Lymphedema Management in Women’s Health Physical Therapy

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Dr Debora Chassé received her master’s degree in 1996 and her post-professional doctorate in 2006 from Loma Linda University. A few years later, she also received a board certification clinical specialty in Women’s Health Physical Thera-py. Debora has become a leading authority on lymphedema. In 2000, she finished the Complete Decongestive Therapy training course and a year later became LANA (Lymphology Association in North America) certified. After finding great clinical success by combining connective tissue mobilization techniques with Complete Decongestive Therapy in patients with lymphedema, Debora successfully expanded the application of these techniques to include patients with lymphatic dysfunction and congestion following surgery, trauma, chronic pain, wound healing, CRPS, toxicity, pelvic pain, Dercum’s disease and many more diagnoses related to inflammation. In addition to her achievements in the clinic, Debora also has a passion for education and has conducted lymphedema seminars around the United States, including presentations on the topic of lymphedema at the American Physical Therapy Association Combined Section Meeting. In addition, she will be conducting a seminar on pelvic pain and the lymphatic system. Debora has also been dedicated to shaping the education of physical therapy students, and has been teaching lymphedema system at Loma Linda University since 2000 as well as mentoring aspiring physical therapists. She is enthusiastic about this home study module and expects the reader to find it beneficial in the clinical practice.
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LEARNING OBJECTIVES
1. Understand the design and purpose of basic lymph flow in the circulatory system.
2. Identify, stage, and classify lymphedema.
3. Organize and interpret the involvement or noninvolvement of the lymphatic system in a variety of lymphedema patients.
4. Understand how to use Complete Decongestive Therapy to manage lymphedema patients.
5. Create a manual lymph drainage protocol for a lymphedema patient.
6. Describe how to perform a physical therapy lymphedema initial evaluation according to the description of specialty practice.
7. Define the indications and contraindications for manual lymph drainage.

ANATOMY AND FUNCTIONS OF THE LYMPHATIC SYSTEM
The two main functions of the lymphatic system are lymphatic circulation and immune support. The lymph circulatory system is a one-way drainage route designed to help the tissues eliminate unwanted material and excess fluid. This is accomplished by capturing the wastes and proteins that are too large to re-enter circulation and processing them via the lymph system.

The direction of flow in lymphatic circulation is from lymphatic capillaries and precollectors to lymph nodes to lymph trunks to lymph ducts, and venous angles where it returns to blood circulation. Each quadrant of the body pumps its fluid to its primary lymph node region. Lymphatic collectors in each quadrant of the body create an anastomosis to allow for a support system of lymph flow. The valves in each collateral quadrant direct its flow to nearby regional lymph nodes. Think of the lymphatic system as “a garbage route and overflow pipe.”

Major lymph node collection sites include the:
- Colon
- Axilla
- Neck
- Inguinal region
- Bronchial region

Immune support lymph organs consist of lymph vessels and nodes, thymus gland, bone marrow, Peyer’s patch, spleen, and tonsils. These organs support the immune system by producing B and T lymphocytes, macrophages, and dendrite cells. When an antigen attacks the body, the antigen migrates from the tissue where the attack is initiated to the lymph nodes via the lymph vessels. Encapsulated in the lymph node, the macrophages and dendrite cells phagocytize the antigen, process it, and present the antigen to the lymphocytes located in the lymph node. The lymphocytes produce antibodies or make memory cells for later recognition. Thymosin is a hormone secreted by the thymus, and the excess will produce abnormal T cells commonly seen in autoimmune disorders. Conversely, lack of thymosin will not sufficiently support the immune system. Bone marrow constitutes a tissue producing lymphocytes. The B lymphocytes mature in the bone marrow whereas T lymphocytes mature in the thymus gland. The lymph node contains both lymphocytes and macrophages. The mucosa of the epithelium contains 30 lymphoid follicles also known as Peyer’s patch, which is the lymph system of the intestinal tract and supports its immune function. The spleen filters and purifies blood and lymph fluid as well as removes dead red blood cells. New red blood cells are manufactured in the bone marrow. The spleen protects us from infections. The tonsils tests bacteria and viruses that enter our mouth and nose to avoid potential infection. Each lymph organ has a significant role and contributes to the lymphatic system.

Lymph organs consist of:
- Lymph vessels
- Lymph nodes
- Thymus gland
- Bone marrow
- Peyer’s patch
- Spleen
- Tonsils

There are 600 to 700 lymph nodes in the body that range in size between 2 mm to 2 cm. The lymph node is responsible for immune cells, phagocytosis, and antibody production. The lymph node stores B and T cells as well as foreign cells to keep them isolated from the rest of the body. In the lymph node, the lymphocyte collects and destroys bacteria as well as filters noxious material, thus protecting us from viruses and bacteria. The lymph node reabsors approximately 40% of the lymph fluid entering into it. This causes the lymph fluid to thicken making it more difficult for lymph to transport to the circulatory system due to its resistance. Its fibrous capsule protects the body from the noxious material inside the lymph node. Inflammation will cause lymphocytes to multiply in the lymph node causing swelling. The lymph node has a fibrous capsule containing trabeculae and is made up of 3 components: lymphatic sinuses, blood vessels, and the parenchyma consisting of the cortex, paracortex, and medulla. The lymphatic system transports lymph fluid via the jugular and subclavian veins to return fluid to the blood circulatory system equalizing the concentration of protein in the interstitial space.

Lymph node functions include:
- Phagocytosis
- Antigen presentation
- Immune cell recognition

Lymph system functions include:
- Noxious material filtration
- Lymphocyte production
- Protein concentration
The lymph fluid contains a high number of lymphocytes, fat cells, water, proteins, and waste products. Twenty-four liters of fluid move out of the plasma and into the interstitial fluid every 24 hours. Two to four liters (10%-15% of the 24 liters) of lymph fluid are processed in the tissues of the body each day; consider the fact that the heart pumps 7,580 L of blood per day. Of the 2 to 4 liters, 85% to 90% is absorbed back into the venule. Every day 50% to 100% of the proteins in the blood are taken up by the lymph system.

Lymph fluid substances include:
- Water
- Protein load
- Cells
- Fat
- Lymphocytes
- Waste products

Lymph fluid begins at the entry into the lymph capillary. It is taken up from the interstitial spaces throughout the body into the lymphatic vessels, and then transported to the venous system. The lymphatic system is comprised of lymphatic capillaries, lymphatic pre-collectors, lymphatic collectors, and lymphatic trunks. Lymphatic vessels are located superficially in the skin, subcutaneous tissues, and in the deep tissues of the fascia.

Lymph vessels normally parallel the venous system. The difference is lymph vessels have thinner walls, more valves, and contain lymph nodes at designated points. The lymph collector is comprised of 3 layers: intima, media, and adventitia. The intima is made of one layer of endothelial cells. The media is made up of smooth muscles. The adventitia is composed of collagen. Each lymph vessel contains lymph angions spaced 6 mm to 20 mm apart. There are smooth muscle stretch reflexes within each lymph angion sensing when it fills with lymph fluid. When full, it contracts and forces lymph fluid to the next lymph angion. Other physiological pressures influencing lymph flow are arterial pulsations, and postural and respiratory pressure changes. Mechanically, manual lymph drainage (MLD) is a passive compression of body segments influencing lymph flow. The lymph angion contracts 6 to 10 times per minute at rest and increases 10-fold with aerobic activity. An increase in circulation will increase the contraction rate to pump more fluid more quickly in less time; this is referred to as the lymphatic load. Lymph flow is directed to a lymph node group.

Lymph capillaries begin with overlapping flat endothelial cells with an attachment to anchoring filaments located in the interstitial space (Figure 1). The anchoring filament is stimulated with an increase in fluid pressure in the interstitial space causing the flap to open and allowing large proteins, fluids, and solutes into the lymph capillary (Figure 2). They are then transported to lymph vessels via a one-way valve from distal to proximal in the direction of lower pressure from lymph capillaries to the larger pre-collector.

There are two types of lymph vessels: initial lymphatics and collecting lymphatics. The initial lymphatics are small lymph capillaries and larger pre-collector lymph vessels. The collecting lymphatic vessel collects from the pre-collectors and transports it to the lymph nodes groups. The lymph vessel’s one-way valve prevents back flow of lymph fluid. A lymph angion is the space located between each valve and is stimulated by a sequential contraction of the smooth muscle. Innervated by the sympathetic nervous system, lymph fluid is pumped from nodes to lymph trunks, lymph ducts, and the venous angle where lymph returns to the venous system (Figure 3).
The lymphatic trunks transport lymph fluid to ducts. The “right and left lumbar lymphatic trunks drain the lower extremities, pelvis, and genitalia. The gastrointestinal trunk drains the digestive system and adjoins to the thoracic duct via the cisterna chyle. The jugular trunk drains the head and neck. The subclavian trunk drains the upper extremities, chest wall, upper back, shoulder and breasts. The supraclavicular trunk, located in the terminus, drains the shoulders and breasts. The bronchomediastinal trunks enter the thoracic duct and right lymphatic duct. The parasternal trunk drains the internal mammary lymph nodes and portions of the pleura, diaphragm, liver, pericardium, chest wall, abdominal wall and empties into the ipsilateral venous angle. The lower extremities and left upper quadrant empty into the thoracic duct, and the right upper quadrant empties into the right lymphatic duct. All lymph fluid returns to circulation via the jugular and subclavian vein into the venous angle.

Lymph circulatory structures include:
- Vessels
- Nodes
- Trunks
- Ducts
- Venous angle

Sympathetic, parasympathetic, and sensory nerve endings are found in lymph vessels and lymph nodes. The sympathetic nervous system regulates contraction in the lymph angion. Pain and stress can decrease the activity of the lymph flow in the lymph angion. Deep abdominal breathing exercises are performed prior to MLD, thus stimulating the parasympathetic nervous system and regulating pressure changes in the respiratory system. A skilled visceral mobilization technique can stimulate lymph flow in the thoracic and right lymphatic duct. The lymphatic system is controlled by pressure, whereas the circulatory system is controlled by a central pump.

Characteristics and functions of lymph angions include:
- They are spaced 6 mm to 10 mm apart
- Dynamic movement of fluid
- They contract 6 to 10 times per minute
- They are regulated by the sympathetic nervous system

Dynamic movement of the lymph angion is caused by:
- Smooth muscles
- Stretch reflexes
- The autonomic nervous system
- Aerobic activity

The thoracic duct collects fluid from the left side of the body and the right lower quadrant. The thoracic duct begins at L2, the level of the cisterna chyle, and empties into the left venous angle located in the left subclavian vein and left jugular vein (Figure 4).

The right lymphatic duct collects fluid from the right upper quadrant of the body and drains into the right subclavian vein and right internal jugular vein. It is only 1.25 cm in length and travels along the medial border of the scalenus anterior at the base of the neck (Figure 4).

**Physiology of the Lymphatic System**
Ernest Starling presented “Frank-Starling law of the heart” in 1915. Starling’s equation describes the role of hydrostatic and oncotic forces in the movement of fluid across a capillary membrane. Capillary fluid movement occurs because of diffusion and filtration. Based on Starling’s theory, filtration and absorption are usually in a state of equilibrium.

Fluid balances:
- Arteriole pressure
- Hydrostatic pressure
- Osmotic pressure
- Filtration

Diffusion is an intermingling of molecules as a result of kinetic energy. If you place iodine in a glass of water, the molecules will separate and mingle with the water. Once the color changes evenly, there is no longer diffusion. If you place a semi-permeable membrane, which is only permeable to water, into a glass of water and add more salt to side A compared to side B, the water from side B will diffuse into side A to dilute the salt water until both sides are even. Diffusion is the spreading of molecules from an area of high concentration to an area of low concentration. Osmosis occurs when solutes diffuse across a semi-permeable membrane. The energy to facilitate this process is osmotic pressure. If more solutes diffuse across the membrane, the osmotic pressure decreases in the area it is leaving.

Temperature changes will increase the kinetic energy to speed up the diffusion. Increased body heat from infection, inflammation, heat modalities, massage, or heavy exercise will increase the rate of diffusion. An increase in body heat causes more water and solutes to diffuse passively depending on the concentration gradient of the solutes into the interstitium. If the temperature is
too high in the interstitium, the lymph system will become overloaded and will slow down lymph transport.

Transport capacity is the amount of lymph volume that can be transported by the lymph system in a given period of time.2 A factor in reducing skin infections is to prevent an increase in heat and inflammation to the tissue. Patients should avoid skin abrasions to decrease excess limb inflammation. They should also avoid hot tubs or excess sun burning to avoid an inflammatory response. In a person whose lymph system is compromised, too much lymphatic fluid too fast will overload and slow down lymph transport.

Hydrostatic pressure, the pressure exerted by tissue fluid against the capillary, is the main force pushing fluid out of the blood capillary from an area of high pressure to an area of low pressure.17 Due to the increase in hydrostatic pressure and, additionally, the lower colloid osmotic pressure in the arteriole, fluid is pushed out into the interstitium. The movement of fluid from the arteriole to the interstitium is called filtration. The osmotic pressure is the influence of moving water into a solution and is called absorption because the osmotic pressure causes interstitial fluid to be absorbed into the plasma.18 The protein concentrations in the blood and tissue have different osmotic pressures; the osmotic pressure of the blood is approximately 22 mm Hg higher than that of the fluid in the interstitium, making it hypertonic to the interstitium. This phenomena causes water to move into the capillaries from the interstitium by osmosis.17 The arteriole portion of the capillary on average is 32 mm Hg higher than the pressure of the tissue fluid outside the capillaries. The concentration of proteins in the capillary decreases, creating a 15 mm Hg blood pressure decrease in the venule.17 During filtration, the capillary permits large molecular weight substances inadequately absorbed by the blood capillary to be removed from the interstitial space via the lymph capillary. As proteins pass into the interstitium, the protein concentration in the blood capillary decreases causing 90% of the fluid from the interstitium to be reabsorbed into the venule. The remaining 10% of the fluid and proteins in the interstitium are filtrated into the lymph capillary (Figure 5). Summarizing, filtration and absorption at the capillary bed are controlled by blood pressure and protein concentration changes. If this process of filtration and absorption was absent, we would die in 24 hours.17 If the blood pressure rises another 20 mm Hg compared to normal blood pressure, there would be an increase in filtration requiring the lymph system to transport 68 times more fluid. This amount is too much work on the lymph system and will cause an overload, thus slowing down the lymph transport resulting in edema. According to Starling’s law, our body is always trying to achieve equilibrium through fluid exchanges across capillary membranes. In a patient whose lymph nodes have been removed or encased in scar tissue, he will potentially have a block in lymphatic return resulting in fluid and pressure imbalances.

The villi of the small intestines, known as lacteals, serve an important function in the absorption of fats and other nutrients. Lymph is found in the lacteals following digestion and contains 1% to 2% fats and is called chyle. Proteins filtrating from the blood capillary to the interstitium are used as nourishment at the cellular level for nearby tissues or organs. The lymphatic load needs to be removed from the tissues by the lymphatic system and returned to the venous system.

If there is an increase in the protein concentration in the interstitium, there will be an increase in the colloid osmotic pressure causing an increase in lymphatic load. This results in a decrease in re-absorption in the venule. An increase in protein-rich fluid in the interstitium causes an increase in macrophage activity, thus increasing fibroblasts and fibrosclerosis. Fibrosclerosis causes tissue damage creating trophic changes, seen by loss of tissue elasticity and skin’s indurated tissue. Non-edematous skin elasticity is maintained by tissue hydrostatic pressure and keeps a force on the blood vessel capillary. Loss of elasticity causes a decrease in the tissues’ ability to maintain normal hydrostatic pressure. This loss results in an increased limb size due to an increased fibrosclerosis and decreased lymph transport capacity. Therefore, low-grade inflammation in the tissues, loss of elasticity,
and tissue resistance will decrease lymph transport, resulting in fibrosis. Fibrosis is a buildup of connective tissue. Consider the effects of diuretic medication causing protein molecules to stay in the interstitial space. The proteins continue to draw water to high protein areas resulting in greater edema. Due to the increase in protein concentration in the tissue, it will become more fibrotic and indurated.13

Low output failure is when the lymphatic system has difficulty transporting a minimal amount of high protein fluid from the interstitium.9 It is usually due to damage in the lymph vessels or lymph nodes.19 The lymphatics are mechanically insufficient causing the transport capacity to drop below the normal lymph load. The lymph collectors in the interstitium are unable to remove the lymph fluid. Lymph becomes stagnant in the interstitium causing increased colloid osmotic pressure, high protein in the interstitium, and decreased absorption. There is less colloid osmotic pressure when lymph is being transported. A small quantity filtrates to the lymph capillary because the lymph transport has fallen below the normal capacity for removing lymph from the interstitium.9,18 Swelling is produced in the extracellular space and is classic in lymphedema. A patient who had lymph nodes removed or radiated following a right lumpectomy will have a compromised lymph system affecting the right limb. Lymph fluid will flow from the interstitium to the lymph nodes (or may bypass the lymph nodes if not functioning efficiently) and transport to other functioning lymph node groups. For example, if a person receives a minor injury from a paper cut, bacteria has entered the tissues requiring an increased workload from the lymphatic system to remove the bacteria. Since the lymph load is already operating at its highest level, it is unable to increase its lymph transport. Infection will develop creating a high protein environment due to inflammation. Macrophage activity, fibroblasts, and fibrosclerosis18 will develop. The patient will develop cellulitis and subsequently lymphedema.

High output failure is when the lymphatic load is too great to transport the fluid from the interstitium. Unlike low output failure, the protein load is low with a high volume insufficiency. The lymph collectors will work overtime with a “functional reserve” to mobilize the lymph fluid to their respective functional lymph node groups.18 If the functional reserve is used up, it is possible that this can cause damage to the lymph collector walls and valves leading to a reduced transport capacity and low output failure. The transport capacity can become overwhelmed with too much work.18 An ankle sprain is a good example of a high volume insufficiency, low protein load, and high output failure. Upon initial injury, and to promote healing and prevent complications, apply ice and compression, perform exercises, and elevate the limb.

It is possible to have a combination of high output failure and low output failure known as combined insufficiency. Combined insufficiency can be related to other pathologies causing a backup of lymph fluid. For example, a patient with a right hip replacement received proton treatment for prostate cancer. He was unable to receive the radiation to his right hip, therefore increasing his dosage of radiation to his left hip. Two years later his left knee replacement surgery was unsuccessful due to excess swelling and fibrosis; surgery was repeated a second time with lack of success. Collecting the patient’s history during the physical therapy initial evaluation revealed and explained his current status. Left lymph nodes were damaged from proton therapy. His left inguinal lymph nodes were unable to process the tissue’s waste products and debris during the healing process from the total knee replacement. Initially, there was high output failure from the total knee replacement followed by a low output failure due to damaged left inguinal lymph nodes. The high protein fluid resides in the interstitium around the left knee drawing in more fluid causing tissue damage. It was a combination of high output failure to a low output failure.2,20

HISTORY OF LYMPHEDEMA TREATMENT

A lymphedema treatment program consists of skin care, compression, massage, and exercise.21 It was documented in 1890 by a German surgeon, Alexander Von Wininwater. Emil Vodder, PhD, was published in France in the 1930s and in this work, coined the term MLD.18 In 1970, Hungarian physicians, Michael and Ethel Foldi developed complete congestive therapy (CDT) by combining Vodder’s MLD with skin care, compression, and exercise.15,21 In the 1990s, Dr Robert Lerner established the first CDT treatment center in the United States.10,22

Pioneers of lymphedema treatment:

- 1890s, Alexander von Wininwater
- 1930s, Emil and Estrid Vodder
- 1970s, Michael and Ethel Foldi
- 1990s, Dr Robert Lerner

All edemas are due to an imbalance between capillary filtration, lymph drainage, and dysfunctional lymph transport. Lymphedema consists of protein-rich fluid and low-grade inflammation with reactive fibrosis that occurs in dependent tissues due to an increase in blood circulation in which the lymphatic system is unable to transport the fluid to a designated region,2,12,13 and is also known as low output failure. This is an extracellular edema as opposed to intracellular edema.21 The inflammation puts pressure on touch receptors and superficial tissues. Lack of normal skin movement in the subcutaneous tissue inhibits lymph collectors from functioning properly.2,3 Thus, the lymphatic system is mechanically unable to transport the lymph fluid to designated regional lymph nodes.

LYMPHEDEMA DIAGNOSIS

A medical diagnosis for lymphedema is most often made with a thorough physical exam and clinical findings from a physician. The exam will rule out deep vein thrombosis and metastasis. Other assessment tools occasionally used are magnetic resonance imaging to ob-
serve lymphedema tissue characteristics; computerized tomography to reveal blockage in the lymphatic system; Doppler ultrasound to assess venous and lymphatic flow, pressures, and obstructions; and lymphoscintigraphy where a radioactive dye is injected into the lymph vessels to highlight lymph flow, reversal of flow, and areas of obstruction. Lymphoscintigraphy is most often used for research showing the disruption of lymphatics and improvement following CDT.

Primary lymphedema is congenital and often involves lymph vessel damage. Clinically, primary lymphedema is termed when a cause has not been identified. Congenitally, the lymph conducting pathways are faulty with an inadequate number of lymph collectors. Four etiologies related to lymph pathways are probable in primary lymphedema: (1) hypoplasia, a reduced amount of lymphatic collectors and a decreased diameter of lymph vessels; (2) hyperplasia, an increased diameter of lymphatic collectors; (3) aplasia, absence of lymphatic system components; and (4) Kinmonth syndrome, inguinal lymph node fibrosis. When collecting the patient's history, it is important to ask the patient the age relationship to the development of lymphedema, secondary insults at the time of the occurrence, and if it is bilateral. Females are affected twice as often as males, the lower extremities are 3 times more likely to be affected than the upper extremities, and bilateral lymphedema is 60% more common.

If observed at birth, primary lymphedema is called Milroy disease, which is rare and the result of an inherited gene mutation. Another common form of primary lymphedema is lymphedema praecox developed before the age 35. Lymphedema tarda develops after age 35.

Secondary lymphedema is the result of a known insult in the lymphatic system. Lymph capillaries, lymph vessels, or lymph nodes may have been removed, blocked, fibrosed, or damaged and are unable to manage the lymph load accumulated in that region of the body. Donald Inger, PhD, a research cellular biologist, discovered that by changing the surface area of a cell, the function of the cell is changed. Consider patients who have had hernia surgeries, where a mesh is placed in the inguinal region, or a lymph node biopsy following cancer treatment, or radiation therapy to lymph node groups that damage lymph function. In each of these cases, the surrounding tissue in the lymph node matrix is damaged. In secondary lymphedema, the amount of fluid that needs to be transported drops below what the body is physiologically capable of producing. Mechanically, it cannot readily remove the lymph fluid. This creates a backup of fluid followed by tissue damage causing secondary lymphedema.

In the United States, cancer treatment is the most common cause of secondary lymphedema. Other causes are trauma, tumor growth, recurrent cancer, radiation therapy, skin infection, iatrogenic alterations, chronic venous insufficiency, surgery, liposuction, burns, obesity, immobility, self-induced lymphedema, and filariasis.

It is not uncommon for patients to develop secondary lymphedema following a hernia surgery. Patients who have lymphedema due to obesity are normally sedentary with increased pressure on inguinal lymph nodes from continuous sitting. Liposuction is a common cosmetic surgical procedure performed in Brazil and is always followed by MLD to prevent lymphedema, as well as to smooth out the skin’s appearance. Filariasis is the most common form of secondary lymphedema with over 120 million people affected globally according to the 2009 World Health Organization; however, secondary lymphedema is not often seen in the United States.

Filariasis is endemic in tropical and subtropical parts of the world where a nematode worm larva is transmitted to people by a mosquito bite. The adult filarial live, reproduce, and die in the lymph vessel. The death of the parasite causes a localized inflammation followed by chronic inflammation causing damage and blockage to the local lymphatic vessels.

Differential Diagnosis

Chronic venous insufficiency could develop into secondary lymphedema; the skin is discolored and ankles can become thin due to atrophy of the subdermal tissues causing fibrosis and sclerosis. Risk factors for chronic venous insufficiency are age, family, smoking, history of deep vein thrombosis, a sedentary lifestyle, obesity, congestive heart failure, diabetes mellitus, or a prolonged standing occupation. The valves in the veins are faulty in chronic venous insufficiency, and the veins are unable to pump enough blood back to the heart. The symptoms are pain due to nerve compression, pressure, dull ache, swelling in the limb, heaviness, itching, varicose veins, and non-healing leg ulcers and wounds, both due to skin changes. An additional symptom includes infection, such as cellulitis; however, fibrosis is absent. The fluid is protein rich and can be treated with CDT. Secondary lymphedema is a known obstruction to the lymph system resulting in fluid retention, tissue swelling, and a compromised lymph system. Lack of attention to fluid stagnation, increased macrophages, and increased lymphocytes will increase the patient’s risk for cellulitis.

It may be difficult to distinguish between lymphedema and lipedema. Clinically, classic symptoms are captured during an evaluation and revealed in the patient history and with clinical observation. This diagnosis cannot be made without seeing the patient. The symptoms occur in females only, her feet are not involved, her affected tissue is painful to touch and bruises easily, and the swelling is symmetrical in the legs and buttocks.

The difference between a patient with lipedema and chronic venous insufficiency is that lipedema does not involve the feet, and with chronic venous insufficiency the feet are involved. Leg elevation does not decrease swelling in lipedema; whereas, chronic venous insufficiency as well as lymphedema is related to the heart and circulatory system. In lipedema you will not see ulcers or infection, and 40% of patients will report a family history of the disease. Oftentimes there is a hormonal imbalance in patients with lipedema. Lipedema consists of an excess accumulation of fat in the subcutaneous tissue.
Treatment usually consists of dietary control, MLD, exercise, and custom garments.

Stewart-Treves syndrome is a rare and deadly angiosarcoma that develops in chronic lymphedema patients. It is a secondary cancer and will cause the patient's lymphedema to worsen. The malignancy comes from the blood vessel and is not a lymph vessel; it is sometimes called hemangiosarcoma and is a very rare complication. Recurrent cancer is one of the reasons lymphedema may not improve. If the patient is not progressing, she should be re-examined by the physician for metastatic cancer.

According to the 2009 Consensus Document of the International Society of Lymphology, staging of lymphedema is determined by the “Diagnosis and treatment of peripheral lymphedema.” Stage 0 is a latent or subclinical condition where swelling is not evident; however, there is impaired lymph drainage that may exist for months or years prior to the onset of stage 1 lymphedema. Stage 1 is an early accumulation of high protein fluid; the swelling subsides with elevation of the affected limb and is reversible. Pitting edema is soft in stage 1 and without fibrosis of the tissues. An increase in connective tissue proliferation may begin to appear. Limb elevation alone will unlikely reduce swelling in stage 2, the limb begins showing fibrosis in the tissue and pitting is less likely. Fibrotic tissue increases and is shown in skin thickness especially in the skin folds. Skin texture and consistency changes and becomes asymmetrical. A clear sticky lymph fluid may ooze out of the pores. Fibrosis occurs from chronic inflammation, the skin is thick and rigid due to an excess of protein-rich fluid (Figure 6).

Stage 3 is known as elephantiasis with large lobular folds where trophic skin changes such as papillomas, a warty like overgrowth, and hypercarotenosis occur. In each stage, functional severity is determined by volume differences and is classified into minimal, moderate, and severe. Volume can be measured by water displacement or from a circumferential computation by measuring with a tape measure the segmental changes in the volume of a cone, $V = \frac{\pi r^2 h}{3}$. Minimal lymphedema has less than 3 cm difference between the right and left limb, or less than a 20% increase in limb volume. Moderate lymphedema is 3 cm to 5 cm difference between limbs and a positive stemmer's sign, or a 20% to 40% increase in limb volume. Severe lymphedema is greater than 5 cm difference between limbs and a positive stemmer's sign, or a 40% increase in limb volume.

A positive stemmer's sign is thickening of skin at the base of the second toe or second finger that cannot be lifted. Staging and classification is necessary for documentation in the treatment phase measuring successful awareness for the patient, therapist, physician, and third party payers.

COMPLETE DECONGESTIVE THERAPY

Lymphedema is an incurable disease due to permanent damage to the lymphatic system. Now that you understand the anatomy and physiology of the lymphatic system you will have the basis to understand the importance of the gold standard treatment method called CDT. Consider the fact that, there are additional treatment methods that may complement the CDT program. Complete decongestive therapy consists of patient educated skin care, MLD, short stretch bandaging, and limb clearance exercises. Michael and Ethyl Foldi captured Vodders' MLD and created CDT. It is a two-phase treatment program; the first phase is the decongestive phase lasting 2 to 6 weeks depending on the severity, and the second phase is the self-care phase that is continuous.

This two-phase program is used for treating lymphedema and edema caused by chronic venous insufficiency. Once a patient has lymphedema and her tissues have been damaged, the tissue will always need to be cared for and maintained.

The treatment phase consists of redirecting lymph flow from a non-functioning region to a functional region. Patients must be educated in meticulous skin health to prevent skin infections. Manual lymph drainage is performed to redirect lymph flow and stimulate new lymphatic circulation. Short stretch compression bandaging application reduces fibrosis and maintains limb reduction. Limb clearance therapeutic exercises stimulate lymph vessel activity throughout the day. The treatment phase is performed one to two times daily. Ethyl Foldi, the developer of CDT, states the goal is to mobilize edema fluid and stop the production of fibrosclerotic tissue.

The self-care phase is commenced when your patient has achieved the desired volume reduction and is ready to maintain the reduction. During the treatment phase you will have prescribed a graded custom or non-cus-
Manual lymph drainage “increases lymph vessel activity, increases reabsorption of protein-rich fluid in the capillary bed, promotes relaxation and has an analgesic effect.”

Complete decongestive therapy is not only well tolerated but is the best treatment approach for patients with lymphedema. Contraindications and precautions must be observed. General contraindications and precautions for treatment include active skin infections, recurrent tumors, acute deep vein thrombosis, arterial disease, recent abdominal surgery, malnutrition, cardiac edema, kidney disease, hyperthyroidism, thyroid or liver disease, hyper-sensitivity of the carotid sinuses, radiation fibrosis, aortic aneurism, diverticulitis, pregnancy, and unexplained pain. Tumors can consist of abnormal masses compressing the lymphatic vessels, thus affecting the rate of fluid movement. The patient should first complete care with his oncologist regarding recurrent tumors and may then return to complete treatment. Manual lymph drainage will not increase the tumor size or cause any harm to the patient. It is considered palliative care if you are performing MLD on a patient with a malignant tumor. My colleague had a patient with signs and symptoms of cellulitis in her right upper extremity. Prior to sending her back to the physician, she performed MLD. Along her right arm she had thin red strips as a result of the spread of the infection. Manual lymph drainage is contraindicated in patients with infections. The patient must immediately follow a prescription of antibiotic treatment to prevent severe cellulitis and resume CDT when authorized by the physician; this normally occurs within 48 hours. Patients who are malnourished have decreased protein levels in their blood; maintaining homeostasis, the body will shift fluid out of the lymph vessels and cause edema in the tissues. Manual lymph drainage and compression therapy are contraindicated in cardiac insufficiency because they will cause an increase in fluid volumes returning to the heart and create a cardiac overload with potential cardiac damage. Heart failure patients have an excess of fluid.
pressure in the blood vessels causing the fluid to shift into the interstitial spaces. Left side heart failure can cause pulmonary edema as fluid shifts into the lungs. Right side heart failure can cause pitting edema and swelling in the lower legs and feet. Thyroid and liver disease can change the concentration of protein in the blood affecting fluid movement in and out of the tissues. The liver is enlarged in a patient with advanced liver disease causing fluid buildup in the abdomen. The author always consults with the physician when the patient has cardiac edema or thyroid or liver disease to determine if it is safe to proceed. A patient with deep vein thrombosis will have a warm red region on a limb or lower abdomen causing fluid pooling. If it is a large clot and becomes dislodged, it can be pumped into the lungs becoming a pulmonary embolism; a significant contraindication when performing MLD. Radiation fibrosis is a burn that should not receive MLD until authorized by the physician; however, you can mobilize fluid on the opposite side. For example, a patient with radiation burns on the left breast will tolerate treatment on the posterior back and still be effective. Consider a conservative approach by waiting until the radiation burn has healed and proceed with caution. Consult with your patient's physician when you incur a precaution or contraindication.\textsuperscript{15} There are other treatment options opposed to CDT and is a decision the patient will make with his physician. Debulking is a surgical procedure to reduce lobular folds in severe cases of lymphedema and must involve a plan to provide lymph drainage for the remaining tissue. Surgery will not cure lymphedema. Pharmaceuticals may include benzopyrene to stimulate lymph collectors; however, because of reports of liver toxicity, the Food and Drug Administration has not approved of its use in the United States.\textsuperscript{47,48} Diuretics are not well supported\textsuperscript{49} but according to Ethel Foldi, diuretics can be useful in the beginning of treatment but not for the long-term. Antimicrobials are necessary for acute infections. If a pneumatic compression pump is used, it should have sequential chambers that move from the distal limb proximately over a 45 to 90 second period with a milking action. If using a compression pump, do so with caution. Compression pumps are not recommended on the lower extremities since it places the patient at risk for developing genital lymphedema.\textsuperscript{50} Conflicting data does exist regarding the use of lymphedema compression pumps.\textsuperscript{51,52} The author recommends you complete your own research if you plan to use compression pumps in your clinic. One of the author’s patients used the compression pump daily for 5 years prior to seeking CDT. Her left arm continued to increase in fibrosis and her left breast tissue severely lacked mobility with loss of separation from the ribs. She attended the CDT Klose Norton Training Course as a patient demonstration where the lymphatic drainage was mobilized across her back. In 30 minutes her left upper extremity had softened and lymph flow had improved. A compression garment is recommended as part of the self-care phase in CDT. Patients who are in stage 0 may choose to wear a compression garment as a precautionary measure. Once the patient begins to see signs of lymphedema, such as heaviness or a decreased range of motion, the patient should begin wearing a compression garment and allow a trained professional to perform MLD on him or her. Patients in stage 1 require 5 consecutive days of treatment followed by self-home treatment for 2 days for 2 weeks to transport lymph fluid. The patients are instructed how to perform self-MLD for the 2 days between visits. Whatever treatment method is used, it is the choice the patient must ultimately make.\textbf{Intensive Phase} The CDT treatment phase consists of skin health, MLD, short stretch compression bandaging, and limb clearance exercise.\textsuperscript{15} Each item is clearly explained below along with patient examples.\textbf{Skin care/patient education} Our skin is the largest organ in our body weighing approximately 8 pounds. It is a protective barrier from the outside world yet connects us to the outside world. Our skin protects us against the damaging sun and dangerous chemicals. It will rid itself of toxic substances in our body through exudation. Some patients with lymphedema will exude lymph fluid through their pores. Our skin is our first line of defense to protect our body from infection. In a compromised lymphatic system where the lymph fluid is protein rich, the patient is more susceptible to infection. The patient must be extra cautious to prevent skin abrasions; chemical reactions; excessively increasing body temperature, externally or internally; and any restrictions to blood flow. MD came for her third CDT session and complained of redness and pain in her arm 6 hours after a paper cut on her right finger. Recognizing it as a potential infection, the author immediately contacted MD’s physician who recommended she go to the emergency room. By the time she was admitted to the hospital, she had an extreme case of cellulitis and was hospitalized for one week. The author recommends that all patients who get any abrasions wash their abrasion immediately and apply an antibiotic ointment, covering it with a Band-Aid, which will significantly prevent skin infections. Examples of minor skin abrasions that can cause cellulitis in a lymph compromised patient are manicures, pet scratches, gardening abrasions, routine medical interventions, razor burns, and sun burns. TS is a beautiful redhead who had melanoma skin cancer removed from her left thigh. She visited Disneyland wearing shorts on a hot day with her family. Following a minor burn, she developed lymphedema. No symptoms were previously visible. She was in stage 0 where her lymph system was already compromised with protein-rich fluid and was unable to manage the removal of waste product; the lymph fluid became stagnant and she developed cellulitis.\textsuperscript{53} When she came in for treatment, her left calf was 5 cm larger than her right. Recommend to your patients to avoid extreme temperatures, hot
tubes, repetitive motions that increase muscle temperature, and lifting more than 15 pounds.

KT received treatment for left breast cancer and a year later she suffered a heart attack. Her cardiac rehabilitation included weight lifting. After lifting weights in excess of what was normal for her, her lymph system was unable to meet its demands and lymph fluid became stagnant in her limb developing protein-rich fluid. Stage 2 lymphedema developed. Another hidden enemy is restrictive items such as tight brassieres, jewelry, clothes, and blood pressure cuffs. Inflated blood pressure cuffs have been the initiating factor to developing lymphedema in some patients. Always ask patients if there was any reason that their blood pressure should not be taken on their arm. If they had breast cancer, it would serve as a reminder that there was a potential precaution, and if further explanation is required, explain the question to them. Oftentimes the patient’s intake information did not include information about breast cancer. Patients need to be educated to protect themselves from soft tissue infections such as cellulitis and lymphangitis.

Some people develop lymphedema from obesity; however, this does not mean because a person has lymphedema and is obese it is due to the obesity. When a person is obese and has lymphedema, the recommendation is to start a weight loss program approved by the physician, and after losing the first 10 pounds, then begin CDT. In the author’s personal experience, those patients who were overweight and began a weight loss program during lymphedema treatment experienced significantly decrease swelling. The author has also noted a change in lymph stagnation and flow when a patient has an increased amount of salt in her diet. SE’s spouse normally prepares dinner for her and uses excessive salt in food preparation. He was away on business for a week when less swelling was observed; now she has him prepare food with less salt. Italian, Mexican, and Asian foods normally have excess salt. The author has found it is easier to ask patients to avoid salt than to avoid specific foods. In addition, recommend that patients avoid inflammatory foods such as “white” foods: sugar, breads, pastas, and dairy. Gluten and dairy allergies are very common and cause increased inflammation in the body. Treatment is expensive and involves a commitment from the patient and the therapist.

**Manual lymph drainage**

*Manual lymph drainage* is an amazing modality used on many patients for a variety of diagnoses involving inflammation. Many disease processes are a result of inflammation. To view how to perform MLD, a DVD can be purchased online titled “A Physical Therapy Treatment Approach to Manual Lymph Drainage DVD” at www.FunctionAbilityPT.com. Manual lymph drainage alleviates pain by reducing pain signals to the brain; decreasing scar tissue formation; removing metabolic waste products, excess water, toxins, bacteria, and foreign substances from the tissues; supporting the immune system; and increasing lymph vessel activity and absorption of protein-rich fluid. Remember to drink lots of water prior to and following MLD treatment.

Principles to follow regarding MLD are keep strokes minimally spaced, mobilize lymphatic fluid from distal to proximal, and perform strokes slowly and rhythmically. To enhance the pumping mechanism, incorporate aerobic activity during your treatment session or as part of the home program. The combination of diaphragmatic breathing and gentle exercise will decrease secondary upper extremity lymphedema. The speed of red blood cells in the capillary is very slow, approximately 8.2 feet per hour. The red corpuscles are often larger than the diameter of the capillaries and too large to pass through the small blood vessel. At the capillary, the speed slows down and can even stop. Due to this phenomenon, the capillaries use pressure rather than movement to transport red blood cells out of the blood capillary. Visualize the heart as a pressure pump maintaining pressure inside the blood vessel as you support lymph transport from the blood vessel to the lymph vessel.

The goals for MLD are to alleviate blockages in a lymph drainage area, re-route lymph to functioning lymph channels, promote movement of lymph toward the lymph nodes and stimulate lymphangiomotor activity, detoxify the body, and strengthen the immune system. A damaged lymph system limits normal drainage to the affected area. Lymph accumulates and fluid becomes stagnant resulting in lymphedema. In the United States, the most common cause of lymphedema is cancer treatment. The cancer is surgically removed creating scar tissue; often times the patient receives chemotherapy and radiation treatment creating more scar tissue. If the lymph nodes are damaged from scar tissue, chemicals, or radiation, lymph nodes become non-functional and will not be able to accept lymph fluid from its designated region. A blockage and back up of lymph occurs creating high protein fluid and lymphedema. Manual lymph drainage increases transport capacity by creating a mechanical stretch in the wall of the lymph angion to improve lymph vessel activity and mechanically transports lymph fluid to blood circulation. It also re-educates the smooth muscle in the lymph vessels and changes the direction of valves to new drainage areas. In addition, Advanced Positional Therapy Release Techniques to transport lymph fluid can be used. Recall there are 600 to 700 lymph nodes in the body.

**Contraindications**

Contraindications for MLD include an active skin infection, impaired arterial perfusion, and an untreated ma-
lignant tumor. Precautions should be adhered to with a history of cardiac disease, congestive heart failure, renal failure, a history of a deep vein thrombosis or type I or type II diabetes mellitus, and a current malignant tumor. Manual lymph drainage can be performed for palliative care without the risk of spreading the tumor. With all contraindications and precautions, consult with the patient's oncologist or primary care physician.\textsuperscript{15}

**Manual lymph drainage techniques**

*Specific techniques are used to promote movement of lymph fluid towards functioning lymph node groups. The pressure is light, the hand is kept flat, and the skin is stretched parallel to lymph vessels encouraging a reflex from the stretch receptor in the lymph angion. Hand contact is constant and frequency is slow allowing a rhythmical alternating peristaltic wave of dilation and contraction in each lymph angion. The lymph nodes are grouped together in drainage ports throughout the body. Manual lymph drainage is stimulating superficial lymph nodes and vessels to remove unwanted protein, fluid, and solutes from the skin and subcutaneous tissue. Therefore, the contact on lymph node groups must be light with large slow circles, with the exception of the abdomen.\textsuperscript{15} Lymph angions are spaced 6 mm to 20 mm apart and each is lined with a delicate smooth muscle and enclosed with valves entering and exiting. The stretch reflexes will sense the bulging lymph angion contracting and will pump the fluid through the one-way valves to the next lymph angion.\textsuperscript{9} Your sensitive manipulations will have an impact on the comprehensive flow of lymph fluid along each lymph vessel. In this process, allow the hands to sense the fluid dynamics and frequency changes of each move before proceeding to the next step. The success of reducing inflammation with MLD is to clear each region prior to moving to the next region; this requires feeling the tissue as its integrity improves. Manual lymph drainage relaxes the sympathetic nervous system as deep abdominal breathing stimulates the parasympathetic nervous system.\textsuperscript{57}

Provide privacy for patients to undress and supply a sheet in which to cover themselves. Use a high-low table to insure good body mechanics; all treatments are more effective if you and your patient are relaxed and not straining in any positions. Breathe slowly during the treatment to quiet the lymphatic system. Encourage your patient to drink water and eat light healthy foods to avoid post treatment reactions.\textsuperscript{23} In the treatment room, have access to a tape measure, extra bandaging products, and handouts for skin care and exercise.\textsuperscript{21} In addition, it may be beneficial to have available modalities for use during your treatment such as a low light laser, homeopathic lymph stimulating gel and applicator tool, Kinesio tape, and frequency specific microcurrent (FSM). Explain to your patient the modality you are preparing to use and ask for permission to place your hands on the breasts, buttocks, and inner thigh. Follow contraindications and precautions as described previously.

Begin with breathing exercises to increase the flow of lymph fluid in the thoracic duct by creating pressure changes between the abdomen, diaphragm, and lungs. The thoracic duct normally removes 4 L of lymph from the lower extremities, pelvis, and left side of the body. Place the palm of your hand on your patient’s abdomen with a tolerated pain free pressure depth, and resist the abdominal muscles to increase muscle stimulation. Ask the patient to inhale raising her belly as she resists your pressure in the abdomen. While she exhales slowly, quickly move your hand to the abdominal obliques located inferior to their right rib cage and repeat the breathing sequence. During exhalation, move your hand inferior and medial to the anterior superior iliac spine and repeat. Continue to repeat the sequence at the umbilicus, left inferior ribs, left medial anterior superior iliac spine, and for the third time, on the umbilicus.\textsuperscript{18} A negative intrathoracic pressure is created during inspiration; these respiratory pressure changes create a suction force to stimulate lymph flow. At this time, teach your patients a myofascial technique to passively stimulate thoracic duct activity. Place one hand on the region of the cisterna chyly and another on the left terminus; allow fascial release. Reviewing the fascial anatomy, the middle cervical and subclavian aponeuroses play a role in respiratory function promoting venous circulation in the thoracic, cervical, and cerebral connective tissue.\textsuperscript{58} Breathing exercises will stimulate the parasympathetic nervous system and relieve stress.\textsuperscript{16}

The terminus is the soft tissue space located between the base of the ear and length of the clavicle along the neck; it is the region of the subclavian veins and the internal jugular veins where the lymph returns to the circulatory system. There are approximately 160 lymph nodes located in this region and they are responsible for lymph drainage of the head and neck. Make note of the clavicular fossa covering the clavicle, coracoid process, and axilla; it merges with the skin of the axillary fossa and turns into the suspensory ligament of the axilla.\textsuperscript{58} If you are trained in visceral manipulation, the author recommends releasing connective tissue adhesions to improve the effects of MLD. Gently place the length of 3 fingers on the anterior scalenes muscle superior to the clavicle. If the patient reports pain, your pressure is too deep; you risk collapsing the lymphatics.\textsuperscript{23,59} Feel the firmness and congestion in the tissues below your hand; ask the patient to feel it as well. Slowly move your whole hand in large circles stimulating lymph nodes to release waste products.\textsuperscript{18} Deep pointed pressure of the fingertips will only stimulate trigger points in the muscle tissue, not lymph nodes. As lymph nodes release waste and protein, you will feel the tissue under your fingers soften and become pliable with gentle stationary circles. Remind the patient of what it felt like initially. This is important for the patient to feel because she will learn to perform this technique on herself. Repeat on the opposite side and, when comfortable, you may perform this technique.
simultaneously. Oftentimes the left side is more congested than the right, especially when lower extremities are involved. The thoracic duct is the largest lymph vessel and drains tissue from below the waist bilaterally and the left side of the body. Precautions for the neck are carotid sinus syndrome, hyperthyroidism, and thinning skin from aging. Consult with the patient's physician regarding precautions.¹⁸

There are 100 to 200 lymph nodes around the colon. Prior to beginning MLD in the abdomen, verify any potential contraindications such as a recent abdominal surgery, diverticulitis, aortic aneurism, acute deep vein thrombosis, pregnancy, or pain. Before beginning MLD in the abdomen, visualize the depth of the lymph nodes located within the greater omentum and gently engage the tissue. Place both hands on the abdomen to feel the inflammation and tension in the peritoneum and ask the patient to notice the restrictions in the tissue. Place the palm of your hand with the medial border along the patient's ilium; pressure is deep since lymph nodes are deep along the colon and should be tolerated without pain.¹⁸ Always ask the patient if the pressure is tolerable, and if not, decrease your pressure. Slowly move your hand in circles to stimulate each lymph node to release waste and lymph. When the tissue softens, move to the next abdominal region. It is normal to perform more than 25 stationary circles on the patient's first MLD session; subsequent visits may only require 10 to 20 stationary circles. The ultimate goal is to continue with the strokes until the tissues soften. Move your hand to the left transverse abdominis muscle and repeat the sequence, follow with the right transverse abdominis muscle, and lastly the ascending colon. Once completed, return to your initial abdominal assessment. The abdominal peritoneal tissue will have softened, inflammation in the abdomen decreases, and the patient will notice her softer belly. If it has not softened, you may have been hasty, either with stationary circles or lack of time in one region. Stimulating lymph nodes to release the lymph fluid is crucial to the lymph nodes accepting more lymph fluid. Many times, during the first treatment session, the author only cleared the trunk and not treated the extremities due to time constraints.

Determine your treatment protocol based on assessment of the involved extremities and functional lymph node groups. Typical scenarios include one upper extremity limb involvement or single or bilateral lower extremity involvement. Occasionally you will have bilateral upper extremity involvement, head involvement, or unilateral double limb involvement.⁶⁰ More importantly, you must consider potential lymph node involvement and the work capacity for the related duct. For example, LT is a 55-year-old female who had cervical cancer but was treated without radiation or chemotherapy; she had no other health concerns. She presented with stage 2 right lower extremity lymphedema and stage 1 lymphedema in her left lower extremity. Abdominal, cervical, and axillary lymph nodes were intact. Radiation therapy was not part of her cancer treatment; therefore, it was determined that her inguinal lymph nodes were functional. However, scar tissue was present causing damage to her abdominal lymph nodes. The thoracic duct is responsible for draining the lower extremities. Her MLD treatment session consisted of abdominal breathing exercises; "stationary circles" to lymph node groups in the abdomen, neck, bilateral axilla, and bilateral inguinal region; lymph drainage in her trunk from inguinal to axilla bilaterally; and MLD to her bilateral lower extremities initially, with repetition of sequence in the prone position (Figure 7). Once the left lower extremity returned to normal, her treatment program changed from treatment of bilateral legs to right leg only. Incidentally, her left lower extremity swelling has never returned. It is important to understand the anatomy and physiology to make the best clinical decision for your treatment approach.

ML is a 54-year-old female with bilateral breast cancer followed by chemotherapy and left late stage 1 lymphedema and right beginning stage 1 lymphedema; she received no radiation therapy. She reported seeing another therapist who transported lymph fluid across the trunk from the left side to the right side causing the right side to begin swelling. Appearance alone would not have indicated she had swelling in her right arm; however, the tissue in the right arm felt congested, heavy, and firm, all signs of stage 1 lymphedema. Other related health history concerns were celiac disease and Dercum
disease consisting of painful adipose cysts imbedded in connective tissue throughout her entire body. Special consideration was given to her treatment plan due to her rare disease in active autoimmune response. ML's MLD treatment plan consisted of abdominal breathing exercises; MLD in her abdomen, neck, inguinal, and axillary lymph node groups; MLD from bilateral axilla to inguinal; upper trunk MLD with repeated MLD from axilla to inguinal, followed by MLD to both arms (Figure 8). Treatment of Dercum disease consisted of MLD and release of the connective tissue adhesion surrounding each individual adipose tumor.

TREATMENT OF DERCUM DISEASE CONSISTED OF MLD AND RELEASE OF THE CONNECTIVE TISSUE ADHESION SURROUNDING EACH INDIVIDUAL ADIPOSE TUMOR.

Stimulate the lymph node groups in each region by placing the palm of your hand on the lymph node group and moving your hand in slow stationary circles covering the complete range of lymph nodes. Initially it may require 25 strokes and eventually only 10 to 15 strokes. Proceeding when the tissue softens is the key to successful lymph flow. This technique will allow lymph nodes to drain, which will then allow fluid from lymph channels to enter lymph node groups. Stimulate the functioning lymph node groups that are ipsilateral and contralateral to the affected limb. In an affected right arm, clear lymph node groups in the contralateral arm and ipsilateral groin. In an affected right leg, clear lymph node groups in the contralateral left inguinal region and ipsilateral right axilla. It is common to have one leg affected and the other leg periodically showing symptoms of swelling. If this is the case, clear lymph node groups in the ipsilateral and contralateral axilla. This also would require using the MLD stroke, referred to as the "pump," to the axilla on the contralateral trunk and the "rotary" on the lower trunk to make a lymphatic drainage pathway. The same scenario can occur in the upper extremity; however, only drain into the ipsilateral inguinal region for each limb. There are 100 to 200 lymph nodes in the abdomen that will assist in processing the lymph fluid. Clinical decisions are based on understanding the anatomy and physiology of the lymph system.

SE had a typical case of right breast cancer, radiation, and chemotherapy and right upper extremity lymphedema. She was a university professor who repetitively used her right upper extremity for writing on the board and correcting papers, thus increasing her lymphatic transport load in her dominant right arm. Her MLD treatment session included abdominal breathing exercises; MLD to lymph node groups in her abdomen, neck, left axilla, and right inguinal; MLD across the breast and back from right to left; and MLD from right axilla to right inguinal followed by MLD to her right arm (Figure 9).

The axilla contains 20 to 30 lymph nodes, and the inguinal contains approximately 11 lymph nodes. Gently assess the tissue restrictions in the axilla and inguinal region, and demonstrate the restrictions to your patient. These lymph nodes are sometimes removed following excision of cancer in an associated region. Stimulate the lymph node groups in each region by placing the palm of your hand on the lymph node group and moving your hand in slow stationary circles covering the complete range of lymph nodes. Initially it may require 25 strokes and eventually only 10 to 15 strokes. Proceeding when the tissue softens is the key to successful lymph flow. This technique will allow lymph nodes to drain, which will then allow fluid from lymph channels to enter lymph node groups.
Choose which lymph drainage pathway is required for the trunk. Fluid transport can occur from the axilla to the inguinal region or vice versa. Begin at the lymphatic anastomoses, following the direction of normal flow. To pump fluid from the axilla to the inguinal region, place your hand at the waist and direct your strokes from the waist to the inguinal region using the “pump.” This is best seen with a demonstration and perfected in a CDT training course. Begin with the web of your hand at the waist directed toward the pelvis. Bring your hand flat to the side of the trunk and stretch the lymphatics with a slight push toward the pelvis approximately 2 cm, relax your hand, and return to the web of your hand 2 cm lower. Then repeat the sequence to the inguinal region. After 5 to 10 repetitions, place your hand at the axilla with your hand directed toward the pelvis, and repeat the sequence with at least 5 repetitions. If you choose to mobilize lymph flow from the inguinal to the axilla, place the web of your hand at the waist directed toward the axilla. Repeat the first sequence with the flat hand on the side of the trunk and slightly push toward the axilla 2 cm, return your position with the web of your hand 2 cm higher and repeat the sequence to the axillary region. After 5 to 10 repetitions, place the web of your hand at the inguinal region directed to the axilla, flatten your hand moving 2 cm, relax, return to the web of your hand 2 cm higher and repeat to the axilla for 5 to 10 repetitions. The most common treatment plan in a patient with lower extremity lymphedema is to direct fluid flow from the inguinal region to the ipsilateral axilla. The direction will be reversed if your patient has upper extremity lymphedema.

The rotary stroke is only used on the trunk. It is a specialized technique that mimics an inchworm with the hand. Determine the direction of flow between the lateral sides of the body. Right upper extremity lymphedema will require fluid to move away from the right and move to the left. Begin with your hand raised, thumb and fingers separated and the fingertips on the patients skin on the lateral right upper anterior trunk; include the breasts. Drag your thumb across the skin to your fingers; flatten your hand while stretching the skin moving 2 cm. Relax your hand, raise your position to finger tips, and repeat the sequence 5 to 10 times across the upper anterior and posterior trunk. Determine logical sequencing with other strokes for the prone position. The rotary stroke is repeated on the abdomen and lower back for lower extremity lymphedema. To determine if you use this stroke on the upper anterior and posterior trunk or lower anterior and posterior trunk will be based on the involved lymph node groups and limbs. If a patient has right lower extremity lymphedema, choose to mobilize tissue from the right lower abdomen to the left side. If both legs are involved, mobilize the fluid to the left side but follow up with a pathway from the left waist to the left axilla to avoid increasing lymph fluid in an affected limb. It is helpful to draw a picture to determine the pathway for lymph flow.

Finalize MLD with treatment to the affected limb. In a clinical setting, the patient is lying supine. Begin performing MLD on the upper extremity by applying 3 to 5 stationary circles on the cubital fossa consisting of a very small number of lymph nodes located in this region. Manual lymph drainage on the upper extremity is performed from distal to proximal; however, begin proximal. In other words, initiate your stroke on the upper arm at the elbow to the shoulder, follow with the lower arm, and finalize with the hand and fingers. The most common stroke used on the arm is the spiro-stroke in the vertical plane parallel to the lymph vessels. Imagine a spiro-graph creating progressive designs inching along a pathway. You will apply a gentle, pain-free stretch with a flat hand directly on the skin proximal to the lateral elbow in a crescent shape moving up the arm towards the shoulder. The lymph system moves very slowly; therefore, strokes should be performed slowly. Manual lymph drainage for the medial upper arm is performed by placing your flat hand above the elbow with an upward angle as you glide and stretch the tissue to the lateral arm previously cleared. The process is repeated by continually returning to the medial arm, mobilizing lymph drainage to the lateral arm with 5 to 10 strokes as you migrate from the elbow to the axilla. Repeat Step 1 an additional one to two times. You may use the pump in place of the spiro-stroke in Step 1 if it is more conducive for body mechanics. Step 3 begins at the wrist with the spiro-stroke, pump, or scoop from the wrist to the elbow with 5 to 10 repetitions. The size of the limb will determine the number of pathways you will drain. Typically you will have two pathways for the anterior and two for the posterior with any of the 3 strokes. There is often increased swelling and fibrosis in the hand and fingers. Beginning at the distal metacarpals in Step 4, use your fingers or thumbs in the spiro-stroke 10 to 20 times, vertically parallel to the lymph vessels from distal to proximal, to the wrist. Each finger is performed the same way from distal to proximal with short strokes (Step 5). Consider wrapping your hand around the patient’s finger and apply a milking pressure distal to proximal. Place the patient in a position to easily access the posterior arm. In the clinic, the prone position is often used. Repeat Step 2 then Step 1. Mobilize and stretch the tissue medially and proximally at the elbow to the lateral upper arm from the elbow to the axilla. Use the spiro-stroke on the lateral upper arm from the proximal elbow to the shoulder. Repeat Steps 3 and 4 on the posterior lower arm and palmer surface of the hand. Consider a follow-through of spiro-strokes, pump, or scoop from the limb to the new channels created in functional lymph node group. You have now completed the affected limb.

Lymphedema in the lower extremity is performed with the same approach; begin with the patient lying su-
pine. Step 1 begins with spiro-strokes on the anterior thigh from the proximal knee to the iliac crest with 10 to 15 repetitions. The line of the path will be from the anterior thigh to the lateral hip with the exception of a patient with functional lymph nodes in the inguinal region. In Step 2, place your hand on the medial thigh proximal to the knee and mobilize lymph at an upward angle to the anterior thigh. Step 3 consists of the pump on the lateral upper leg from the knee to the hip. Perform 3 to 5 stationary circles behind the knee. Step 4 begins in the lower leg proximal to the ankle using the spiro-strokes or the pump. Normally, more vessels are located along the medial lower leg. Make a pathway on the medial border from the ankle to the knee. In Step 5, place your hand on the lateral lower leg as you stretch the tissue from lateral to medial with an upward motion. The foot in Step 6 is performed using thumbs, long fingers, or hands in a parallel spiro-stroke from the base of the toes to the ankle. The tissue in the foot is often filled with more fluid and fibrosis due to a dependent position and will require additional tissue mobilization. Step 7 consists of spiro-strokes from distal to proximal along the length of the toes. Position the patient in prone to manipulate lymph drainage from the posterior side. Begin with spiro-strokes (Step 1) above the posterior knee from distal upper thigh to proximal lateral upper thigh; also include the buttocks with spiro-strokes from the gluteal fold to the iliac crest. The goal is to direct lymph flow from the leg to the axilla. Repeat Step 2 by placing your hand on the medial thigh proximal to the knee and mobilize fluid at an upward angle to the lateral thigh. Repeat Step 4 with spiro-strokes or the pump from the posterior ankle to the posterior knee. Repeat Step 6 on the palmar surface of the foot from the base of the toes to the heel. You may repeat any of the sequences for the best follow-through of care and for continuous flow of lymph fluid. You have completed lymphatic drainage for the lower extremity. If your patient has bilateral lymphedema, treat one limb at a time but keep the other limb in a garment during the day. Increasing lymph flow to one limb will improve lymph flow to the other limb.

TS had stage II left lower extremity lymphedema as a result of left leg melanoma. In addition to removing the melanoma she had a left inguinal lymph node dissection; she did not receive radiation or chemotherapy. Manual lymph drainage was performed on TS in the following sequences: step 1 begins with breathing exercises. Step 2 followed with stationary circles to the lymph node groups in the abdomen, bilateral neck, and bilateral inguinal region. Step 3 followed with creating pathways from bilateral inguinal to bilateral axilla. Step 4 followed with limb clearance of bilateral lower extremities first with the upper leg; second with the lower leg; and last with the feet using the pump, spiro-stroke, or scoop. Omitting the abdomen and breathing exercises, repeat on the posterior side (Figure 10).

MK, who will be further discussed in a case example presented to you in a later section, had primary lymphedema stage 3. Her MLD treatment was similar to TS; however, the difference is she had lymphedema in her bilateral lower extremities with no damage performed to the lymph nodes groups. Step 1 begins with breathing exercises. Step 2 followed with stationary circles to the lymph node groups in the abdomen, bilateral neck, and bilateral inguinal region. Step 3 followed with creating pathways from bilateral inguinal to bilateral axilla. Step 4 followed with limb clearance of bilateral lower extremities first with the upper leg; second with the lower leg; and last with the feet using the pump, spiro-stroke, or scoop. Omitting the abdomen and breathing exercises, repeat on the posterior side (Figure 11).

Lymphedema bandaging
To prevent return of lymph fluid to a pre-evacuated limb, you will need compression to mimic the body’s natural hydrostatic pressure. Short stretch layered bandaging is used during the treatment phase. Ace bandages are inappropriate due to excessive elasticity in the center of the bandage. Bandaging performed without MLD does not provide a drainage route for lymph to flow to its primary center. Contraindications for compression bandages and garments are arterial disease, ulcers, infection, or wound. Signs of arterial disease are a diminished pulse and impaired skin integrity consisting of pale, blue, smooth, shiny, and clammy skin with possible arterial
ulcers. Arterial ulcers are normally found in the lower third of the leg. They are small round shallow ulcers with little drainage and are painful with elevation. This is a red flag and can be ruled out with an arterial Doppler or perfusion test. Short stretch bandaging reduces the filtration rate at the capillary bed, improves the efficiency of the muscle joint pump, and softens indurated tissue. Typically our skin provides adequate tension forces to prevent swelling. The contraction of muscles and pulsation of arteries provides a pumping action to mobilize lymph fluid. Skin integrity has been compromised in lymphedema and is unable to provide the support. Short stretch bandaging products consist of Elastomull for the fingers or toes; an absorbent tubular stockinette; Artiflex, a cotton padding, to provide even distribution around the limb; and Comprilan to provide short stretch compression (Figures 12 and 13). The Artiflex is compressed under the Comprilan when initially bandaged. As the limb circumference decreases, the Artiflex fills in the space to allow increased pressure. Other products such as gray foam and orange foam may be used to further decrease indurated tissue. Combination rules for gray and orange foam must be observed; gray foam can overlap gray or orange foam; however, orange foam cannot overlap orange foam. Pressure is gradient with increased pressure at the distal end. If the bandaged limb is painful or if the patient reports losing sensation, the bandage must be removed. Consider a looser application of the compression bandages on the first day, and if tolerated, increase the tension with each subsequent day. Bandaging is a skill that requires practice for perfection. Refer to Figures 12 and 13 for proper bandaging; however, a training course for lymphedema and bandaging is recommended. Practice the technique on yourself. We expect our patients to bandage their own limb on the weekends and during the self-care phase. Can you successfully bandage your own limb? Can you bandage your arm with your nondominant hand? During the self-care phase, consider a JoViPak or Tribute providing 30 mm Hg to 40 mm Hg for nighttime compression. Tribute directs interstitial flow away from
the edematous region supporting the proper concentration and distribution of plasma protein in the tissue. It is a soft appliance using high to low pressure support with small cubes of varying foam densities directed along lymph pathways.28

Limb clearance exercises
Exercises should be performed slowly and rhythmically with the limb compressed with bandages or a garment.21 Exercise increases lymph flow at the cellular level beginning with the initial lymphatics.65,66 Correct posture and breathing will improve the effectiveness of each exercise. Limb clearance exercises consist of active range of motion and stretching, isometrics and functional activities, aerobic activity, and aquatic exercises.21

Diaphragmatic breathing improves the muscle and joint pump as well as venous and lymphatic return and should be performed at each physical therapy session. Each slow, extensive movement of the diaphragm improves lymph circulation and stimulates the parasympathetic nervous system.15

Yoga is a wonderful form of exercise for lymphedema patients because it consists of stretching, isometric strengthening, and breathing exercises.21 Isometrics can include ball knee squeezes, lunges, and walking on toes for the lower extremities. Begin active range of motion strengthening and stretching exercises closest to the trunk and progress distally. If the patient has upper extremity lymphedema, perform neck rolls, shoulder rolls, reaching exercises, pole rotations and lifts, elbow and wrist flexion and extension, pronation and supination, finger pad exercises, and handball squeezes.21 Likewise, the lower extremity exercises would be performed around the pelvis, hip, knee, ankle, foot, and toes.21 These lower extremity exercises could include marching, lunges, quad sets, hip flexor stretches, hamstring stretches, gluteal sets on all 4 limbs, gastrocnemius stretches, foot windshield slides, towel scrunches, and marble-in-toe pick up.21

Functional activities can include waist circles, kneading ball, and stationary walking with contralateral arm flexion. Each movement and stretch presses against the skin; compression is similar to normal skin elasticity stimulating lymph flow.

Aerobic activity increases lymph flow 15 times the normal resting rate. Some patients perform their own aerobic activity with an in-home step video, walking, hiking, and biking. Exercises should be monitored to avoid excessive over-heating and exhaustion to the affected limb muscles. A favorite aerobic exercise for lymphedema patients is swimming.67 Patients achieve aerobic fitness while receiving external water compression to the limb, and there is no need to wear a compression garment since the hydrostatic pressure in water provides the needed compression.68 A safe temperature for pool water is 68° to 86°. Aquatic exercises will help soften indurated tissue. Free style and the breaststroke are safe swimming exercises; however, avoid the butterfly stroke since it is too forceful on the joints.

As with all exercises, recommend that patients stay hydrated, protect the skin with a low pH moisturizer, and avoid fungal exposure to the feet in public places. Patients should avoid dangerous and high-speed exercises such as skiing and repetitive exercises such as golf. This is a sensitive subject for some patients, and likewise, the therapist must be respectful of the patient’s lifestyle. For example, a patient with minimal lymphedema was also an avid golfer. She would not have agreed to therapy if it meant she had to discontinue golfing. Instructions included limiting her golfing time, performing MLD prior to and following her golf days, wearing her compression garment, bandaging on the nights she played golf, protecting her skin from the sun, decreasing salt intake, and promoting hydration. Her lymphedema worsened slightly when she golfed regularly following her treatment program; however, that is the choice she made.

Should patients who have had breast cancer surgery fear returning to their normal physical activity? Sagen et al researched this question with 204 breast cancer subjects following axillary lymph node dissection.70 It was a prospective, randomized control trial with a two-year follow up. Sagen and his colleagues concluded that patients who have breast cancer surgery with axillary lymph node dissection should be encouraged to maintain their physical activity in their daily lives without restrictions and fear of developing lymphedema.70,71

Third party billing
Complete decongestive therapy treatment is the gold standard for lymphedema rehabilitation. Acceptable CPT codes for MLD are 97140, 97110, 97124, and 97112. Bandaging codes for the upper extremity are 29260 for the elbow and wrist; and 29280 for the hand and fingers. Likewise, bandaging codes for the lower extremity include 29530 for the knee, 29540 for the ankle, and 29550 for the toes. The recommended therapeutic exercise code is 97110. In addition, use 99211 for patient education.

Self-care Phase
The self-care phase includes a daily compression garment with nighttime bandaging or bandaging substitute such as a JoViPak or Tribute. The compression garment will reduce the diameter and the blood volume of the superficial veins, reduce reflux of lymph flow and diminish pooling or stasis of venous blood. Additional benefits include improved diffusion of oxygen and nutrients and increased pressure in the interstitial fluid compartment and reduced gaps in the vein walls. Reabsorption at the venule will be increased as well as microcellular circulation in the blood.72 Maintaining edema reduction is essential; a gradient compression garment compensates for the loss of elasticity in the skin after reducing the limb size.73 Lymphedema garments must have a gradient pressure with increased pressure at the distal end to support lymph flow. Garments are normally worn when you've achieved your target reduction. Jobst Manufacturing rec-
ommends that patients with mild lymphedema of the arm wear a 20 mm Hg to 30 mm Hg class I garment, moderate arm or mild leg lymphedema should wear a 30 mm Hg to 40 mm Hg class II garment, severe lymphedema of the arm or moderate lymphedema of the leg should wear a 40 mm Hg to 50 mm Hg class III garment, and severe lymphedema of the leg should wear a garment greater than 50 mm Hg class IV. These are the recommended pressures, but it is better to be conservative with the amount of pressure you prescribe. It is recommended that a slightly lighter compression with the first compression garment be used to improve patient compliance. Once the patient is accustomed to donning and wearing a garment, she will be comfortable with more compression. Garments should be replaced every 3 months due to damage with wash and wear. Patients will need a minimum of two pairs to alternate wash and wear. In the case of an extraordinary shaped limb, especially seen in stage 3 lymphedema, it is recommended you order the patient a custom garment. Interview companies and other patients who support custom garments to determine which company will be most advantageous for your patient and receive training if you plan to be the one who measures your patient. Attendance at a custom garment measuring course is beneficial whether or not you plan to measure your patients for their garments.

**Complete Decongestive Therapy Goals**

The goals for CDT are to reduce the volume of the limb and soften indurated tissue, restore mobility in the joints and connective tissue, prevent infection, improve cosmesis, improve quality of life and psychosocial awareness, and maintain independence in self-care. Your complete treatment program will consist of verifying payment, an initial evaluation, medical authorization, and diagnosis with a prescription, and if required, an order with authorization for two sets of lymphedema bandages and two classified pressure compression garments. A commitment of 5 consecutive treatment days per week for a prearranged duration of two to 6 weeks depending on the severity of lymphedema will be expected. During the treatment program, you will have taught your patient about skin health and infection prevention and precautions, instructed her in self-manual lymph drainage, self-bandaging, and a home limb clearance exercise program. You will have measured for the compression garment and scheduled follow-up care. The CDT program is very expensive for the payer and a rewarding commitment for both the therapist and the patient. At the time of the initial evaluation, I review the plan of care and receive a verbal commitment for the program frequency and duration. Not all patients are ready to commit to the extent of treatment required. Treatment is initiated when the patient has committed to the program and is emotionally ready for treatment.

**Alternative Modalities**

In addition to the CDT program you may consider incorporating other modalities and devices. For nighttime compression the JoViPak, tribute, or D-ring tightening gradient system are a consideration. These items are excellent for the patient who is not likely to perform nighttime bandaging. For anytime compression, a CircAid juxta-fit from CircAid Corporation (A6545 with RT, LT) located in San Diego, CA may be more suitable than bandages. Other alternative approaches include laser, Kinesio tape, galvanic stimulation, FSM, and a pneumatic compression pump. Carati et al74,75 researched low-level laser therapy in a double-blind, placebo controlled, randomized study on postmastectomy lymphedema patients. They concluded that following 18 sessions in 3 months of a 17-point laser treatment to the axilla, limb volume and tissue hardness were reduced in 33% of the patients with postmastectomy lymphedema. Some therapists use Kinesio tape as opposed to bandaging two limbs or prefer to use Kinesio tape in patients who cannot tolerate bandaging. A pilot study in 2008 supported replacing bandages with Kinesio tape in breast cancer-related lymphedema. Tsai et al76 conducted a randomized pilot study on 41 patients who received the CDT program with an additional one hour of pneumatic compression therapy and Kinesio tape or short stretch bandages. There was no significant difference in the outcomes between the two groups; both had a reduction in limb size and excess water composition. They found some benefits of using Kinesio tape were a longer wearing time, less difficult to apply, and increased comfort and convenience. They concluded that if patient compliance is poor following one month of short-stretch bandaging, to consider an alternative approach with Kinesio tape. Polska et al77 conducted a study with 25 women with breast cancer and subsequent lymphedema who all received Kinesio tape and followed mastectomy precautions. Measurements taken were volume, muscle strength, and upper extremity active range of motion and were measured pretreatment, at the beginning of each treatment, and posttreatment with a 20-day treatment duration. Results showed lymphedema was reduced by 24%, active range of motion increased 20%, and muscle tension normalized. The mechanism of effectiveness in Kinesio tape is to mimic a pump by lifting the skin to allow more space between the skin and the lymph vessels and open initial lymphatic vessels and drainage. Deeper lymphatic efficiency is improved by allowing maximum contractions and relaxation of muscles. The Kinesio tape channels lymph in a specific direction to increase lymphatic flow. Prior to use, scars should be fully healed.78 Nu Skin Enterprises has an anti-aging galvanic stimulation device that can be useful in conjunction with lymphomyosot gel (Heel Incorporated, Albuquerque, NM); this device improves lymph flow and decreases indurated tissue. In January 2012, Nu Skin Enterprises released an anti-aging body skin care device and product that will additionally stimulate lymph support. Research is available on www.nuskinusa.com. Case studies have been performed using FSM and presented at the 2011 FSM Symposium. Frequency-specific microcurrent reduces inflammatory chemicals in the tissues, improves oxygenation and cellular repair, supports immune function, and increases adenosine triphosphate energy levels up to
500%. Some third-party payers have approved electrical therapy on patients along with CDT. The FlexiTouch has gained popularity with good treatment results for a home program. Opposing recommendations exist for a lymphedema pneumatic compression pump.\textsuperscript{80} Boris et al\textsuperscript{87} reported a risk of genital edema after use of the compression pump on the lower extremity. Using the compression pump on the brawny extremity is contraindicated as it causes extreme pain, unless the tissue is softened prior to use.\textsuperscript{64} Szuba et al\textsuperscript{82} support the intermittent pneumatic compression pump being used for 30 minutes per day for 10 days which enhances an initial reduction volume. They also support use of a CDT program. With contradiective evidence, conduct your own research to make a sound decision for individualized patients. All modalities should be supported with clinical reasoning when choosing your treatment plan.

**PHYSICAL THERAPY LYMPHEDEMA INITIAL EVALUATION**

Follow the guidelines in the *Description for Specialty Practice* to conduct an initial evaluation for lymphedema.\textsuperscript{83} List the patient's complaints and symptoms and the time and incident of the first appearance of swelling in the patient profile. Collect information related to past surgeries, cancer treatment, metastasis, trauma, and potential blockages to the lymphatic system.\textsuperscript{7} Reviewing the past medical history and oncologic history is important in understanding if the patient has primary or secondary lymphedema. This can be done with a patient interview including direct observation, a medical history questionnaire, and lymphedema questionnaire.\textsuperscript{84} The patient's past or current medical history may include the onset of cancer, grade or stage of tumor, medications prescribed with special attention to side effects and fluid imbalances, past medical and surgical history, current treatment plan and complications, the impact of her medical condition on the activities of daily living, and social habits. A multisystem review will analyze the individual physiological response to the disease. Gather information in regards to the impact of surgery, chemotherapy, and radiation treatment in relation to the entire body. Is your patient at risk for osteopenia and loss of bone density, changes in hormone status and menopause with symptoms related to weight gain, vaginal atrophy, fatigue, or cognitive deficits; and is this all related to cancer treatment? Does your patient have swelling in the genitals and does it interfere with sexual activity? Are there co-morbidities such as an arm fracture, or risk fractures or contraindications (ie, congestive heart failure or aortic aneurism), or is she at risk for metastasis? Has she previously received lymphedema treatment, and what is her current maintenance program? What is the coping mechanism for her chronic disease? Many patients are in tears because they thought they had won their battle against cancer and now realize they have a secondary complication due to cancer. Some are very upset with the thought that it will never be completely eliminated requiring daily care to manage their symptoms the rest of their lives. ES was tearful realizing she'd have to bandage her own limbs during the self-care phase. What is the prior and current functional status? Measure functional status pre- and post-therapy using Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH), Shoulder Pain and Disability Index (SPADI), or Upper Extremity Lymphedema and Lower Extremity Function Scale (LEFS), and emotional quality of life with a FACT B+4, for outcome comparisons.\textsuperscript{85} Does the patient require instrumental and activities of daily living assistance in dressing, hygiene, meal preparation, housework, or shopping? Is she handicapped with physical barriers such as opening doors or walking up and down steps? Does she participate in community activities such as church groups? What is her occupation; does she fly often or have a sedentary office position? Does she have a routine exercise program, difficulty with weight management, or does she ambulate with a front wheel walker? Who is part of her support system? Will a loving family member be willing to wash her bandaging daily for her during the treatment program? Does she live alone, does she have stairs in her home, and does she perform her own gardening? Which hand is dominant? What is the patient's health literacy and knowledge base for lymphedema treatment? This information will be helpful in determining the impact of bandages on functional status, reinforcement in skin health precautions, frequency of MLD, and prescribed exercise routine. Lastly, what are the patient's goals and commitment to the treatment program? This information is important in order to design an individualized treatment program to which your patient will be committed. Consider a patient whose cancer disease has progressed to a level not medically treated. Consider providing palliative care to improve her comfort level, and consider providing relief of her symptoms.

A systems review in the evaluation should include the cardiovascular, musculoskeletal, neuromuscular, immune, and integumentary systems. Check the patient's cardiovascular system for heart disease and circulation abnormalities. In the musculoskeletal system, look at the upper extremities for shoulder mechanics such as limited joint mobility, the lower extremities for pelvic girdle mechanics, and any painful regions. In the neuromuscular system, upper or lower motor neuron and reflex integrity deficiencies may be present. Discuss any family history for autoimmune diseases and metastasis in the immune system and cellulitis, skin lesions, hypercarotenosis, papillomas, and fungus, and screen for signs of disease progression in the integumentary system.

Patients who have lymphedema will report symptoms of swelling, heaviness of the limb, increased pressure in the limb with numbness or tingling, fullness, tightness, clothes and jewelry that are tight fitting, restriction in active range of motion, and may have a deepening of natural skin folds; however, the color and temperature are usually normal and pain is normally absent.\textsuperscript{2,12,13} If pain is present, consider a comorbidity of chronic venous insufficiency or nerve compression. Excess heat and pressure will exacerbate symptoms and should be avoided.
Examples include a hot tub, sunburns, infection, exercise to the level of pain, blood pressure measurements on the affected limb, and restrictive jewelry and clothing. It is important to understand lymphatic physiology to educate your patient regarding susceptibility to skin infections and impaired wound healing.86

There are many diagnoses that look like lymphedema requiring that you differentiate between the two. Differential diagnosis may include lipedema, acute trauma, surgery, recurrent or metastatic disease, thrombophlebitis, deep vein thrombosis, arterial insufficiency, congestive heart failure, chronic venous insufficiency, venous stasis, and varicose veins. Determine which disease is actually involved by reviewing signs and symptoms. Lipedema is bilateral from the ankles to the pelvis with symmetrical fatty deposits. Swelling from trauma or surgery normally resolves in 6 to 8 weeks. Recurrent or metastatic growth can block lymph flow and worsen lymphedema; these are the patients who don’t improve with CDT. Screen for signs of disease progression or infections. A cancer staging system known as “TNM” describes the extent of the cancer in the body, size and extension of the primary tumor, lymphatic involvement, and metastasis of cancer. The “T” describes the size of the tumor and its involvement to nearby tissue, “N” describes the regional lymph nodes involved, “M” describes metastasis to another body region. Thrombophlebitis occurs when a blood clot causes swelling in a superficial vein, typically in the lower extremities; if it is deep it is called deep vein thrombosis. The painful region will be tender, warm, red, and swollen. If you suspect thrombophlebitis or deep vein thrombosis this is a red flag requiring medical attention. Consult with the patient’s physician regarding resuming CDT. An insufficient amount of blood flow in the arteries is known as arterial insufficiency and needs to be ruled out if the patient’s limb is cold, pale, or has cold sensitivity and stiffness.64 Congestive heart failure is a condition where the heart is unable to pump enough blood to the other organs and can cause an overload from shifts in fluid balance on the cardiovascular system.87 Obtain authorization from the patient’s physician prior to performing CDT. Chronic venous insufficiency causes blood to pool in the lower extremities resisting the return of blood back to the heart; symptoms would involve leg pain, skin discolorations, possibly with a brawny edema, and leg ulcers with potential infections and void of fibrosis.88 Effective patient treatment for chronic venous insufficiency is CDT. Varicose veins have valves that do not function properly, therefore allowing blood to pool in the veins. Veins are enlarged with mild swelling and brown skin discoloration at the ankles; sometimes there is pain associated with the swelling.89 Venous stasis is a build-up of fluid under the skin from a poorly functioning venous system where a wound or ulcer can occur.

Physical Therapy Initial Evaluation

- Patient profile
- Medical history
- Co-morbidities, vital signs
- Cardiovascular system
- Musculoskeletal system
- Neurovascular system
- Immune system
- TNM classification of malignant tumors
  - Integumentary system

- Differential diagnosis and referrals
- Contraindications and precautions
- Coping mechanism
- Functional status
  - DASH, SPADI, LEFS, Fact B+4, IADL, ADL
  - Assistive devices, physical barriers
- Quality of life
  - Community, vocational, exercise
  - Body mass index, support system
- Patient’s goals and commitment to program

The objective data includes tests and measures related to the patient’s diagnosis. Inspect, palpate, measure, and rate the patients’ skin observing her skin integrity, skin mobility, scar tissue, adhesions, color, elasticity, sensory status, and edema status. Is the skin fibrous or brawny, soft, smooth and flexible, rigid or raised? Assess the thickness of the skin fold at the base of the second toe or finger. If you are unable to lift the skin, your patient has a positive stemmer’s sign; however, if it is negative, it does not rule out lymphedema.

Observe breast tissue skin integrity for scar tissue and determine if mobilizing lymph fluid across the anterior trunk would be effective. If lymphedema is related to the pelvis, either from cancer treatment, surgery, or trauma, inspect the pelvis to determine tissue integrity of the inguinal lymph node groups and abdomen. Also, with permission from the patient, palpate and inspect genital swelling. Some patients have adhesions in the abdomen that block the flow of lymph back to the thoracic duct. Will another pathway for lymphatic flow need to be developed?

Measure edema involvement with a tape measure to record girth and volume. With the patient in a supine position, record the circumference in bilateral limbs every 5 cm in the upper extremity and every 10 cm in the lower extremity with the same amount of tautness for each patient’s tissue. In a conversation with D.P. Hickman and R.N. Chasse (2009), it was stated that the most appropriate mathematical formula to use for the volume of a limb is the volume of a cone, \( V = \frac{1}{3} \pi r^2 h \). The volume equals \( \pi \) times the radius of the base squared times the height divided by 3 to calculate segmental differences. This allows a measurement and the ability to estimate progress. Stages 0, 1, 2, and 3 were described in the medical diagnosis section. Classification of lymphedema is determined by the difference of a normal limb girth compared to the involved limb: a 2.0 cm or 200 mL difference in girth and volume is indicative of lymphedema or with a 10% girth volume difference.90,91 Volume is most effectively measured with water displacement; however, this would require access to warm water for filling and the facilities for emptying and cleaning.
Edema and fibrotic tissue can interfere with active and passive range of motion in the adjacent joints; likewise, the impaired active range of motion can interfere with the muscle joint pump and its relationship with lymphatic flow. Assess scapulohumeral rhythm, glenohumeral joint restrictions, and cervical spine restrictions for upper extremity involvement. Assess pelvis, hip, knee, and ankle mobility for the lower extremity. Upper extremity strength can be measured with a dynamometer. Take a digital photograph of the patient's limb at the initial evaluation and upon completion of treatment. Other relevant data includes vital signs, body mass index, pain, posture, and gait assessments. Limb circumference and lymphedema status improved significantly when patients followed a weight loss program during their lymphedema treatment. Calculate the patient's body mass index by weight in kilograms divided by height in meters squared. Progress will encourage the patient to follow a weight management program and reveal her commitment to managing her disease process.\(^9^2\)

Pain symptoms are seldom directly related to lymphedema; however, the patient may have joint pain or functional limitations due to a heavy limb and can be measured using the visual analog scale. Further, assess postural alignment and connective tissue associations with the kinematic chain. Assess the heaviness of the lower extremity during the swing phase of gait. What are the gait impairments on uneven surfaces with and without assistive devices? Collecting objective data will improve the development of an individualized treatment program, motivate the patient and support the need for lymphedema treatment to the third party payer.

Impairments list\(^8^3\):
- Impaired sensation and pain level
- Impaired skin integrity
- Connective tissue dysfunction
- Increased girth and volume
- Lymphedema staging and classification
- Active and passive range of motion
- Posture and gait
- Limb photographs

Risk Management
Reduce potential causes of malpractice with risk management. Document informed consent and commitment to the treatment program, explain treatment procedures, and measure quality outcomes with questionnaires and volume measurements.

The treatment rationale identifies your choice in the treatment plan for your individual patient. Describe the impairment of the affected limb and its relationship to the flexibility of the kinematic chain. List the relationship between injuries, surgical and medical procedures, and the current diagnosis. What caused damage to the lymph vessels or lymph nodes? State the stage, classification, and extent of fibrosis. Detail the significance of the contraindications, precautions, or complications that may interfere with treatment and additional interventions that you recommend using. Outline the risks involved if the patient does not receive treatment and then list the benefits. Expected outcomes of treatment are to restore elasticity and reduce integumentary scarring; improve pressure system function in the thorax, abdomen, and pelvis; transport lymphatic drainage from the nonfunctional region to a functional region; increase reabsorption of protein-rich fluid at the cellular level; remove cellular waste; promote healing; and strengthen the immune system. Short stretch bandaging will decrease the ultrafiltration rate, improve the muscle joint pump, break down indurated tissue, and prevent re-accumulation of fluid.

Supplies
Durable medical equipment required for the CDT program should be included, such as short stretch bandages, fitting for garment and compression grade, 2 compression garments to be replaced every 3 months, Kinesio tape, assistive devices, and a post-op boot if needed for the lower extremity. Educate yourself on a variety of suppliers to determine all of those who will best support your program.

Frequency and Duration
Determine the number of visits and length of time required to meet your goals. Standard care based on outcome measures is treatment 5 days per week, for approximately one hour per treatment depending on the severity of lymphedema. Training a family member is a great way to offer more treatment during a limited session. Duration for mild lymphedema is minimally two weeks depending on severity and complications.

Cultural Considerations
Consider cultural and ethnic differences in your treatment program. Based on a woman's sexuality, health, body image, culture, and religion, the patient may request a female physical therapist. Show respect to all patients with your intention and touch, as well as draping for privacy. Muslim women have standards of modesty with a religious belief that women should dress to preserve modesty and be covered from neck to feet.\(^9^3\) They would prefer to avoid medical care than risk embarrassment and humiliation that someone other than their husband would see them uncovered. Based on a questionnaire survey of lesbians in Fraser Valley, most lesbians prefer a female family doctor and would prefer to disclose their sexual orientation without fear of lower quality health care.\(^9^4\) It is important to diagnose cancer early in the disease process; however, there is disparity among early detection and ethnicity. Lantz et al\(^9^5\) investigated the relationship between race, ethnicity, individual socioeconomic status, and the stage breast cancer was diagnosed. Women in a lower socioeconomic group were more likely to be diagnosed at advanced stages of cancer. This study included 1700 white, black, and Hispanic women with stage 0 to 3 breast cancer from the Detroit and Los Angeles area and concluded that black and Hispanic
women were less likely to be diagnosed with early stage breast cancer. In 1998 “The Women’s Health and Cancer Act” required that health plans had to make certain benefits available to those undergoing mastectomy; it included reconstruction surgery for breast symmetry, prostheses, and treatment of physical complications including lymphedema. This bill was very beneficial in promoting treatment and requiring health maintenance organization coverage for lymphedema patients who were not receiving care. A new bill, HR 4662, was introduced in 2010 with intentions to amend the Social Security Act. This lymphedema treatment act will offer CDT to anyone with lymphedema related to any cause. The purpose is to reduce health care costs related to patient treatment for cellulitis. The new law will also provide patients with the supplies needed for the self-care phase. In addition, it will qualify therapists treating lymphedema for a uniform coding and established fee schedule. Lymphedema has an emotional impact on a patient’s lifestyle from finding clothes that fit, to loss of self-esteem, to anxiety related to availability of treatment; and this may also decrease her activity level. Cultural, ethnic, and socioeconomic medical differences have influenced greater awareness to politicians and practitioners; let us all continue to strive for optimal health care solutions available to all people.

CASE EXAMPLE

Patient’s Name: MK
Diagnosis: Lymphedema
Medical History: Lymphedema began at 13 years old. Congenital dysplasia of hip, casted during infancy. Gravida 2, para 2, abortus 0. Three episodes of left lower extremity cellulitis.
Social History: 35-year-old female, elementary school teacher, active in the community. Spouse travels frequently.
Past Lymphedema Treatment History: Diuretics and compression pump.
Patient Profile: Stage 3 primary lymphedema, left is more severe. MK’s lymphedema worsened during her two pregnancies. She is currently on a weight loss program involving diet and exercise (Figures 14 and 15).
Objective Measures:
• Signs and symptoms: swelling, fibrosis, loss of mobility, previous skin infections, heaviness, hyperkeratosis, and lobular folds.
• Volume measurements: 23,254 cu cm, left lower extremity.
• Obesity: height is 5’10”, weight is 250 pounds.
Patient’s Goals: She is committed to decreasing her limb size in her left lower extremity.
Physical Therapy Diagnosis: Stage 3, primary lower extremity lymphedema.
Short-term Goals: Increase lymphatic fluid dynamics.
Long-term Goals: Decrease limb size and restore connective tissue flexibility. Patient to be measured and fit for a compression garment (Figure 16).
Assessment: Physical therapy treatment will re-educate the neuromuscular lymph angion to improve lymph flow and direction; support negative pressure above the diaphragm and positive pressure below the diaphragm to increase lymphatic dynamics in the thoracic duct. Complete decongestive therapy will reduce connective tissue scarring, decrease risk for cellulitis, improve filtration and absorption at the capillary bed, and decrease left lower extremity limb volume.
Treatment Plan of Care: Two-phase CDT involving patient education in skin care to prevent infections, MLD, com-
pression bandaging, therapeutic exercise for limb clearance, compression pantyhose for day time compression, JoVi Pak night time compression, independence in self MLD, and follow-up visits every 6 months.

**Frequency and Duration:** 5 days per week for 6 weeks.

**Treatment Results:** Left limb volume decrease 54%, fibrotic tissue softened (Figure 17).

**RESEARCH SUPPORT**

Complete decongestive therapy for an average of 15.7 days is a highly effective treatment program for primary and secondary lymphedema. Compliance to the initial treatment phase without complications can yield an average limb reduction of 59.1% in the upper extremity and 67.7% in the lower extremity. Compliance with the home program yielded 90% improvement in maintenance. Early intervention improves prognosis by 26%.

**Prognosis** is determined by medical history, past surgeries, complications, lymphedema severity, metastasis, current lifestyle, and commitment. Progress is improved with MLD, compression bandaging, and compression garments compared to compression garments alone. Badger et al conducted a randomized, controlled, parallel-group clinical trial of 90 upper and lower extremity lymphedema patients comparing multilayer bandaging for 18 days followed by 24 weeks of a compression garment compared to a compression garment alone. Results were in favor of the short stretch bandaging followed by compression garments; 31% compared to garments alone at 15.8%. Low-intensity exercise does not exacerbate symptoms of lymphedema. Johansson et al conducted research testing the effects between low-intensity resistance exercise with weights for breast cancer patients with arm lymphedema, with or without a compression sleeve. Thirty-one breast cancer patients with small or moderate axillary lymphedema participated in a study with a specially designed arm exercise program with and without a compression garment on different days and in randomized order. Total arm volume increased immediately after exercise in both groups; however, after 24 hours volume did not increase compared to pre-exercise measurements. Results showed that low-intensity exercises can be performed by patients with arm lymphedema with or without the compression garment and without fear of the lymphedema worsening. Also noted, these patients would benefit from wearing the compression garment regularly. Ahmed et al conducted a randomized controlled trial of 45 breast cancer survivors, of whom 13 women had prevalent lymphedema at baseline. Participants were 4 to 36 months posttreatment and participated in a study of weight training and lymphedema in breast cancer survivors. The intervention consisted of weight training twice a week for a period of 6 months. Lymphedema was circumferentially measured at baseline and at 6 months and additionally by self-report of symptoms and clinical diagnosis. None of the participants experienced a change in arm circumferences greater than 2.0 cm after a 6-month exercise intervention.

Fifty women with lymphedema participated in a 4-week program of MLD and compression therapy or compression therapy alone. Research has shown there was an increased reduction in the group with MLD and compression therapy compared to compression therapy alone. Manual lymph drainage with compression ther-
therapy has been compared to compression therapy alone in a randomized controlled trial for breast cancer-related lymphedema.103

Initial volume amount is the key to a responsive reduction in limb volume following CDT. Ramos et al101 conducted a study of 69 females with lymphedema whose initial volume was less than 250 ml in the upper extremity compared to those with 250 ml to 500 ml volume. Research shows that those with an initial volume of 250 ml had a greater reduction of 78% compared to only a 56% reduction in those with an initial volume of 250 ml to 500 ml. Japan had not traditionally used the CDT two-phase treatment program. A hospital study was completed in 2006 consisting of 82 Japanese women with lymphedema; 27 participants had secondary lymphedema of the upper extremity, 55 had secondary lymphedema, and 3 had primary lymphedema of the lower extremity. Volume was calculated by circumference $V = \frac{\pi}{12} (C_2 + C_C + c_2)$. The duration for upper extremity treatment was 3 to 26 days with a median of 6 days, and the duration for the lower extremity was 2 to 35 days with a median of 10 days. The treatment reduction in the upper extremity was 58.9%, 328.7 ml, and in the lower extremity the reduction was 73.9%, 1573.7 ml. During the treatment program, no one developed cellulitis. The CDT two-phase treatment program on Japanese women with lymphedema was effective.105

**Goals and procedural intervention** consist of a frequency of 5 days per week and a duration of 4 to 8 weeks depending on lymphedema severity. Patients will see an improvement in the following: skin integrity; cosmesis; fibrosis and lobular folds will minimize and soften; hydration and circulation will increase; postural and limb functional mobility will be more efficient; and girth and volume will decrease between 25% and 78% depending on length of program and prognosis. As a personal example, I took a final photograph for the discharge of a patient with primary lymphedema; she began to cry when she saw the look on my face when I compared the pre- and post-pictures. She was very appreciative and thankful for the improved quality of life. Preparing the patient for the self-care phase is normally initiated at the beginning of the treatment phase. I continually ask for return demonstrations on tasks given from the previous treatment with ongoing discussion of patient self-care. Towards the end of the treatment phase, measure the patient for a compression garment. Patients or caregivers will demonstrate independence in skin health awareness, home exercise program, self or caregiver bandaging, self or caregiver MLD, and donning and doffing the compression garment. The *procedural intervention* will include an explanation of the procedure, an informed consent, an efficient pathway for lymph transport, contraindications and precautions to be observed, proper fit of compression therapy with precautions, patient referral with a multidisciplinary approach, limb clearance exercise program for low-intensity and high-intensity exercise, education in skin health, medical awareness, and self and caregiver care for lymphedema management. Complete decongestive therapy is an effective treatment method for lymphedema.43

**CLOSING COMMENTS**

The home study module you have just completed has taken you through a patient case study, the anatomy and physiology of lymphedema, the history of lymphedema, diagnosing lymphedema, CDT, lymphedema physical therapy evaluation, and lymphedema research. The information provided in each section will help guide you in knowledgeable clinical decision making for lymphedema patients. As women's health clinical specialists, health care providers, and educators, it is our responsibility to learn about treatment available for a variety of diagnoses as it is related to women's health specialty. Patients not only rely on their health care practitioner's knowledge and experience but also increase their awareness with easy access to the Internet and media. Organizations such as the National Lymphedema Network and the Lymphology Association of North America are informative and educational for patients as well as practitioners. The information provided in this home study module is to be used for creating an individualized treatment program with optimal results.

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**REFERENCES**


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