

Lymphedema

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Overview

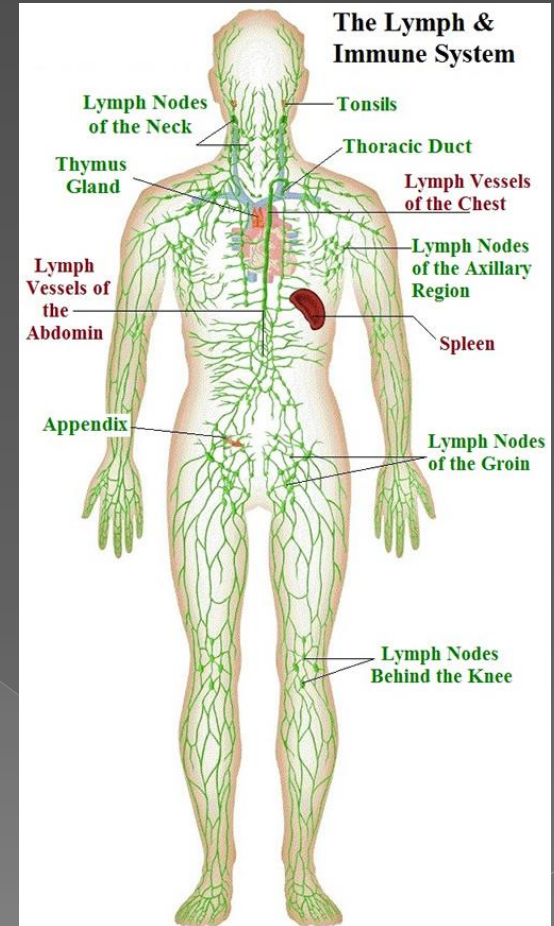
- Anatomy and Physiology of the Lymphatic System
- Lymphedema Definition
- Complete Decongestive Therapy (CDT)
- Bandaging
- Exercise
- Skin and Self Care
- Compression Garments

Incidence of Lymphedema

- Hayes et al. examined 247 women who were recently diagnosed with invasive breast cancer and found **33%** had lymphedema, **40%** had long-term lymphedema.
- Systematic review by Disipio et al. found that more than **1/5** women who survive breast cancer will develop arm lymphedema.

Components of the Lymphatic System

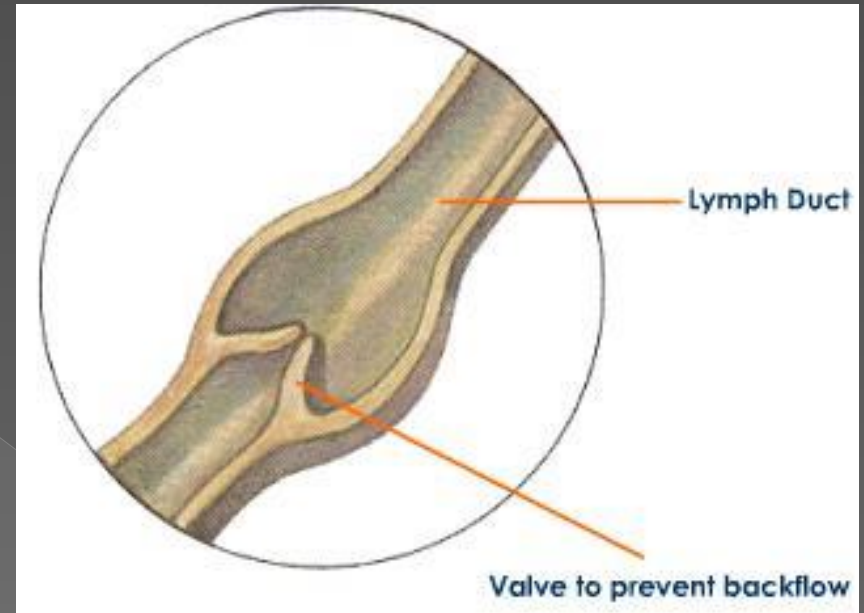
- Lymph Vessels (Collectors)
- Lymph Nodes
- Spleen
- Thymus Gland
- Tonsils
- Lymphocytes
- Peyer's patches



Taken from:
<http://www.getwellnatural.com/lymph-cleanse-herbal.aspx>

Function of the Lymphatic System

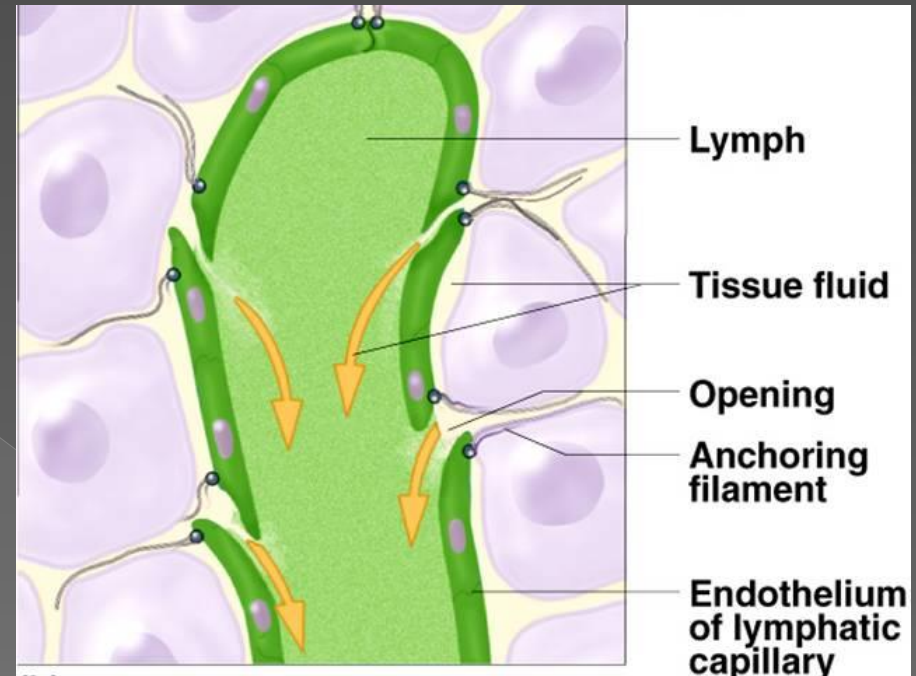
- Returns Protein and water from the interstitium to the cardiovascular system.
- Intestinal lymph absorbs protein, fat and fat-soluble vitamins (chyle)
- Recognizes and responds to foreign cells (Immune defense)



<http://www.tutorvista.com/content/biology/biology-iv/circulation-animals/lymphatic-system.php>

Lymph Capillaries

- Larger than blood capillaries
- Located close to blood capillaries
- Have a wall made of flat endothelial cells that overlap
- Do contain one-way valves
- Larger diameter



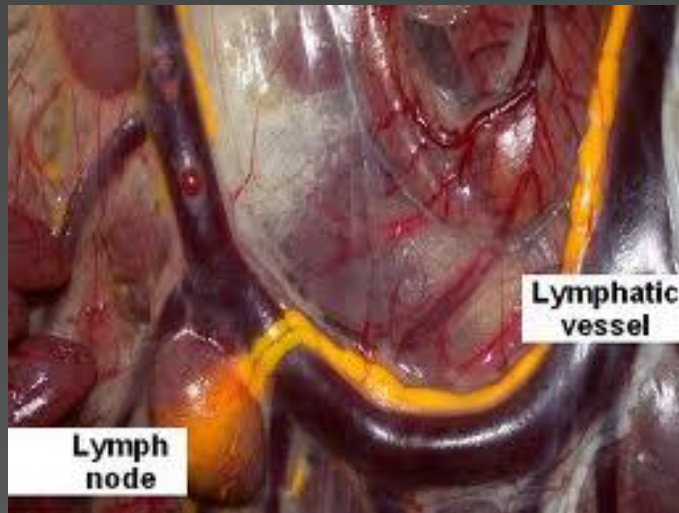
<http://www.altamontemobilemassage.com/lymphatic-drainage.htm>

“LYMPH-ANGIO-ACTIVITY”

Intrinsic contractility of the lymph vessels.

At the extremities the lymph fluid is transported from distal to proximal by collectors that run more or less parallel to the arms and legs.

Lymph transport can be effected by: contraction of skeletal muscle, arterial pulsation, manual lymph drainage, respiratory pressure changes etc.

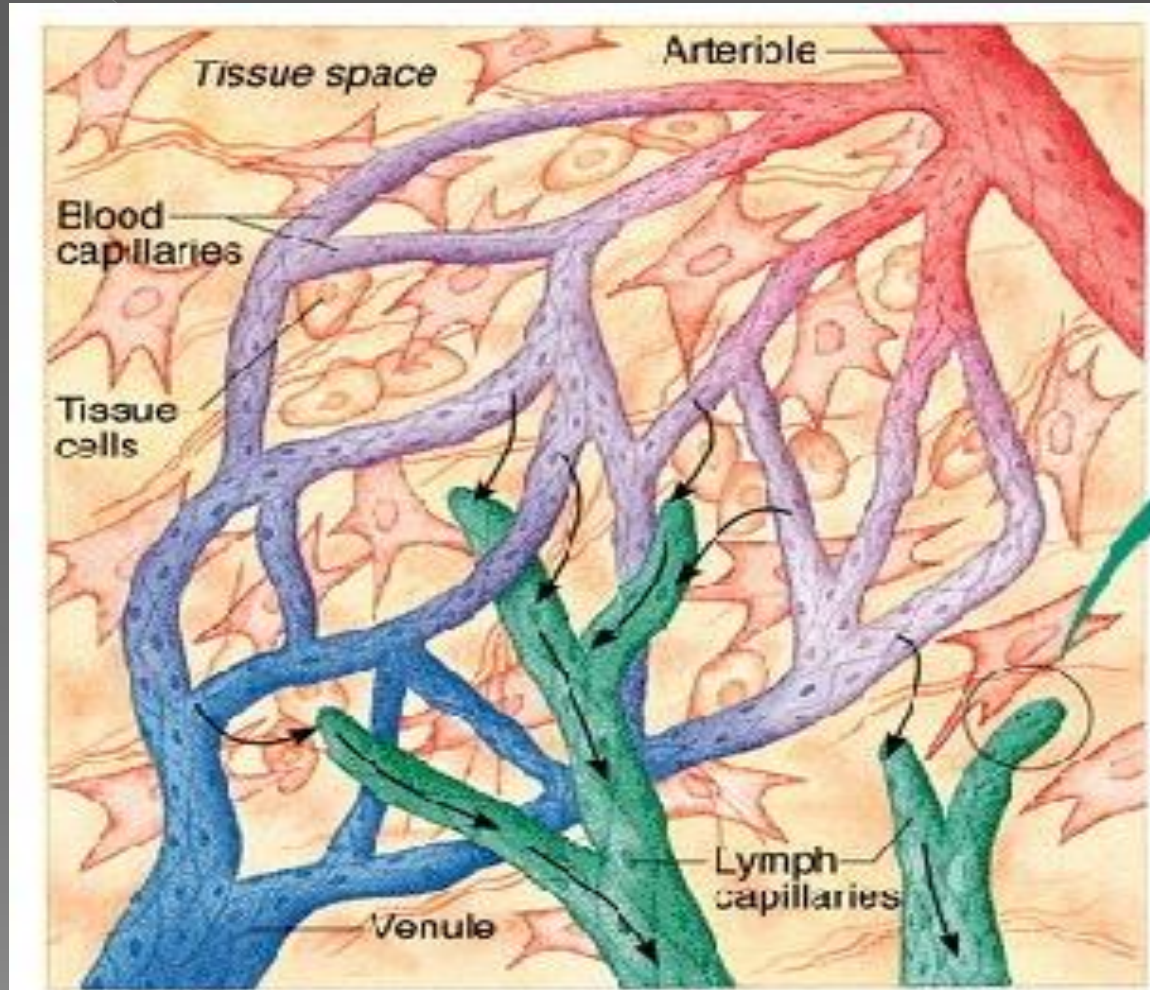


<http://www.lymphovenous-canada.ca/research.htm>



http://www.realbodywork.com/articles/lymphatic_article.html

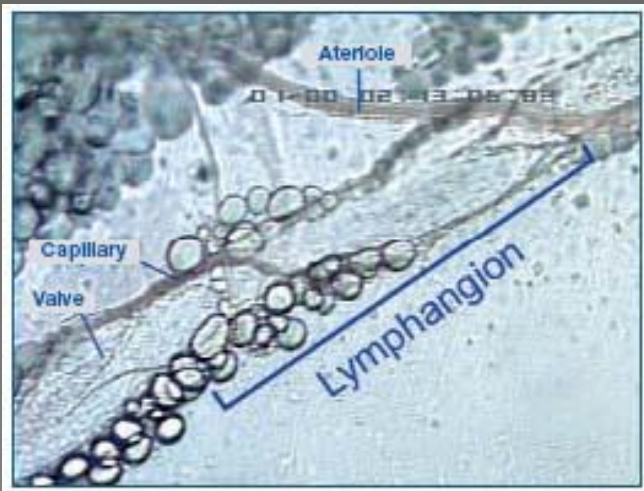
Lymphatics vs. Circulatory



Lymphagion

- Smallest functional unit of the lymph collector. (“little heart”)
- Autonomic NS innervation
- Intrinsic contractions = 6-10x/min (2-2.5L/day)

- Extrinsic Factors:
 - > Breathing
 - > Muscle Movement
 - > Pulsation of arteries
 - > Negative pressure in central veins
 - > External compression (MLD)
 - > *Like the heart, lymphagions respond to an increased load (Starlings Law)

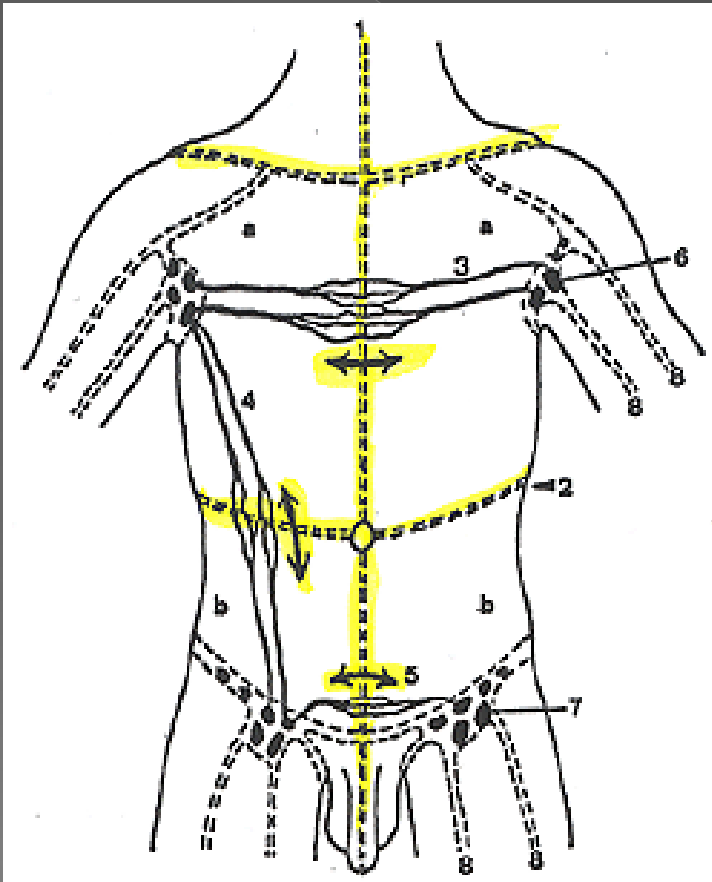


Physiology and Pathophysiology of the Lymphatic System

Starling Equilibrium for Capillary Exchange:

“E.H. Starling pointed out a century ago that under normal conditions, a state of near-equilibrium exists at the capillary membrane. That is, the amount of fluid filtering outward from the arterial ends of capillaries equals almost exactly the fluid returned to the circulation by absorption. The slight disequilibrium that does occur accounts for the small amount of fluid that is eventually returned by way of the lymphatics.”

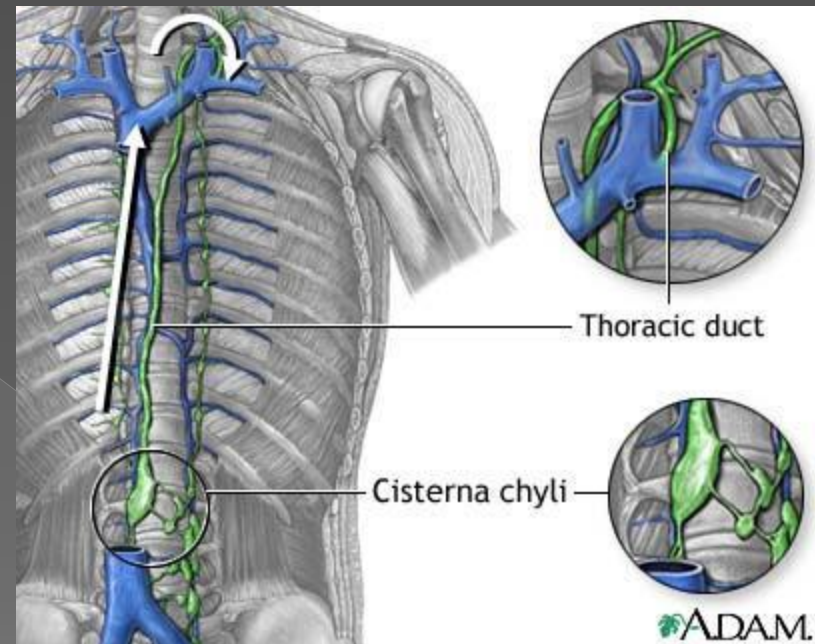
Lymphatic Watersheds and Anastomosis



- Separate tributary regions
- Important Watersheds:
 - > Median-sagittal
 - > Transverse
 - > Clavicle
 - > Spine of the scapula
 - > Chaps (gluteal)

Lymphatic Trunks and Ducts

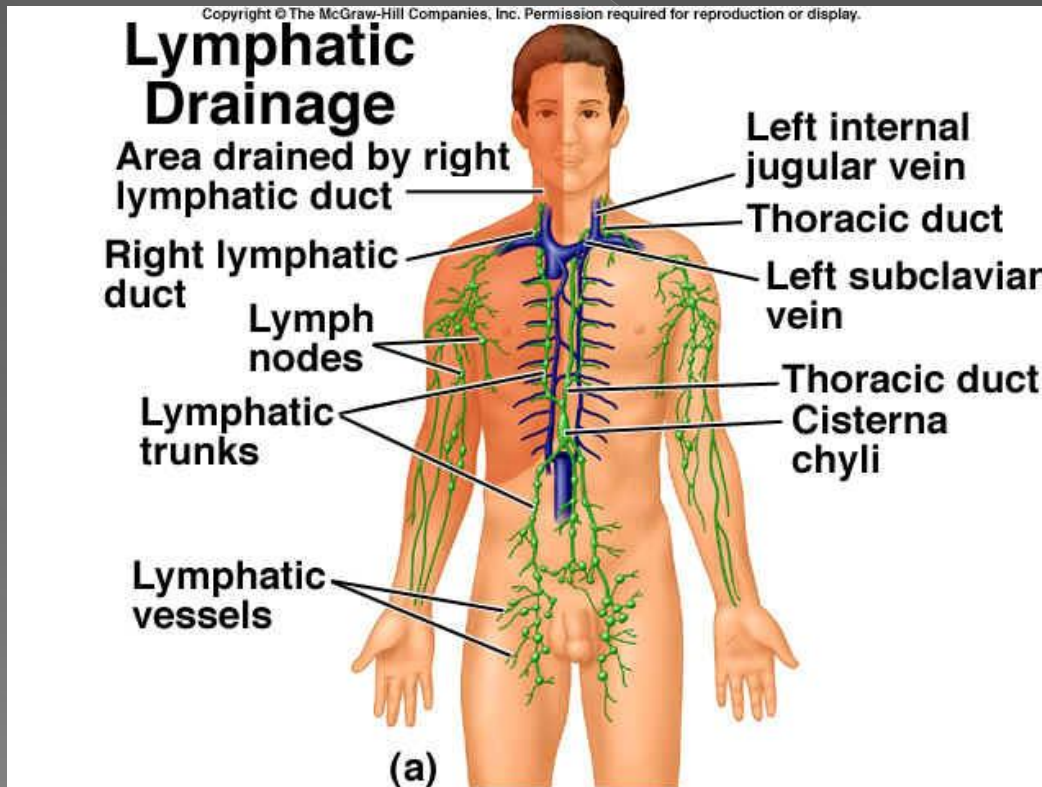
- Trunks collect fluid from organs, extremities and related quadrants of the trunk
- Ducts empty into the venous side of the blood circulation
- Largest lymph vessel: Thoracic Duct (40cm long!)



<http://faculty.ccri.edu/kamontgomery/anatomy%20lymphatic.htm>

Thoracic duct drains ~ $\frac{3}{4}$ of the body's lymph into the left venous angle (subclavian vein)

The right lymphatic duct drains ~ $\frac{1}{4}$ into the right venous angle (subclavian vein)

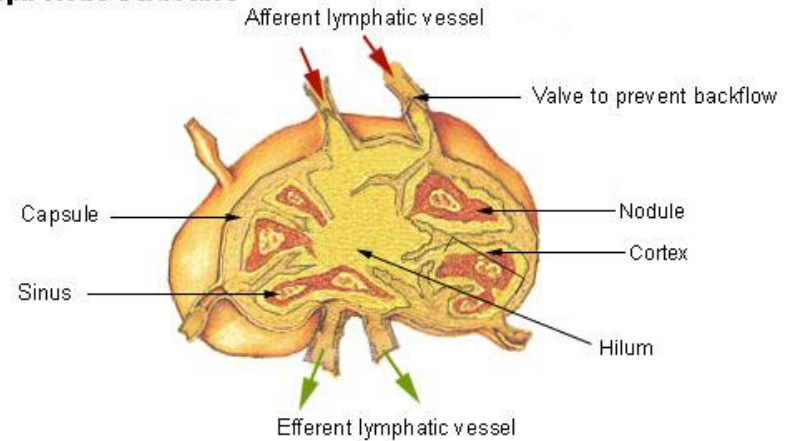


Lymph Fluid consists of:
Proteins, Water, Cells,
Waste Products, Fat

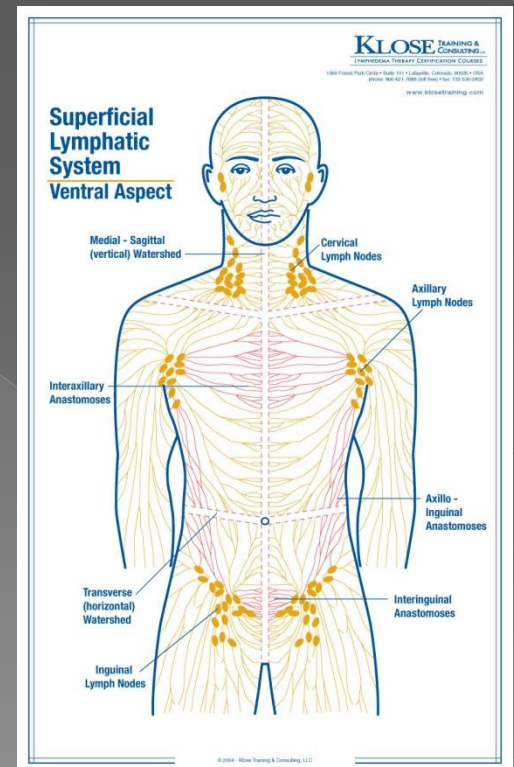
Lymph Nodes

- 600-700 in the human body
- Functions:
 - Filtering stations for noxious matter
 - Produce lymphocytes
 - Regulate concentration of protein

Lymph Node Structure



http://en.wikipedia.org/wiki/Hilum_of_lymph_node



http://www.stepup-speakout.org/manual_lymphatic_drainage_massage_lymphedema.htm

Comparison

Lymph Flow

- One way
- 1-2 liters/day
- Intrinsic contractions
- Obstruction leads to high protein fluid
- Long latency period between injury and clinical appearance
- Fluid is filtered by lymph nodes

Blood Flow

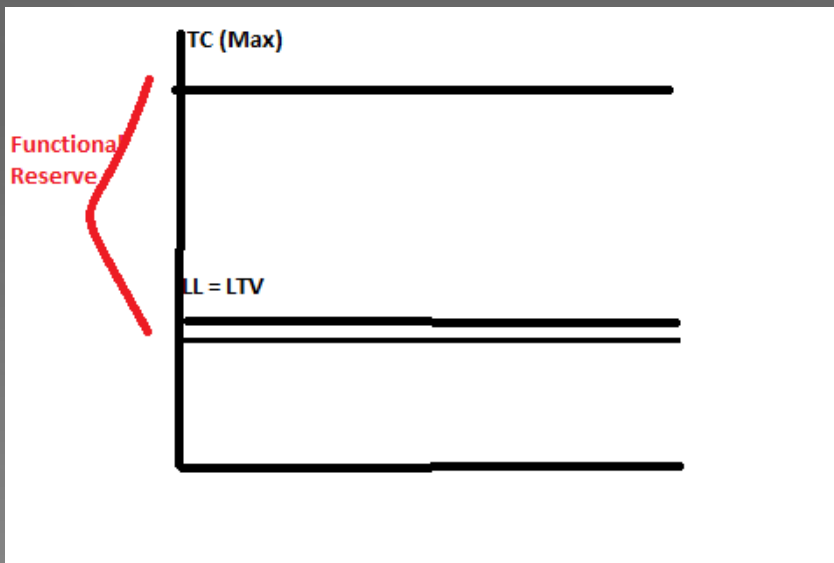
- 6-10 liters/hour
- Separate pump (heart)
- Obstruction leads to collect of low protein fluid
- Brief latency period between injury and clinical appearance

References:

Foeldi: Textbook of Lymphology. 2nd edition, 2006. Chapter 1; Anatomy of the Lymphatic System.

Lymphatic Load

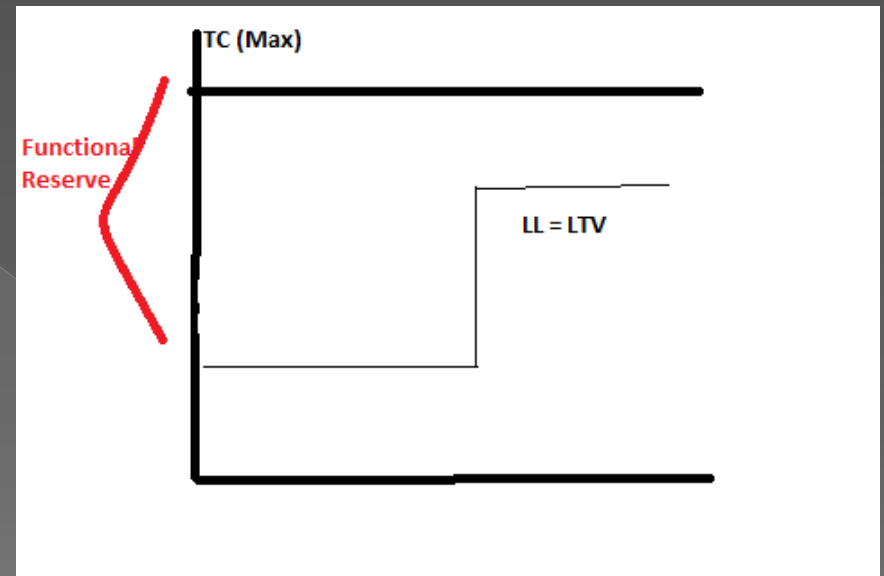
- The amount of substances that have to be removed from the interstitium to the lymphatic system



- Lymph Time Volume (LTV): amount of lymph which is transported in a unit of time.
- Transport capacity (TC): is equal to the maximum lymph time volume.
- *LTV is ~10% of the max TC* (Has a great functional reserve)

No Edema

- Lymph Vessels react to an increase in load with an increase in lymph time volume (LTV).
- Use more of the functional reserve



What Can Increase Lymphatic Load?

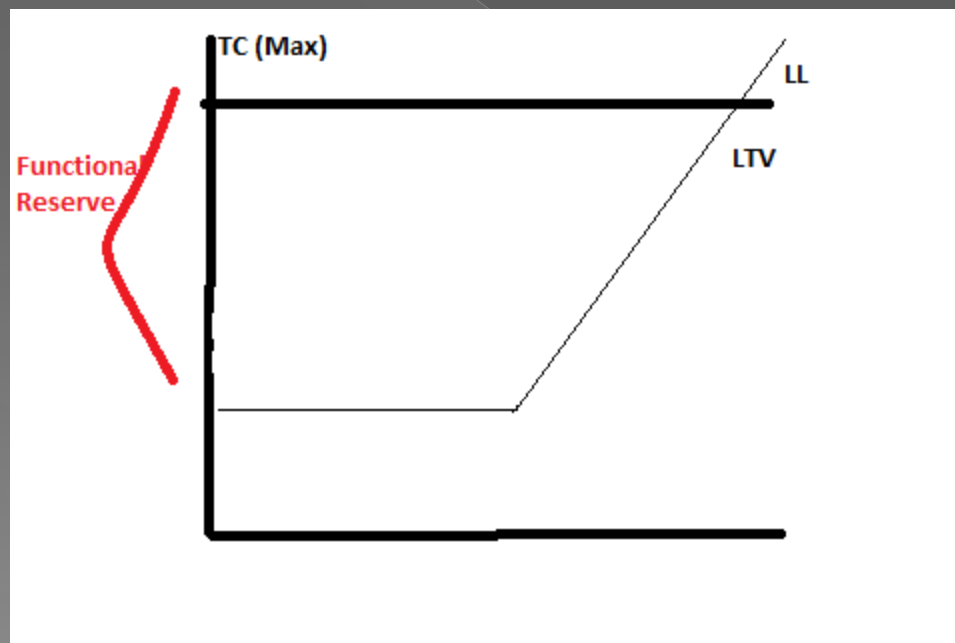
Active Hyperemia: dilation of pre-capillary arteriole-blood flow increases-blood capillary pressure increases-filtration increases-lymphatic load increases (Ex: inflammation, heat, infection)

Passive Hyperemia: obstruction of venous return-blood backs up-blood capillary pressure increases-filtration increases-lymphatic load increases (Ex: DVT, CHF, CVI)

Hypoproteinemia: decreased plasma protein concentration-reduced absorption in venous capillaries-increased lymphatic load (Ex: malnutrition, nephritic syndrome)

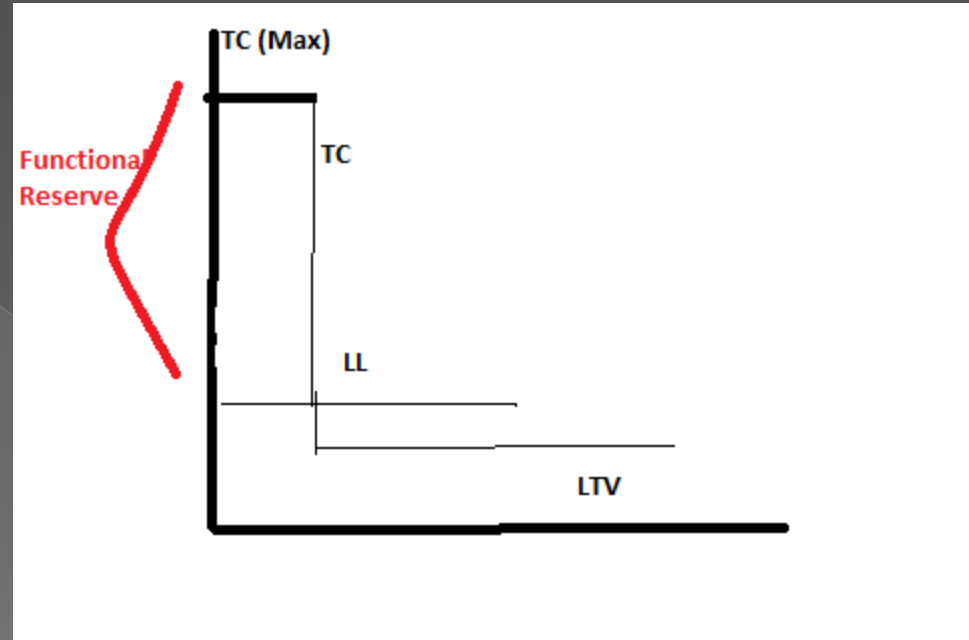
Insufficiencies

- High Output Failure: Lymphatic Load exceeds the TC of a healthy system. Result = edema (Ex: DVT)

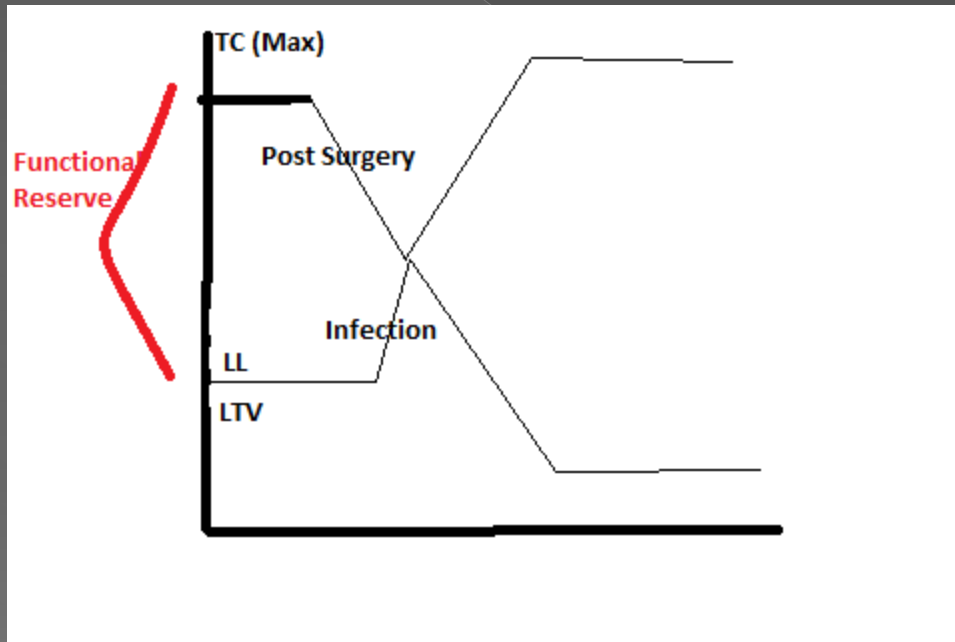


Low Output Failure

- TC drops below the physiological lymph load due to organic or functional causes. Result is lymphedema. (Ex: axillary node dissection, radiation treatment, severe burn injury)



Combined Lymphatic Insufficiency



- Lymphatic system is impaired, TC is reduced AND LL is higher than normal. (Ex: trauma, post surgical)

References

Despopoulos & Silbernagl; Color Atlas of Physiology, 1991. Chapter of heart and Circulation, pgs. 154-191.

Gylton & Hall; Textbook of Medical Physiology, 10th edition, 2000. Chapter 16; The microcirculation and the lymphatic system: Capillary Fluid Exchange, Interstitial Fluid and lymph flow.

Foeldi; Textbook of Lymphology; 2nd edition, 2006. Chapter 2; Terminal vascular, interstitial connect tissue, lymph capillaries and precollectors. Chapter 4; Physiology and pathphysiology of the lymphatic system.

What is Lymphedema?

Abnormal accumulation of protein-rich fluid in the interstitium which usually causes chronic inflammation and reactive fibrosis of the affected tissues.



<http://senselesshousewife.blogspot.com/p/lymph-edema.html>

Comparison

Lymphedema

- Disease (ICD-9 Code)
- High protein fluid
- Increased risk for infection
- Chronic

Edema

- Symptom
- Fluid accumulation in extracellular space
- After successful treatment of underlying cause, resolution is expected
- Ex: Ankle sprain, CHF

Lymphedema Classification

- Primary or Secondary
- Pure Lymphedema or Combination Forms
- Stages 0-III

Anatomic Locations: extremities, head/neck, intestinal and genital



<http://www.lymphedemablog.com/2012/05/11/secondary-lymphedema-of-the-head-and-neck/>



<http://www.nwlymphedemacenter.org/whatislymph.htm>



<http://www.lymphedemablog.com/2010/09/27/review-of-currently-available-treatment-modalities-for-lymphedema/>

Primary Lymphedema

- Imperfect development of lymph vascular system (aplasia, hypoplasia, hyperplasia)
- Abnormal at birth vs. degenerative progress
- Sporadic or Hereditary
- Female > Male (10:1)
- Congenital: present at birth or soon after
- Praecox: (80%): occurs before age 35, often at puberty
- Tardum: After age 35



21 Year Old with Primary Lymphedema

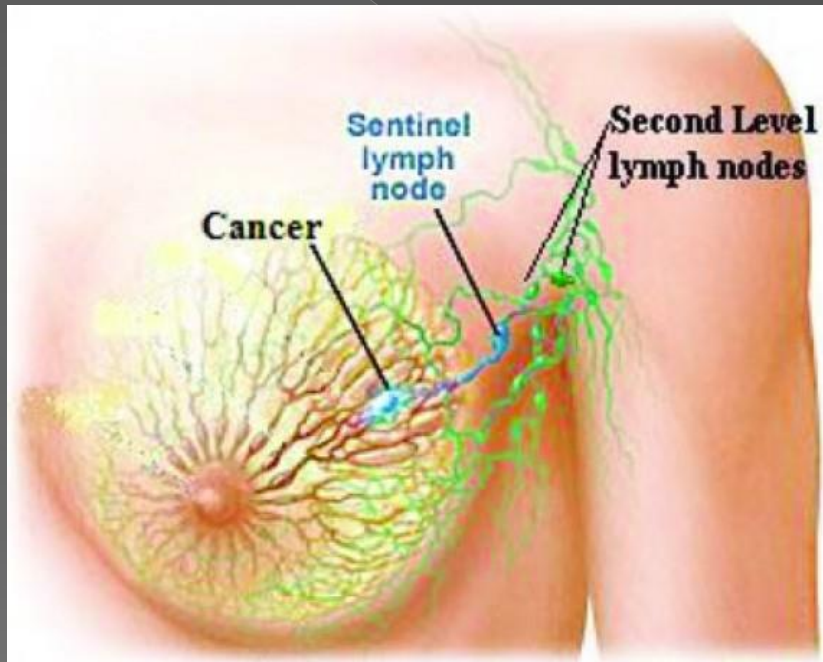


Associated Abnormalities with Primary Lymphedema

- ◉ Distichiasis (double row of eyelashes)
- ◉ Yellow nails (all over swelling and pleural effusions)
- ◉ Vertebral abnormalities
- ◉ Hearing loss
- ◉ Cleft palate



Secondary Lymphedema



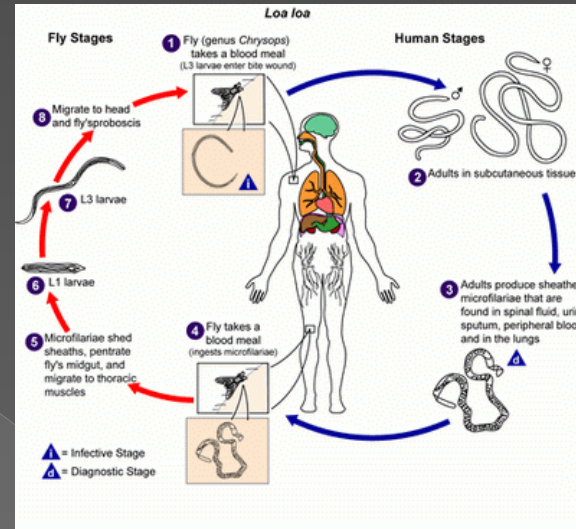
<http://lymphedemaclinics.com/secondary-lymphedema-symptoms/>

- Filariasis
- Surgery and/or Radiation for cancer
- Cancer (Malignant)
- Trauma
- Infection
- C.V.I.
- Obesity
- Self Induced (Fictitious)

* Most common form of secondary lymphedema in the U.S. is breast cancer and it's treatment.*

Parasitic Lymphedema

- Mosquito transmission
- Adult worm-inflammation and fibrosis- obstruction - elephantiasis
- Treatment: Ivermectin, diethylcarbamazine
- Eradicated in the U.S.



http://www.medicallook.com/diseases_images/Filariasis.gif



<http://diseasespictures.com/wp-content/uploads/2012/07/Lymphatic-Filariasis-3.jpg>

How is Lymphedema Diagnosed?

- Physical Exam
- History
- Stemmers sign
- Soft tissue imaging
- Measures in volume
- Changes in electrical conductance



Taken from: <http://presentwoc.com/ezines/view/12-Is-it-Chronic-Venous-Insufficiency-or-Lymphedema/13>



Stages

- ◉ **Stage 0 (Latency):** no visible changes, no edema. Patient reports “fullness or heaviness” feeling in limb. Patient is at risk for lymphedema.
- ◉ **Stage 1 (Reversible):** visible swelling, responds to elevation
- ◉ **Stage 2 (Spontaneously Irreversible):** Visible, chronic swelling, fibrosis, elevation not very effective.
- ◉ **Stage 3 (Lymphostatic Elephantiasis):** chronic swelling, fibrosis, cellulitis, elevation not effective.

Staging of Lymphedema



Stage 0 Left Unilateral Arm



Stage I Left Unilateral Arm



Stage II Left Unilateral arm



Stage III Left Unilateral arm

- Characterized by pitting edema and is reversible with elevation of the arm

- Is no longer spontaneously reversible
- Development of protein-rich edema
- Proliferation of fibrotic tissue

- Known as Elephantitis
- Massive swelling of the extremity
- Protein-rich fluid
- Connective and scar tissue
- Hardening of the dermal tissue
- Panillomatosis







What other sources could lead to swelling?



Figure 1 – Extensive swelling of the left upper and lower eyelids with marked proptosis is evident in this woman with periorbital cellulitis. She also had clear discharge with dried crusting on the eyelashes.

Lymphedema: Differential Diagnosis

- Venous Insufficiency/Obstruction
- CHF
- Renal Disorders
- Nutritional Disorders
- Lipedema
- Myxedema (Thyroid disease)
- CRPS
- Fluid retention syndromes
- Immobility/Dependency

Venous Edema

- Hemosiderin staining
- Fibrosis
- Pitting (+/-)
- Malleolar ulcerations
- Tired, Aching legs
- Worse in the evening, or with prolonged standing



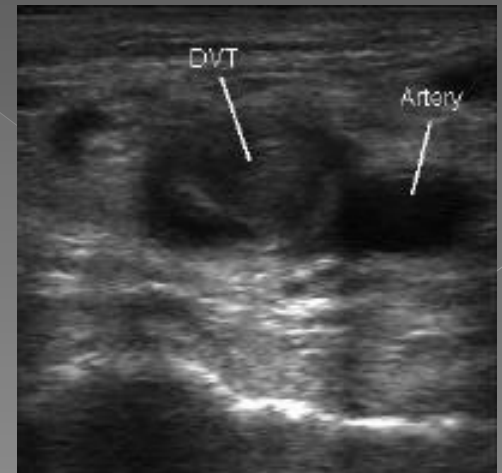
http://meded.ucsd.edu/clinicalimg/extremities_venous_insuf21.jpg

Acute Deep Vein Thrombosis



<http://www.healthmango.com/wp-content/uploads/2011/02/deep-vein-thrombosis.jpg>

- Sudden onset
- Usually unilateral
- Swelling in calf
- Often painful
- Can be lethal (PE)



http://img.medscape.com/pi/emed/ckb/clinical_procedures/79926-104340-1362989-1383583tn.jpg

Congestive Heart Failure

- Greatest edema distally
- Bilateral and symmetric
- Pitting
- Swelling may decrease with elevation
- Usually painless
- Jugular vein distention
- Dyspnea on exertion
- Paroxysmal nocturnal dyspnea



[http://www.pharmacology2000.com/
Cardio/CHF/CHF2/CHF_1.htm](http://www.pharmacology2000.com/Cardio/CHF/CHF2/CHF_1.htm)

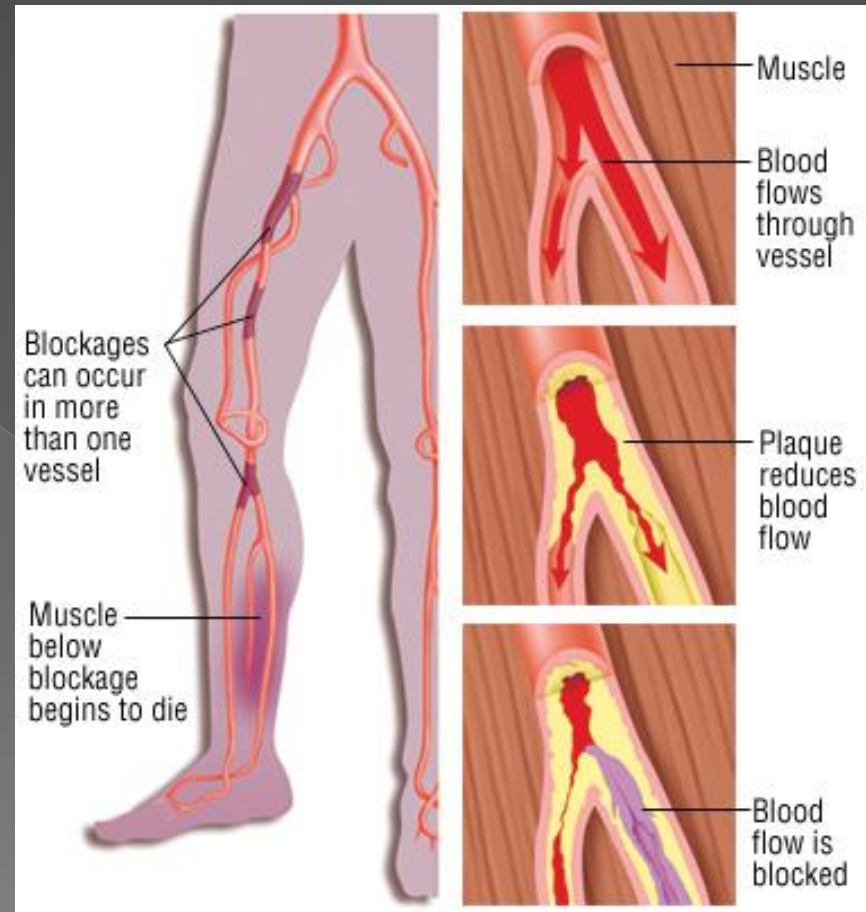
Lipedema

- Mainly in women
- Bilateral, symmetrical from iliac crests to ankles
- Dorsum of feet never involved
- Little or no pitting
- No cellulitis history
- Painful to palpation, may bruise easily



Special Consideration: PAD

- Painful cramping during activity
- Leg numbness/weakness
- Sores that won't heal
- Shiny skin on legs
- No pulse or weak pulse in legs
- Change in color of legs



Taken from:
<http://www.patienteducationcenter.org/articles/peripheral-arterial-disease/>

Screening for PAD

- **Ankle Brachial Index (ABI):** Compares blood pressure in your ankle vs. arm
 - > Normal 1.0-1.4.
 - > <.9 and >1.4 abnormal
 - > .91-1.0 borderline
- Doppler ultrasound
- Angiography
- Blood Tests

Aboyans V, et al. (2012). Measurement and interpretation of the ankle-brachial index: A scientific statement from the American [Heart](#) Association. *Circulation*, 126(24): 2890-2909

Lymphedema

Management,
Contraindications and
Precautions

Goals:

1. Decrease swelling
2. increase lymph drainage from the congested areas
3. Reduce skin fibrosis and improve the skin condition
4. Enhance patient's functional mobility
5. Relieve discomfort and improve quality of life
6. Reduce the risk of cellulitis and Stewart-Treves-Syndrome, a rare form of angiosarcoma (NLN 2016)

Treating Lymphedema

Contraindications

Absolute:

Decompensated CHF

Acute infection/cellulitis (can generally resume with MD agreement after 2-3 days of antibiotics)

Acute DVT

Relative:

Advanced Kidney Disease

Malignant Disease

Precautions

- Cardiac arrhythmias
- Carotid Stenosis (avoid neck during MLD)
- Undergoing treatment for active malignancy
- PAD
- Open wounds

Manual Lymphatic Drainage

Contraindications for the Abdomen

- Pregnancy
- Recent abdominal surgery
- Radiation colitis
- Pelvic DVT
- Diverticulitis/IBS
- Crohn's Disease
- AAA

Complete Decongestive Therapy (CDT)

- Manual Lymph Drainage
- Compression Bandaging/Pump
- Remedial Exercise
- Meticulous skin and nail care
- Instruction on self-care



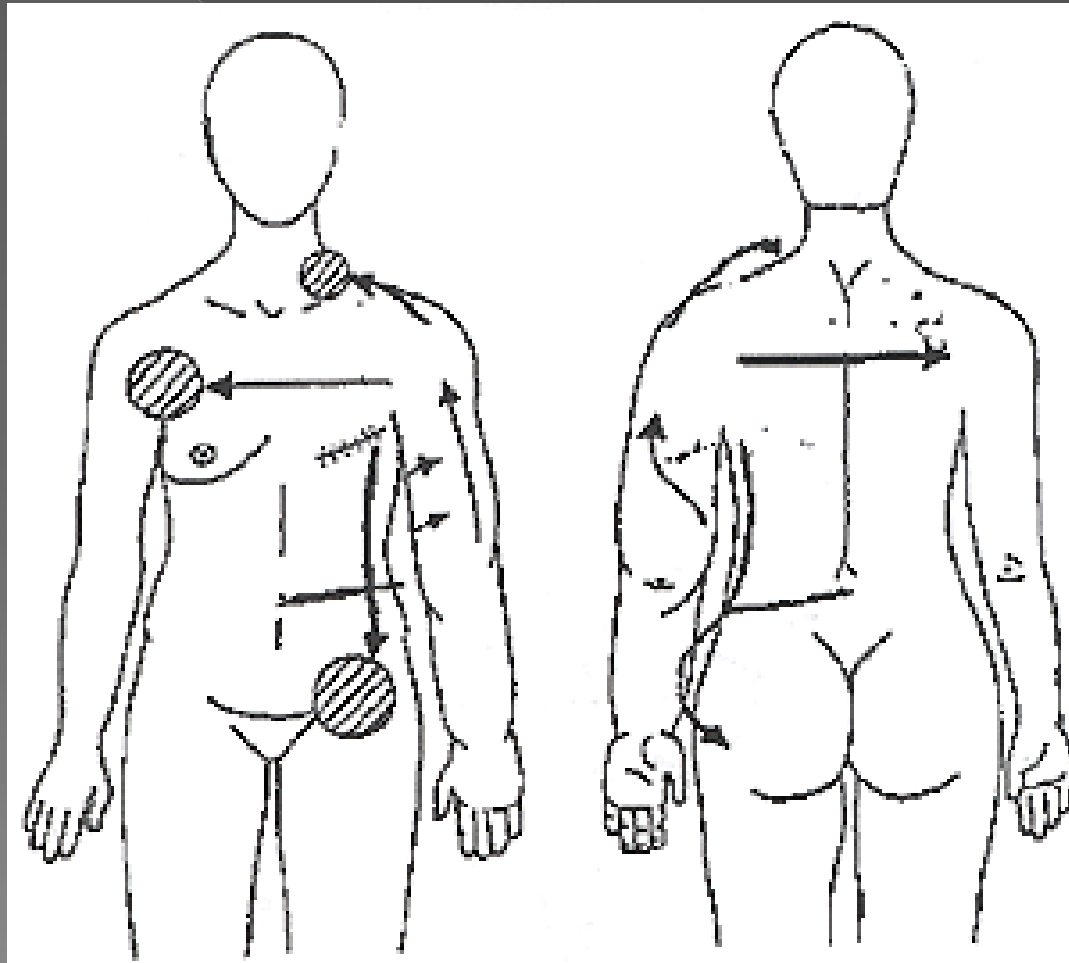
[http://www.niisg.co.uk/Treatment/Complex-Decongestive-Therapy-\(CDT\).aspx](http://www.niisg.co.uk/Treatment/Complex-Decongestive-Therapy-(CDT).aspx)

Manual Lymph Drainage



- Increases lymph angio activity
- Increases reabsorption of protein-rich fluid
- Promotes relaxation
- Analgesic effect
- 45-60 minute sessions

Manual Lymph Drainage



<http://www.cyberounds.com/cmcontent/art137.html?pf=yes>

Bandaging

- ◉ Reduces filtration rate
- ◉ Improve efficiency of muscle and joint pumps
- ◉ Prevents reaccumulation of evacuated edema fluid
- ◉ Breaks down indurated tissue



<http://www.klosetraining.com/LymphedemaCertification.asp>

Bandaging Principals

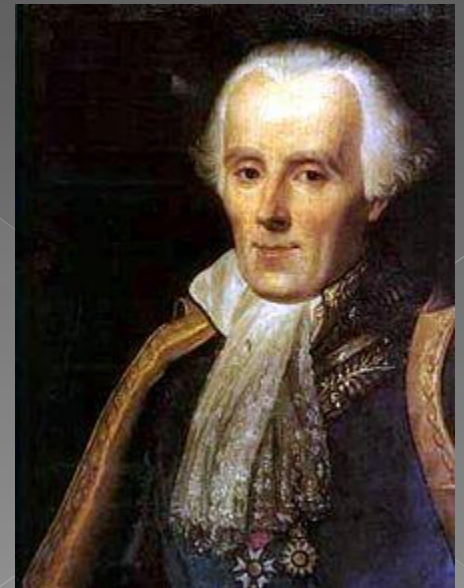
- Factors that can affect pressure:
 - > Type of bandage
 - > Application (amount of tension applied)
 - > Number of layers
 - > **Law of Laplace**



<http://www.jobst-usa.com/products/lymphedema/lymphcare.html>

Law of Laplace

- Pressure = Tension/Radius
- If each bandage is applied with even tension, the smaller the radius of the limb, the greater the pressure exerted on the tissues.



Pressure Considerations

- Resting Pressure: amount of pressure the bandage exerts on the tissues at rest
- Working Pressure: is achieved because of the resistance that the bandage creates against muscle and joint movement (during exercise and ADLs)

For Lymphedema...Low Resting pressure, high working pressure (Short stretch vs. ACE)

Importance of Bandaging

- A course of short stretch compression bandaging followed by compression hosiery was significantly more effective than hosiery alone at reducing moderate-to-severe lymphedema (i.e., > 20% excess limb volume), with the benefit maintained for at least 6 months. (Badger et al)



Exercise



http://www.nytimes.com/2006/05/18/fashion/tuesdaystyles/18Fitness.html?pagewanted=all&_r=0

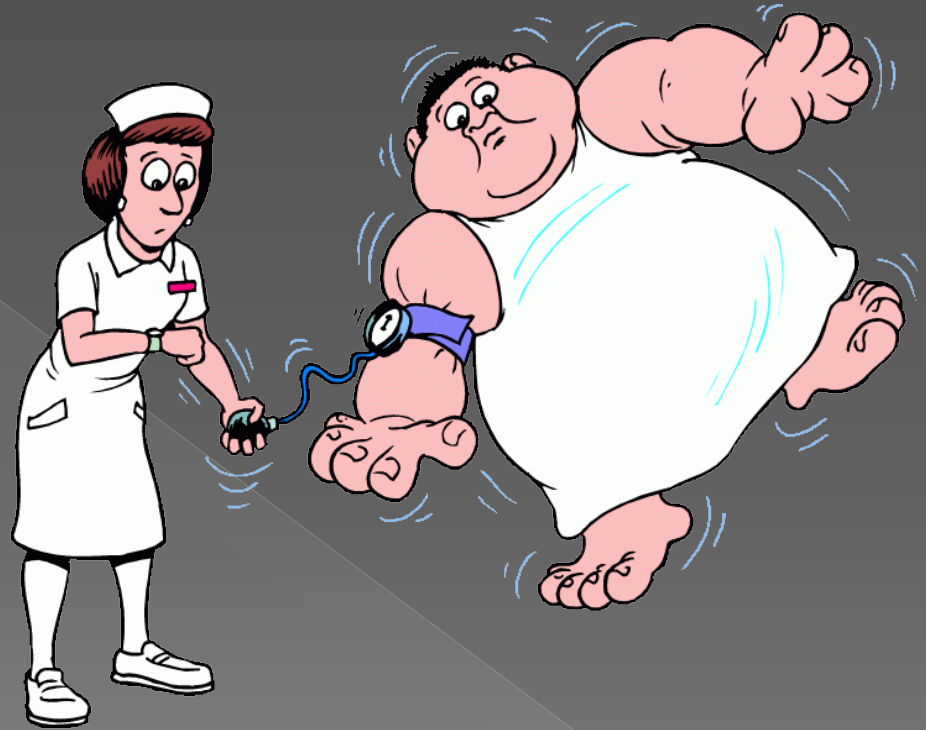
- Performed with bandages or garment
- Active ROM, strength, stretching
- Include diaphragmatic breathing
- Increase muscle and joint pump
- Strength training is encouraged with slow progression with close monitoring of the at risk limb

Skin and Nail Care

- ◉ Decreases risk of infection
- ◉ Keep skin clean and supple
- ◉ Avoid injury (insect bites, cuts)
- ◉ Clean all injuries asap
- ◉ Call physician with first sign of infection

General Recommendations

- Do not wear tight jewelry (rings, watches)
- No blood pressure or needle sticks in affected side
- Maintain a healthy weight
- Avoid extreme heat/cold
- Wear compression for air travel



Compression garments

- Elastic garments
- Off the shelf
- Made to measure
- Nonelastic garments
- Velcro closure vs Foam garments















Before and After



http://www.cheshire-med.com/rehabilitation_services/lymphedema_services.html



<http://www.cclymptx.com/treatmentresults.html>

Before and After



<http://lymphedematreatmentact.org/what-is-lymphedema/>



<http://www2.mdanderson.org/depts/oncolog/articles/13/aug/8-13-1.html>

Research

- Literature review by Ridner et al. found that full-body exercise and Phase 2 CDT are the intervention techniques that will most likely benefit lymphedema patients. (self management techniques)
- Systematic review by Lansinski et al. concluded that CDT was effective for the treatment of lymphedema, specifically manual lymph drainage and compression bandaging.

Case Report- SU Grads!

- Describes a patient with non-cancer related lymphedema unilateral LE
- 42 year old who was morbidly obese and had left LE stage III lymphedema.
- Difficulty with ambulation, transfers and had reoccurring wounds and pain.

- **RESULTS:** After 23 weeks of physical therapy the left LE reduced 66% and was equal to the uninvolved side.
- Independent with ambulation, transfers and steps.

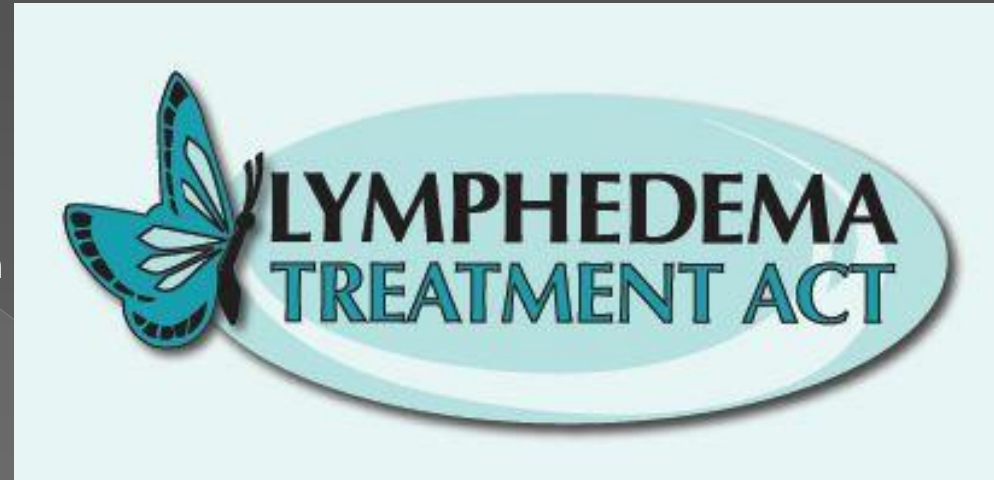
Lesard T, Barrett C. Successful management of severe unilateral lower extremity lymphedema in an outpatient setting. *Physical Therapy*. 2015; 95(9): 1295-1306.

Practical pitfalls

- Inability to maintain nearly 24 hour compression daily.
- Limited coverage for garments.
- Large initial expense for Lymphedema pump
- Significant time lapse to obtain maintenance garments
- Lymphedema Treatment Act
- Limited visits OT/PT per year

Lymphedema Treatment Act

- to provide comprehensive lymphedema treatment coverage, according to current medical treatment standards;
- to enable patient self-treatment plan adherence by providing necessary medical supplies for use at home, as prescribed for each patient (including gradient compression garments, bandages, and other compression devices);
- to allow for new treatment modalities to be considered for coverage as they become available and are approved;
- to reduce the total healthcare costs associated with this disease by decreasing the incidence of complications, co-morbidities and disabilities resulting from this medical condition.



Video:

<https://www.youtube.com/watch?v=npYqXBz2YvE>

References

Hayes et al. Lymphedema after breast cancer: incidence, risk factors and effect on upper body function. *Journal of Clinical Oncology*. 2008; 26(21): 3536-3542.

Disipio et al. Incidence of unilateral arm lymphedema after breast cancer: a systematic review and meta-analysis. *Lancet Oncology*. 2013; 14: 500-515.

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Foeldi: Textbook of Lymphology; 2nd edition, 2006. Chapter 2; Terminal vascular, interstitial connect tissue, lymph capillaries and precollectors. Chapter 4; Physiology and pathphysiology of the lymphatic system.

Klose Training and Consulting

www.lymphedematreatmentact.org

References

- Ridner et al. Lymphedema self management. *Lymphlink reprint*. 2014; 26(1).
- Lansinski et al. A systematic review of the evidence for complete decongestive therapy in the treatment of lymphedema from 2004 to 2011. *American Academy of Physical Medicine and Rehabilitation*. 2012; 4: 580-601.
- Badger et al. A randomized, controlled, parallel-group clinical trial comparing multilayer bandaging followed by hosiery versus hosiery alone in the treatment of patients with lymphedema of the limb. *Cancer*. 2000; 88(12): 2832-2837.