A

Figure 6B

1) Stationary arm - in line with the midline of the body

   Axis - lateral aspect of the hip joint

   Movement arm - in line with the lateral midline of the femur

2) Have client in the supine position with both legs fully extended **(Figure 6A).** Flex the hip by lifting the thigh off of the table **(Figure 6B).** Simultaneously flex the knee. Gently move leg toward the chest. Keep the lower back flat on the table in neutral position and stabilize the pelvis with one hand to prevent posterior tilting. If you see their back arch, have them back off a few degrees to the point where the compensation is no longer obvious.

## G. Hip Extension - ROM Norms: 20˚ - 30˚

Figure 7A

Figure 7B

1) Stationary arm - in line with the midline of the body

   Axis - lateral aspect of the hip joint

   Movement arm - in line with the lateral midline of the femur

2) Have client lie in the prone position with both legs fully extended and head turned to the side, or face down with a small towel rolled up under the forehead **(Figure 7A).** Extend the hip by lifting the thigh off of the table **(Figure 7B).** Make sure that the knee is extended (not locked) throughout the entire motion. Keep the opposing leg flat on the table and hold the pelvis with hand to prevent anterior tilting. If you see their back arch excessively, have them back off a few degrees to the point where the compensation is no longer obvious.

## H. Hip Abduction - ROM Norms: 40˚ - 42˚

Figure 8A

Figure 8B

1) Stationary arm - in line with and imaginary horizontal line extending across the front of the body at the level of both anterior superior iliac spines.

   Axis - over the anterior superior iliac spine (ASIS) of the leg being measured

   Movement arm - in line with the anterior midline of the femur

2) Have client in the supine position with both legs fully extended **(Figure 8A).** Move the leg being tested laterally while keeping the opposing leg stationary **(Figure 8B).** Do not allow any rotation of the hip. Keep your hand on the pelvis at the ASIS to prevent lateral tilting, rotation, and/or lateral trunk flexion.

## I. Hip Adduction - ROM Norms: 20˚ - 22˚

Figure 9A

Figure 9B

1) Stationary arm - in line with and imaginary horizontal line extending across the front of the body at the level of both anterior superior iliac spines.

   Axis - over the anterior superior iliac spine (ASIS) of the leg being tested

   Movement arm - in line with the anterior midline of the femur

2) Have client in the supine position with both legs fully extended. Abduct the opposing leg to allow for adequate movement of the leg being tested **(Figure 9A).** By placing one hand on the knee, slide the leg being tested medially toward the opposite leg. Keep one hand on the pelvis at the ASIS to keep the hip in neutral **(Figure 9B).**

### J. Knee Flexion - ROM Norms: 142˚- 150˚

Figure 10A

Figure 10B

1) Stationary arm - in line with the lateral midline of the femur

   Axis - over the lateral epicondyle of the femur

   Movement arm - in line with the lateral midline of the fibula

2) Have client in the supine position with both legs fully extended **(Figure 10A)**. Do not allow any rotation, abduction, or adduction of the hip. Keep your hand on your client's ankle or shin while placing their thigh at approximately 90 degrees of hip flexion. Move the knee into flexion **(Figure 10B).**

### K. Knee Extension - ROM Norms: 0˚- 10˚

Figure 11A

1) Stationary arm - in line with the lateral midline of the femur

   Axis - over the lateral epicondyle of the femur

   Movement arm - in line with the lateral midline of the fibula

2) Knee extension is usually recorded as the starting position for flexion. Limited extension is present when the starting position does not begin at 0 degrees, but in some amount of flexion. Have client in the supine position with both legs fully extended. Extend the knee of the leg being tested and make sure that the hips are in neutral **(Figure 11A).**

## STRETCHES FOR IMPROVING RANGE OF MOTION

The following stretches may be recommended for anyone wanting to improve shoulder flexion:

### Seated Shoulder Flexion


- Instruct client to sit upright in a chair, about arms distance from the table
- Have them slowly begin to slide their hand/arm forward on table either with palm down or on the side of the hand (pinky down)
- Advise them to go to the point of mild discomfort and then back off just enough to eliminate any pain
- Have them hold the stretch for 30 seconds and try and reach further with exhalation

### Supine Shoulder Flexion

- Instruct client to lie on their back with their knees bent, holding a dowel between their thumbs and forefingers
- Have them slowly raise their arms up overhead, keeping a slight bend in their elbows (make sure that they stay in plane of motion and don't allow their arms to go into abduction)
- Advise them to go to the point of mild discomfort and then back off just enough to eliminate any pain
- Have them hold the stretch for 3-5 seconds, return to start and repeat several times. They can also hold the stretch for 30 seconds as an option

## Supine Shoulder Flexion with Alternating Knees

- Instruct client to lie on their back, bend their knees to 90 degrees, and place their arms by their sides with palms facing their body
- Have them raise one arm up into flexion, and raise the opposite leg off of the floor about 6 inches
- Make sure that they keep the movement fluid and alternate sides

## Standing Arm Extension with Dowel

- Instruct client to stand erect with their knees soft and a neutral pelvis
- Have them hold a dowel between their thumbs and forefingers with their palms facing their body
- Advise them to raise their arms into extension without arching their back or elevating their trapezius
- Instruct them to pause when they can't go any higher without compromising their form
- Have them slowly lower their arms back to start and repeat

## Standing Abduction

- Instruct client to stand erect with their knees soft and a neutral pelvis
- Have them hold a dowel with their hands spread about 30" apart - (R) hand palm faces body and (L) hand palm faces away from body
- Advise them to push gently with their (R) arm upward in abduction; not allowing their (L) shoulder to protract
- Instruct them to pause when they can't go any higher without compromising their form and/or feeling any discomfort
- Have them slowly lower their arms back to start and repeat on other side

## Seated Shoulder Abduction


- Instruct client to sit upright in a chair, about arms' distance from the table
- Have them slowly begin to slide hand/arm to the side on table with palm forward on the side of the hand (pinky down)
- Advise them to go to the point of mild discomfort and then back off just enough to eliminate any pain
- Instruct them to hold the stretch for 30 seconds and try and reach further with exhalation

## Standing Internal/External Rotation with Dowel

- Instruct client to stand erect with their knees soft and a neutral pelvis
- Have them hold a dowel between their thumbs and forefingers (one shoulder should be internally, and one externally rotated)
- They should allow externally rotated shoulder to slightly lift up on dowel, creating a greater stretch to the internally rotated shoulder
- Advise them to pause when they get to the point of mild discomfort
- Instruct them to slowly lower their arms back to start and allow internally rotated arm to slightly pull down on dowel, creating a greater stretch to the externally rotated shoulder

## Standing Internal/External Rotation with Dowel

- Instruct client to stand erect with their knees soft and a neutral pelvis
- Have them hold a dowel overhead with their arms bent at 90 degrees
- Instruct them to rotate their shoulders backward into external rotation (keeping their pelvis in neutral)
- Advise them to pause when they can't rotate any further without compromising their form
- Have them slowly lower their arms down into internal rotation (do not allow excessive protraction of shoulder)

## Supine Internal/External Rotation

- Instruct client to lie on their back with their knees bent and arms out to their side at 90 degrees with their palms toward their knees
- Have them rotate their shoulders backward into external rotation (keep pelvis in neutral)
- Advise them to pause when they can't rotate any further without compromising their form
- Have them slowly lower their arms down into internal rotation (do not allow posterior shoulder to come off of floor, or excessive protraction of shoulder)

## CHAPTER FIVE

## *CORE AND BALANCE EXERCISES*

**Objective:** to understand the role of the Neuromuscular system in balance and stability.

- Understand nervous system side effects caused by cancer or cancer treatment
- Understand the possible causes of nervous system problems
- Be able to implement a progressive and safe core and balance exercise program for clients dealing with neuromuscular issues

**Goal:** to assist our clients in overcoming balance challenges that could lead to falls, fractures, and changes that may affect ambulation and quality of life.

### CORE STABILITY AND BALANCE ON THE BOSU® BALANCE TRAINER

In order to maintain postural stability, one must be able to maintain their center of gravity within specific stability and balance limits. This skill cannot be developed without training the neuromuscular system. This requires practice, training, and experience; all of which have been compromised following cancer surgery and treatment. No matter how fit or athletic your client was prior to their diagnosis, they are starting from ground zero in the aftermath of treatment.

The nervous system is the control center for communication and directs movement throughout the body. Cancer treatment can have temporary or permanent side-effects on the nervous system. Nervous system side effects are common from cancer and cancer treatments. The nervous system is made up of the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is made up of the brain and spinal cord. The PNS is made up of the nerves outside of the CNS that carry information back and forth between the body and the brain. The PNS is involved in movement, sensing (touching, hearing, seeing, tasting, and smelling), and the functioning of the internal organs, (for example, the stomach, lungs, and heart).

***Some of the nervous system side effects that may be caused by cancer or cancer treatment include the following:***

- Hearing loss and/or tinnitus (ringing in the ears)
- Vision loss and/or vision side effects (such as blurred or double vision)
- Speech difficulties, such as slurred speech, difficulty expressing oneself or understanding speech
- Cognitive (thought process) changes including decreased memory, problem solving, and calculation
- Changes in taste and smell
- Difficulty swallowing
- Problems with balance, dizziness, vertigo (feeling like the room is spinning), and nausea
- Ataxia (problems with coordination) and movement, including problems with posture, walking, or holding objects
- Asthenia, a general weakness that causes an overall lack of strength, hemiparesis (weakness on one side of the body), drowsiness
- Paralysis of different parts of the body, ranging from hemiplegia (paralysis of one side of the body) to paralysis of a smaller area, such as the muscles in the face
- Seizures
- Changes in the functioning of organs, which can cause constipation, incontinence (inability to control the flow of urine), and impotence (an inability to get or maintain an erection)
- Pain which can be caused by a tumor pressing on the nerves or damage to the nerves from treatment
- Peripheral neuropathy which is a condition caused by damage or irritation to the peripheral nerves. The symptoms may include numbness, tingling ("pins and needles"), or burning pain in the arms, hands, legs, or feet, decreased ability to sense hot and cold, difficulty lifting the feet or toes, difficulty picking up small objects, decreased muscle strength, vision or hearing changes, and/or constipation

Nervous system side effects are caused by many factors, including cancer, cancer treatments, other medications, or other disorders. The symptoms may appear soon after treatment or may appear several years after treatment.

***Possible causes of nervous system problems:***

- Cancer that has metastasized (spread) to the brain or spinal cord
- Tumors growing in other parts of the body that press on nerves
- Some types of chemotherapy may cause peripheral neuropathy
- Radiation therapy
- Surgery, if nerves are damaged during surgery to remove a tumor or to perform a biopsy
- Specific medications, including some anti-nausea drugs, opioid pain killers, and anticonvulsants
- Infections causing swelling or inflammation of the brain, spinal cord, or inner ear
- Other conditions or symptoms related to cancer or cancer treatments, including anemia (low number of red blood cells), dehydration, fatigue, stress, and depression
- Other conditions or disorders not related to cancer, such as diabetes, vitamin deficiency, thyroid dysfunction, human immunodeficiency virus (HIV), stroke, Alzheimer’s disease, multiple sclerosis, and nerve injury

If a muscle is not activated by the nervous system, it will not contribute to movement. I have seen this in clients whose breast cancer metastasized to their brain. They began to lose reflexes and strength in particular muscles/movements. This is sometimes the first indication that there is, in fact, a brain metastasis. If you notice that your client has lost motor control, calmly suggest that they see their attending physician without alarming them. ***Do not make a diagnosis, or even an educated guess!***

Because muscles need to learn how to contribute to movement patterns through ongoing training and repetition, the BOSU® Balance Trainer is the perfect medium in which to do so. You can help your client to gradually and progressively learn how to control their muscular force output for any given movement. This begins with kinesthetic awareness that may need to be re-learned after treatment.

Be patient and don't get frustrated if they do not progress at a speed that you would have anticipated. Sometimes the best that we as fitness professionals can do is to minimize the loss of function. I have worked with clients in which there is no marked progress over time. I consider the fact that there is no ***decline*** in performance a success story for those people. Set realistic expectations when you are working with your clients. Be encouraging and optimistic, but also be a realist!

## SHOULDER SHRUGS

**Level 1 –** Instruct your client to stand with feet hip width apart on the floor with their arms hanging by their sides, palms facing their body. Have them exhale and raise their shoulders up towards their ears. Pause for 2-3 seconds and relax back into starting position. Now instruct them to reach down as far as they can (as if trying to slide their hands down the side of their legs toward their knees) pause for 2-3 seconds and relax back into starting position. Perform several repetitions and increase as their comfort level and strength dictates.

*For the client who is ready for a greater balance challenge, have them try to minimize contact with the floor by lifting the heel of the right foot off of the floor. They may alternate lifting their right and then left heel off of the ground. Progress/regress as needed for the individual's fitness level.*

When the client is confident and stable at **Level 1 Shoulder shrugs,** they may progress to **Level 2 Shoulder shrugs on the BOSU® Balance Trainer.**

**Level 2 –** Instruct your client to stand with their feet hip width apart on the BOSU® Balance Trainer with their arms hanging by their sides, palms facing their body. Have them exhale and raise their shoulders up towards their ears. Pause for 2-3 seconds and relax back into starting position. Now instruct them to reach down as far as they can (as if trying to slide their hands down the side of their legs toward their knees) pause for 2-3 seconds and relax back into starting position. Perform several repetitions and increase as their comfort level and strength dictates.

*For the client who is ready for a greater balance challenge, have them try to minimize contact with the dome by lifting the heel of the right foot off of the dome. They may alternate lifting their right and then left heel off of the dome. Progress/regress as needed for the individual's fitness level.*

If the client is struggling, or in pain, please go back to the **Level 1 Shoulder shrugs.** After performing the **Level 1 Shoulder shrugs** on several occasions, pain free, try **Level 2 Shoulder shrugs on the BOSU® Balance Trainer again.**

### PRECAUTIONS:

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core "education" and exercises.**

**If your client has peripheral neuropathy in their feet, only have them perform the Level 1 exercise.**

## SQUATS

**Level 1 –** Instruct your client to stand with feet hip width apart on the floor. Place the back of a chair in front of them and instruct them to hold on to it for balance. Instruct them to bend their knees as much as they can while maintaining stability as well as avoiding any knee pain. Remind them to engage their abdominal muscles, contract their gluteal muscles and push their heels into the floor as they straighten their body back to start. Remind them to always maintain a slight bend in the knees. Perform several repetitions and increase as their comfort level and strength dictates.

*For the client who is ready for a greater balance challenge, have them try to minimize contact with the floor by lifting the heel of the right foot off of the floor. They may alternate lifting their right and then left heel off of the ground. Progress/regress as needed.*

When you are confident and stable at **Level 1 Squats**, you may progress to **Level 2 Squats on the BOSU® Balance Trainer.**

**Level 2 –** Instruct your client to stand with feet hip width apart and with the left foot on the dome of the BOSU® Balance Trainer. Place the back of a chair in front of them (or have them hold your hands or use a body bar) and instruct them to hold on to it for balance. Instruct them to bend their knees as much as they can while maintaining stability as well as avoiding any knee pain. Remind them to engage their abdominal muscles, contract their gluteal muscles and push their heel into the BOSU® Balance Trainer/floor as they straighten their body back to start. They should always maintain a slight bend in the knees. Perform several repetitions, alternating left/right foot on dome, and increase as their comfort level and strength dictates.

*For the client who is ready for a greater balance challenge, have them try to minimize contact with the BOSU® Balance Trainer by lifting the heel of the foot off of the dome and performing a squat. They may alternate lifting their toes and their heel. Progress/regress as needed for the individual's fitness level.*

When the client is confident and stable at **Level 2 Squats on the BOSU® Balance Trainer,** they may progress to **Level 3 Squats on the BOSU® Balance Trainer.**

**Level 3 –** Instruct your client to stand with feet hip width apart on the BOSU® Balance Trainer. Have them raise their arms out to their sides for balance and lift the toes of their right foot off of the dome while slightly bending the left knee. Instruct them to bend their left knee as much as they can while maintaining stability as well as avoiding any knee pain. Remind them to engage their abdominal muscles, contract their gluteal muscles and push their heel into the BOSU® Balance Trainer as they straighten their body back to start. They should always maintain a slight bend in the knees. Perform several repetitions and increase as their comfort level and strength dictates.

*For the client who is ready for a greater balance challenge, have them hold a soft weighted ball out in front of them while performing the squat. If they are able to do that and maintain good form, have them move the ball to one side and then the other while tracking it with their eyes. Progress/regress as needed for the individual's fitness level.*

If the client is struggling, or in pain, please go back to the **Level 2 Squats on the BOSU® Balance Trainer.** After performing the **Level 2 Squats on the BOSU®** Balance Trainer on several occasions, pain free, try **Level 3 Squat s on the BOSU® Balance Trainer again.**

### PRECAUTIONS:

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core "education" and exercises.**

**If your client has peripheral neuropathy in their feet, only have them perform the Level 1 exercise.**

## ABDUCTION

**Level 1 –** Instruct your client to stand with feet hip width apart on the floor. Both feet should be pointing forward. Place the back of a chair in front of them and instruct them to hold on to it for balance. Have them bend their knees as much as they can while maintaining stability as well as avoiding any knee pain. Instruct them to exhale, straighten their left leg (don't lock out the knee), and raise their right leg out to the side (make sure their hip does not rotate and their toes remain pointing forward). Pause, inhale, and return to start. Encourage them not to touch the floor with their right foot unless they absolutely have to for balance. Perform several repetitions on each side and increase as their comfort level and strength dictates.

When the client is confident and stable at **Level 1 Abduction,** they may progress to **Level 2 Abduction.**

**Level 2 –** Instruct your client to stand with feet hip width apart on the floor. Both feet should be pointing forward. Have them bend their knees as much as they can while maintaining stability as well as avoiding any knee pain. Their arms will hang slightly bent by their sides with palms facing inward. Have them exhale, straighten their left leg (don't lock out the knee), raise their right leg out to the side (make sure their hip does not rotate and their toes remain pointing forward), and simultaneously raise their arms out to the side (like wings). Pause, inhale, and return to start. Encourage them not to touch the floor with their right foot unless they absolutely have to for balance. Perform several repetitions on each side and increase as their comfort level and strength dictates.

If the client is struggling, please go back to **Level 1 Abduction**. After performing Level 1 Abduction on several occasions, try **Level 2 Abduction** again. When the client is confident and stable at **Level 2 Abduction,** they may progress to **Level 3 Abduction on the BOSU® Balance Trainer.**

**Level 3 –** Instruct your client to stand with their right foot on the floor and left foot in the center of the BOSU® Balance Trainer. Both feet should be pointing forward. Their arms will hang slightly bent by their sides with palms facing inward. Have them exhale, straighten their left leg (don't lock out the knee), raise their right leg out to the side (make sure their hip does not rotate and their toes remain pointing forward), and simultaneously raise their arms out to the side (like wings). Pause, inhale, and return to start. Encourage them not to touch the floor with their right foot unless they absolutely have to for balance. Perform several repetitions on each side and increase as their comfort level and strength dictates.

If the client is struggling, please go back to **Level 2 Abduction.** After performing **Level 2 Abduction** on several occasions, try **Level 3 Abduction on the BOSU® Balance Trainer again.**

**PRECAUTIONS:**

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core "education" and exercises. If they have not completely healed from surgery and/or are experiencing any discomfort or pain at the incision site, stop performing this exercise and come back to it at a later date.**

**If your client has undergone a TUG Flap, or has tight abductor muscles/weak adductors, work on muscle balance prior to adding this exercise.**

**If your client has peripheral neuropathy in their feet, only have them perform the Level 1 exercise.**

## BACK EXTENSION

**Level 1 –** Have your client lie prone with their torso centered on the BOSU® Balance Trainer (minimize the amount of contact they have with their chest). Once in position, they should bend their arms and place their hands behind their head. Have them contract both their abdominal and gluteal muscles, exhale and lift their chest off of the BOSU® Balance Trainer (make sure they don't arch their back as this may strain their low back and may cause unnecessary pain). Hold for 3-5 seconds, or as long as they can ***without pain*** (make sure that they are not holding their breath or compensating their form). Perform several repetitions and increase as their comfort level and strength dictates.

**PRECAUTIONS:**

**If your client has osteoporosis in their lumbar spine, be conservative with spinal extension while having them perform this exercise.**

**If your client has expanders or breast implants, make sure they are positioned in such a way that there is minimal pressure put on their chest; finding a comfortable spot on the BOSU® Balance Trainer.**

**If your client has undergone a LAT Flap, they will have noticeable weakness and instability in the affected shoulder. Teach them how to retract their shoulders prior to initiating the movement. This will help them to contract their rhomboids and other scapular stabilizers. Keep in mind that one, or both, of their latissimus muscles are now in their chest wall. Because they are still "attached," they may feel a contraction in their chest when back exercises are performed. This is one of the many reasons why it is important to focus on the smaller scapular stabilizers of the back.**

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core "education" and exercises. If they have not completely healed from surgery and/or are experiencing any discomfort or pain at the incision site, stop performing this exercise and come back to it at a later date.**

**If your client has undergone an axillary node dissection or radiation to their chest wall, they may not be able to extend their arms completely. If this is the case, continue to work on shoulder flexion with specific range of motion exercises.**

## TORSO TWIST

**Level 1 –** Have your client sit on the center of the BOSU® Balance Trainer with their arms in front of them and fingers interlocked. Instruct them to sit up tall and engage their abdominal muscles. While keeping their gaze straight ahead, they should raise their arms just below chest height and rotate slowly from 11 o'clock to 1 o'clock. (Make sure that they are not holding their breath or compensating their form). Perform several repetitions on each side and increase as their comfort level and strength dictates.

When the client is confident and stable at **Level 1 Torso Twist on the BOSU® Balance Trainer,** they may progress to **Level 2 Torso Twist on the BOSU® Balance Trainer.**

**Level 2 –** Have your client sit on the center of the BOSU® Balance Trainer with their arms in front of them and holding a 1-2" exercise ball. Instruct them to sit up tall and engage their abdominal muscles. While keeping their gaze straight ahead, they should raise their arms just below chest height and rotate slowly from 11 o'clock to 1 o'clock. (Make sure that they are not holding their breath or compensating their form). Perform several repetitions on each side and increase as their comfort level and strength dictates.

If the client is struggling, please go back to **Level 1 Torso Twist on the BOSU® Balance Trainer.** After performing **Level 1 Torso Twist on the BOSU® Balance Trainer** on several occasions, try the **Level 2 Torso Twist on the BOSU® Balance Trainer again.**

**PRECAUTIONS:**

**Precautions: If your client has undergone a LAT Flap, they will have noticeable weakness and instability in the affected shoulder. Teach them how to retract their shoulders prior to initiating the movement. This will help them to contract their rhomboids and other scapular stabilizers.**

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core "education" and exercises.**

## “V” SIT

**Level 1 –** Have your client sit on the center of the BOSU® Balance Trainer with their arms by their sides; slightly behind their hips. Instruct them to lean back, expand their chest, extend their legs out (and then back in), with their knees bent. Have them engage their abdominal muscles, exhale, and draw their left knee in toward their chest while the right foot maintains contact with the floor. Pause. Instruct them to inhale and allow their upper body and lower body to move away from each other in opposite directions and then repeat on the other leg. Instruct them to only go as far as they can while maintaining control of their core and remaining free of any back pain or discomfort. Perform several repetitions on each side and increase as their comfort level and strength dictates.

When the client is confident and stable at **Level 1 “V” Sit on the BOSU® Balance Trainer,** they may progress to **Level 2 “V” Sit on the BOSU® Balance Trainer.**

**Level 2 –** Have your client sit on the center of the BOSU® Balance Trainer with their arms extended over their head. Instruct them to lean back, expand their chest, extend their legs out (and then back in) with their knees bent. Have them engage their abdominal muscles, exhale, and draw their knees in toward their chest while bringing their hands (arms) toward their feet. Pause. Inhale and allow their upper body and lower body to move away from each other in opposite directions. Instruct them to only go as far as they can while maintaining control of their core and remaining free of any back pain or discomfort. Perform several repetitions on each side and increase as their comfort level and strength dictates.

If the client is struggling, please go back to **Level 1 “V” Sit on the BOSU® Balance Trainer.** After performing **Level 1 “V” Sit on the BOSU® Balance Trainer** on several occasions, try the **Level 2 “V” Sit on the BOSU® Balance Trainer again.**

**PRECAUTIONS:**

**If your client has undergone a LAT Flap, they will have noticeable weakness and instability in the affected shoulder. Teach them how to retract their shoulders prior to initiating the movement. This will help them to contract their rhomboids and other scapular stabilizers.**

**If your client has undergone a TRAM Flap, this is a fantastic opportunity to educate them on how to engage their spinal stabilizers and core musculature. Watch for excessive arching in the lower back. If they complain of low back pain, more attention should be paid to core “education” and exercises.**

**If your client has had lymph nodes removed or irradiated, it is imperative that they begin with minimal repetitions and weight bearing on the affected shoulder, making sure there is no swelling in the affected arm following each session. If there is no sign of swelling they can gradually add more repetitions.**

## CHAPTER SIX

# *MANUAL STRETCHING TECHNIQUES*

**Objective:** to understand the different types of stretching and to determine the safety and efficacy for your client.

- What are the different methods of stretching?
- What muscles are you stretching vs. strengthening and which of the sample stretches are best suited for your client and their specific needs?
- Be able to teach clients how to stretch safely on their own time.
- To communicate with your client and make sure they experience nothing more than a mild stretching sensation (NO PAIN).

**Goal:** to create an exercise program that includes the proper combination of stretches and strength training exercises in order to achieve set goals.

## STRETCHING TO INCREASE RANGE OF MOTION

Scientific literature strongly supports the use of stretching exercises to increase the available ROM at a particular joint. Each joint and muscle group may respond differently to various stretching protocols. When working with a client/patient recovering from cancer surgery and treatment it is critical to proceed slowly and cautiously to evaluate the tolerance level of the individual client. Regardless of their level of fitness prior to their treatment, they are starting from ground zero now.

### TYPES OF STRETCHING

- **Static stretching –** is the most common stretching and ROM technique utilized by health and fitness professionals as well as athletes. It is used to lengthen muscle and connective tissue as well as ROM at a joint. This is the safest form of stretching, with the least risk for injury, because the client/patient performs the stretches on their own with little to no motion being required. Because static stretching does not require the assistance of another person, it can be easily incorporated into a daily exercise program.

- **Passive stretching –** should only be utilized by the experienced fitness/health professional that is confident in their abilities to perform such stretches safely and effectively. The fitness/health professional must be careful not to overstretch their client; which could potentially lead to injuries. The client remains completely passive while the fitness professional executes the stretch. Use extreme caution when stretching the head and neck area and avoid pressing downward on the cervical spine. Stretches should be held for a minimum of fifteen seconds to get the full benefit of the stretch.

- **PNF stretching (proprioceptive neuromuscular facilitation) –** this method is also referred to as the contract/relax method. It should only be utilized by the experienced fitness/health professional that is confident in their abilities to perform such stretches safely and effectively. The fitness/health professional must be careful not to overstretch their client; which could potentially lead to injuries. PNF stretching should be performed after some sort of warm-up and never when your muscles are cold. Significant gains in flexibility are usually made after exercise once the muscles have been warmed up and have been put through some sort of physical activity.

  The fitness/health professional moves the client/patient into an initial passive stretch. The client/patient then applies force (isometric contraction) against the fitness/health professional for 10-15 seconds and then the client/patient is instructed to relax for 20-30 seconds. As the client/patient relaxes, the fitness/health professional moves immediately into a deeper passive stretch. After another period of relaxations, this process can be repeated again. Make sure that you are reminding the client/patient to "breathe into their stretch."

- **Active Isolated stretching (AIS) –** Aaron Mattes, the creator of AIS stretching, believes that prolonged static stretching actually decreases the blood flow within the tissue creating localized ischemia and lactic acid buildup. This can potentially cause irritation or injury of local muscular, tendinous, lymphatic, as well as neural tissues, similar to the effects and consequences of trauma and overuse syndromes. With AIS, the client stretches themselves as far as they can - comfortably. The fitness/health professional then "assists" them to stretch a slight degree further (the client may also use a stretching strap to perform the AIS on themselves).

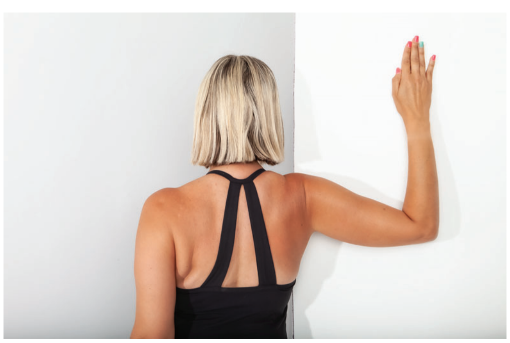
  Identify the muscle to be stretched. Isolate the muscle by positioning into its most relaxed state. Have the client/patient initiate the contraction of that muscle, guiding it through its proper plane, monitoring for relaxation of the opposing antagonist muscle. As the patient contracts the muscle through its proper plane at the endpoint of voluntary contraction, provide a gentle stretch within the same fascial plane to the next endpoint as well as providing a controlled movement back within that same fascial plane. The importance of optimizing full flexibility is that at the end of voluntary muscle movement the gradual extension of the stretch by the fitness/health professional, from that point towards endpoint and return, should be no longer than 3 seconds. Each motion should return back to the isolated muscle's neutral or relaxed state position. The same technique is then repeated anywhere from eight to ten times having each subsequent facilitated stretch achieve an incremental gain in degrees of range of motion. This lengthening with a gentle pressure at end range will microscopically loosen scar tissue and allow restoration of proper muscle length. The result is return back of normal range of motion and alleviation of pain. Once full flexibility is achieved, strengthening can proceed to protect the muscle from re-injury or return of the contracture.

**Performing an Active Isolated Stretch of no longer than three seconds allows the target muscles to optimally lengthen without triggering the protective stretch reflex and subsequent reciprocal antagonistic muscle contraction as the isolated muscle achieves a state of relaxation. These stretches provide maximum benefit and can be accomplished without opposing tension or resulting trauma.**

All of the stretches shown on the next few pages can be done as passive stretching, PNF stretching, or Active Isolated stretching. Stretching not only relieves muscle tension and stretches through scar tissue and adhesions, it can also open up the lymphatic pathways and encourage the flow of lymph. The upper body stretches are extremely beneficial in the recovery from mastectomy and breast reconstruction. As a rule of thumb in your exercise programming, remember to stretch the areas that appear tight and to strengthen the areas that appear weak in order to maintain proper muscle balance.

## CHEST STRETCH ONE:

## CHEST STRETCH TWO:



## CHEST STRETCH THREE:

## CHEST STRETCH FOUR:

## CHEST STRETCH FIVE:

## LAT STRETCH ONE:

## LAT STRETCH TWO:


## LAT STRETCH THREE:

## LOW BACK STRETCH:

## RHOMBOID STRETCH:

## UPPER BACK STRETCH:

## PIRIFORMIS STRETCH:

## QUADRICEP STRETCH ONE:

## HIP FLEXOR STRETCH:

## QUADRICEP STRETCH TWO:

## HAMSTRING STRETCH ONE:

## HAMSTRING STRETCH TWO:

## HIP STRETCH:

## QL STRETCH:

## NECK STRETCH ONE:

## NECK STRETCH TWO:

## NECK STRETCH THREE:

# Cancer Exercise Specialist®

HANDBOOK

## Module Three

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