**Edema Management**

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**Lymphatic System**

- Scavenger system
  - Removes excess fluid, debris, and other materials from the tissue spaces
- Alternate pathway to the heart
  - For substances too large to be disposed of through the venous system

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**Functions of Lymphatic System**

- Immune function
  - By protecting the body from disease and infection
    - Via production, maintenance, and distribution of lymphocytes
  - Responsible for returning proteins that have accumulated in the interstitial spaces back into the venous system
  - Restoring balance

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**Definitions**

- **Lymph**
  - Fluid collected from tissues
  - Flows via lymphatic vessels through lymph nodes and drains into the venous system
- **Interstitium**
  - The spaces between cells
  - Interstitial fluid is the fluid between cells derived by filtration from the capillaries

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**Fluid Transport Through Blood Capillaries**

- Net capillary filtration pressure is the balance of pressure between:
  - Capillary (hydrostatic) pressure
    - Moves fluid from capillary outward through the membrane
    - Pressure is greater at arterial than venous end
    - Results in fluid filtering out at arterial end and being reabsorbed at venous end of blood capillaries
  - Interstitial fluid pressure
    - Forces fluid inward through the capillary membrane when (+) and outward when (−)
  - Interstitial fluid colloid osmotic pressure
    - Pressure created by dissolved proteins causing osmosis of fluid
    - If high will cause osmosis of fluid outward through the membrane
  - Plasma colloid osmotic pressure
    - Pressure created by dissolved proteins causing osmosis of fluid
    - Draws fluid inward through the membrane
**Fluid Transport Through Blood Capillaries**

- When net filtration pressure rises excessively
  - Too much fluid is moved outward into the interstitial spaces for the lymphatics to manage
  - If lymphatic load exceeds the transport capacity, extracellular edema will result

**Mechanism of Edema**

- After injury, the inflammatory response changes the permeability of the microvessels
  - Allowing plasma proteins to leak into interstitial spaces
  - They are too large to permeate the venous system
- The role of the lymphatic system is to dispose of matter too large for venous system
  - If damaged or overloaded (dynamic insufficiency)
  - Ability to dispose of these larger plasma proteins is hindered
- If these proteins remain in the interstitium
  - Colloid osmotic pressure increases and draws more fluid into the interstitial space

**Edema**

- Can only occur if the lymphatic system has failed
- By Definition
  - Accumulation of excess fluid in the intercellular spaces in the body

**Lymphatic Tissue Drainage System**

- 3 levels of structures
  - Lymphatic capillaries
  - Collector lymphatics
  - Nodes

**Lymphatic capillaries**

- Beginning of the lymphatic system
- Found in the dermis at the dermal-epidermal junction forming a flat 2 dimensional continuous network over the entire body
  - Except the CNS and cornea

**Lymphatic capillaries**

- Consists of single layer of overlapping endothelial cells that have connector filaments anchoring them to surrounding CT
- Forms flap like junctions that open when local interstitial pressure changes
  - When open, fluid flows in changing internal pressure from low to high, causing junctions to close
  - Enables vessels to stay open even under high tissue pressure
  - Fluid is unable to flow out
Lymph Precollectors and Collectors

- Lymphatic loads are reabsorbed by the lymph capillaries and flow into larger lymph vessels called precollectors which drain into collectors
  - Collectors have valves spaced every 6-20 mm
  - Prevent the backflow of lymph
  
- Segments between 2 valves in a collector are called lymph angions
  - The contraction of smooth muscle in each angion generates propulsive force of lymph flow along the lymph vessel
  - At rest lymph angions pump 6-10x/min
  - With muscle contraction from exercise they can pump 100x that amount

Lymph Nodes

- Propulsion directs the lymph fluid into regional and central lymph nodes to be filtered
  - Nodes consist of a complex of sinuses that perform immunologic functions
  - Ultimately empties into the venous system

Drainage Areas for Lymphatic Duct

- UE drain mainly into axillary nodes
- Lymph from R thoracic lymphotome, RUE and R side of head drain into trunks that empty into R Lymphatic Duct
  - Duct empties into R Subclavian Vein and into the Superior Vena Cava of the heart

Drainage Areas for Thoracic Duct

- Both LE, both abdominal lymphotomes, L thoracic lymphotome and L side of head drain into the Thoracic Duct
  - Largest lymphatic vessel in the body extending from L2 to T4
  - Thoracic Duct empties into the venous system at the juncture of the Subclavian and Jugular Veins

Trunk Lymphotomes

- Divided into 4 lymphatic quadrants (drainage territories)
  - L and R Upper Quadrant: Thoracic Lymphotomes
    - Extend from anterior midline to vertebral column on L and R sides of upper trunk
    - Lymph drains from superficial to deeper vessels that connect to nodes
    - Between lymphotomes are watershed areas where normal drainage is away from the watershed toward the nodes
    - There are superficial collateral vessels across watershed areas
    - With lymph congestion they provide alternative pathway to uncongested lymph vessels
  - L and R Lower Quadrant: Abdominal Lymphotomes
**Lymphatic Therapies**

- **Types**
  - Complete Decongestive Therapy
  - Manual Lymph Drainage
  - Manual Edema Mobilization

- **Overall Theory**
  - To remove plasma proteins from edematous areas by stimulating the lymphatic system
    - Enables these proteins to leave the interstitial spaces and enter lymphatic structures
    - By ridding the interstitial spaces of these hydrophilic proteins, subacute and chronic edema decreases

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**Complete Decongestive Therapy**

- 2 phase non-invasive intervention for lymphedema
  - **Benefits**
    - Open collateral lymphatic drainage pathways
    - Increased pumping by deep lymphatic pathways
    - Reduction and breakdown of fibrotic tissue
  - **Phases**
    - Phase I (intensive)
      - Involves MLD, bandaging, use of compression garments
    - Phase II (self mgmt)
      - Pt wears compression garment during day, bandaging at night, exercise, and self MLD

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**Manual Lymphatic Drainage**

- Specialized manual technique based on physiologic principles of lymph flow and lymph vessel emptying
  - Affects lymph system by moving lymph fluid around blocked areas toward collateral vessels, anastomoses, and unininvolved lymph node regions
  - **Benefits**
    - Increases lymph angiomotoricity (pulse)
    - Increases volume of transported lymph fluid
    - Increasing pressure in lymph collector vessels
    - Improving lymph transport capacity
    - Potentially increasing arterial blood flow

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**Manual Edema Mobilization**

- A lymphatic stimulation technique used for recalcitrant sub acute or chronic limb/hand edema in the orthopedic population
  - **Basic Premise**
    - Diaphragmatic breathing, light skin-traction massage, and exercise help stimulate the lymphatic system
    - By changing interstitial pressure which enables the proteins to leave the interstitial spaces and enter lymphatic structures
    - By ridding the interstitial spaces of these proteins the edema decreases
  - **Key point:**
    - Lymphatic system is intact but temporarily overloaded

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**Differences**

<table>
<thead>
<tr>
<th>Manual Edema Mobilization</th>
<th>Manual Lymphatic Drainage</th>
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</thead>
<tbody>
<tr>
<td>Designed for orthopedic patients with subacute and chronic edema</td>
<td>Originally intended for individuals w lymphedema</td>
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<tr>
<td>Lymphatic system is intact</td>
<td>Insufficient Lymphatic System</td>
</tr>
<tr>
<td>Temporarily overloaded</td>
<td>High plasma protein edema associated with mechanical obstruction</td>
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<tr>
<td>Treatments are shorter and typically involve moving less fluid</td>
<td>Treatments are longer and more involved</td>
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<tr>
<td></td>
<td>Large amounts of fluid may need to be rerouted throughout the body</td>
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</table>
Critical Points

All edema is not the same

Lymphedema

- High plasma protein edema associated with a mechanical obstruction or insufficiency of the lymphatic system
- Lymphatic system is unable to clear the interstitial tissues
- Most distinguishing feature is resultant high content plasma proteins in the interstitial fluid
- Over time can lead to fibrosis

http://www.agoracosmopolitan.com

Stroke Edema

- Simple pitting edema
  - Perpetuated by the loss of motor function (muscle pump)
  - Eventually can become gel-like and then fibrotic

Edema from Kidney or Liver Disease

- Caused by decreased plasma proteins in the interstitium
  - Pitting edema
  - Contraindication

Edema from Cardiac Conditions

- Increased venous and capillary pressures
  - Bilateral pitting edema around ankles/feet
  - Contraindication

Inflammatory Edema

- Acute (0-72 hours)
  - Inflammatory phase of wound healing
  - Initial flooding of damaged tissue area with electrolytes and water
  - Edema is liquid, soft, and easy to mobilize
  - These low-protein substances readily diffuse by osmosis back into the venous system

http://en.wikipedia.org/wiki/Acute_decompensated_heart_failure
Inflammatory Edema Treatment

- Rest
  - Immobilization, when possible, should occur in the intrinsic-plus position
  - Early active motion when appropriate
- Ice
  - Avoid heat modalities that may increase bleeding
- Compression
- Elevation
  - Decreases hydrostatic pressure, reducing the flow of fluid into the interstitium

Subacute Edema

- Characterized by excess plasma proteins
  - Lymphatic transport is compromised by damaged lymphatics
- Fibroblastic phase of wound healing
  - Edema is more viscous from the elevated protein content
  - Fibroblasts are activated by the proteins trapped in the interstitium and produce collagenous tissue
    - Exudate causes fibrosis/thickening of tissues with subsequent shortening of ligamentous & tendinous structures
    - If untreated will progress to a gel-like state
- Persistent edema, immobilization, and poor will lead to a stiff hand

Subacute Edema-Treatment

- Lymphatics must be specifically stimulated
- AROM/Tendon Gliding
  - Active muscle pumping is single most important stimulus for increasing lymphatic flow
  - Exercise stimulates the superficial lymphatics by altering tissue pressure (allowing fluid to flow into the lymphatic system) and stimulates the deeper lymphatics which aids in propelling the lymph through the deeper vessels
- Lymphangions have a higher rate of contraction or “pumping” during exercise

Subacute Edema-Treatment

- Consider
  - Heat in elevation to precondition structures, increase CT extensibility and circulation in preparation for exercise
  - Splinting
    - Gentle prolonged force to influence collagen fibers
  - Compression
    - Isotoner gloves, Coban wraps, Elastomull wraps
  - Lymphatic Therapies
    - Massage
      - Creates a locally negative pressure gradient, draining the lymphatic system distally
    - Other
      - Kinesiotape, Chip bags

Chronic Edema

- Maturation phase of wound healing
- Persistent edema leads to fibrosis with elevated protein count
- Edema becomes hard, thick, and brawny as the result of connective tissue infiltration and fibrosis

Chronic Edema Treatment

- Lymphatics must be specifically stimulated
- Techniques to increase tissue hydrostatic pressure
  - Compression garments
    - Isotoner gloves, coban, tubigrip, elastomull wraps, chip bags, kinesiotape
  - Lymphatic Therapies
- Splinting
  - To influence tissue remodeling
  - Low load long duration stress
- High-volt pulsed direct current may decrease edema by reducing microvascular permeability to plasma proteins
Chip Bags
- Made from small pieces of varied-density foam
- Provide light stimulating compression
- Retain body heat
- Provide further tissue softening
- Provide significant local pressure
- Extremity should be wrapped from distal to proximal to assist with lymphatic and venous drainage

Kinesiotape
- When applied to the skin over an inflamed area, the stretch in the tape gently lifts the skin
  - Creates an area of negative pressure, allowing both blood vessels and lymphatic vessels to dilate, draining the area
  - Improved blood flow enhances delivery of oxygen and nutrients to the injured tissues, accelerating the healing process

Evidence (Bandaging)
- Leduc et al (1998, 1990) found that the combination of multilayered bandages on the forearm combined with exercise increased protein absorption by lymphatic capillaries
- External pressure and temperature also facilitate lymph movement
  - Kurz (1997) demonstrated that the flow of lymph within the vessel is best between 22-41° C
  - Sharply slows down or stops below and above those temps
  - Bandaging can influence protein absorption by providing light compression and perhaps by providing a buildup of body heat that is within the mid range of ideal temp to mobilize lymph

Critical Points
- Stimulation of the lymphatic system is necessary to decrease sub acute and chronic edema (high- protein edema)
  - Enables the proteins to leave the interstitial spaces and enter lymphatic structures
  - By ridding the interstitial spaces of these proteins the edema decreases

Critical Points
The initial lymphatic system is superficial, fine, and fragile
- Firm compression may collapse the lymph vessels

Critical Points
Diaphragmatic breathing, light massage, and exercise help stimulate the lymphatic system
- By changing interstitial pressure and causing increased lymphatic protein absorption
Diaphragmatic Breathing
- Thoracic duct is the largest lymphatic structure (L2-T4) and one of the deepest
- Diaphragmatic breathing changes pressure in duct
- The pressure change creates a vacuum pulling lymph from peripheral structures centrally toward the subclavian veins

Scars
- Edema cannot go through scars
  - Will need to be rerouted around scars and incisions
- Goal is to reroute congested lymph around areas of tissue damage into adjacent functioning lymph capillaries

References

Case Example
- 43 yo RHD Director Instructional Tech at ACC
- 6 weeks s/p R CTR
- Volumeter testing R 35ml > L
- 15ml decrease in 1 session using MEM
- Home program
  - Diaphragmatic Breathing
  - AROM exercises
  - Light skin-traction massage

Thank You