FLUID AND HEMODYNAMIC IMBALANCES
Fluid Disorders
Water

- 45 – 60% of human body is composed of water
- Contains the electrolytes essential to human life
- Found within (intracellular) and outside (extracellular) the cells
Water

- **Function**
  - Medium for metabolic reactions and other processes
  - Transportation system for the body
    - Carries nutrients into cells and removes wastes
- **Viability of cells**
  - Cells cannot continue to function without adequate fluid
- **Fluid also facilitates movement of body parts**
  - Joints
  - Lungs
Fluid Compartments

- **Intracellular**
- **Extracellular**
  - Intravascular fluid or blood
  - Interstitial fluid
  - Cerebrospinal fluid (CSF)
  - Transcellular fluids present in various secretions
    - Pericardial cavity (Heart)
    - Synovial (joint)
Causes of Fluid and Electrolyte Imbalances

- Burns
- Surgery
- Trauma
- Diabetes
- Tumors
- Alcohol withdrawal
- Eating disorders
Edema

- = excess of fluid in interstitial spaces and/or body cavities
  - Swelling/enlargement of tissues results
- Occurs in extracellular compartment
- Pressure dependant
  - Imbalance between the forces that keep fluid in vessels and those that promote fluid exit into interstitial space
- Usually more severe in dependent areas
Edema

- Prolonged edema can interfere with
  - Venous return
  - Arterial circulation
  - Cell function

- Etiology multifactorial
  - Distribution depends on cause
Edema

- **Localized**
  - Any tissue or organ
  - Cerebral edema, pulmonary edema

- **Generalized**
  - Anasarca
  - Will see ↑ in body weight
Edema

**Sustained edema**

- Arterial circulation may be impaired
- May restrict arterial blood flow into the area
- Prevents normal cell function
  - Tissue necrosis
  - Development of ulcers
  - Varicose veins
    - Dilated veins that have high hydrostatic pressure
      - Skin breakdown, fatigue, slow healing ulcers
Edema

- **Transudate**
  - Little protein and blood cells
  - Ultrafiltrate of plasma fluid
    - Changes in pressure (↑ hydrostatic, ↓ oncotic)
    - Obstruction in interstitial fluid drainage
    - ↑ tissue hydration
Edema

- **Exudate**
  - Rich in protein and blood cells
  - Typical of inflammation
    - Accounts for tissue swelling
- **Etiology**
  - $\uparrow$ Permeability of blood vessels
  - Hydrodynamic changes in peripheral circulation
Edema - Etiology

- Inflammatory
  - ↑vessel permeability and ↑blood flow

- Hydrostatic edema of hypertension
  - ↑Arterial blood pressure
    - Transmembranous passage of fluids
  - Venous stagnation/backpressure
  - Ex. CHF
Edema - Etiology

- **Oncotic**
  - Decrease in osmotic pressure of plasma proteins
    - Albumin - principle serum protein responsible for osmotic pressure
  - Cause
    - Proteinuria secondary to kidney disease
    - ↓ Protein synthesis secondary to cirrhosis
Edema - Etiology

- **Obstruction of the lymphatic circulation**
  - Rare cause
  - Localized damage to a lymph node
    - Tumor
    - Infection
    - Removal
Edema - Etiology

- Hypervolemic
  - Retention of sodium and water
Edema – Clinical Manifestations

- **Functional Impairment**
  - May restrict movement

- **Pain**
  - Edema increases the pressure on the local nerves

- **Pitting edema**
  - Excess interstitial fluid
    - Moves aside when firm finger pressure placed on surface
    - Depression remains after finger removed
    - Rated based on how quickly skin rebounds to original shape
Edema — Clinical Manifestations

http://upload.wikimedia.org/wikipedia/commons/2/21/Pitting_Edema2008.jpg

http://faculty.msmc.edu/zychowic/advanced%20vascular%20examination_files/slide0019_image023.jpg
Dehydration

- Fluid Deficit
  - Insufficient body fluid from
    - Inadequate intake
    - Excessive loss
    - Combination of the two
  - Dehydration more serious for infants and elderly who lack fluid reserves and the ability to conserve fluid
    - Infants also have a higher metabolic rate
Dehydration

- **Etiology**
  - **Vomiting & Diarrhea**
    - Loss of fluids and electrolytes and nutrients
      - Glucose
      - Water
  - **Excessive sweating**
    - Loss of water and sodium
  - **Insufficient water intake**
    - Elderly and unconscious
Dehydration

- Water loss is often accompanied by loss of electrolytes and sometimes proteins
  - Sweating
    - Loss of water and sodium chloride
  - Electrolyte losses
Effects of Dehydration

- **Effects**
  - **Turgor**
    - Decreased elasticity in the skin
  - **Lower blood pressure**
    - Weak pulse, fatigue
  - **Confusion**
  - **Headache**
  - **Lethargy**
Effects of Dehydration

- The body compensates by
  - Thirst
  - Increased heart rate
  - Pale cool skin
  - Decreasing urine output
  - Decreased mental function
    - Loss of water to brain cells
Potassium Imbalances

- Hypokalemia
  - Cardiac dysrhythmia
  - Interferes with neuromuscular function
    - Muscles become less responsive
  - Paresthesia develops
  - Decreased digestive tract motility
  - Respiratory muscles may become weak
  - Renal function may become impaired
Potassium Imbalances

- Hyperkalemia
  - Cardiac dysrhythmias
  - Muscle weakness progressing to paralysis
  - Fatigue, nausea and paresthesias
Acidosis

- Process causing a relative excess of acid in body
- Respiratory acidosis
  - Hypoventilation and retention of carbon dioxide
  - COPD, asthma
  - Clinical manifestations: headache, SOB, cardiovascular abnormalities, restlessness, confusion
Acidosis

- **Metabolic acidosis**
  - Accumulation of acids or a deficit of bases in blood
  - Renal failure, diarrhea
  - Clinical manifestations: muscular twitching, weakness, nausea, vomiting, diarrhea, headache
Alkalosis

- Condition resulting in excess base in the body
- Respiratory alkalosis
  - Hyperventilation: lungs excrete excessive amounts of carbon dioxide
  - Early stage pulmonary problems
  - Clinical manifestations: deep, rapid breathing, dizziness, muscle cramps, numbness of extremities
Alkalosis

- **Metabolic alkalosis**
  - Abnormal loss of acid or excess accumulation of bicarbonate ions
  - Vomiting, gastric suctioning
  - Diarrhea, excessive use of laxatives
  - Clinical manifestations: hypoventilating, muscle weakness, irritability, confusion, muscle twitching
Hemodynamic Disorders
Hemorrhage

- Passage of blood outside the cardiovascular system

- External
  - Flows out of the body
    - Hypovolemia results
      - May lead to death

- Internal
  - Fills various body cavities
  - Causes other complications
    - Hemothorax, hematomas
Hemorrhage

- Important Terminology
  - Hemoptysis
    - Coughing blood from respiratory tract
  - Hematemesis
    - Vomiting blood
  - Melena
    - Black, discolored blood in stool
Hemorrhage

- Has RBCs and plasma
- Form clot (thrombus) due to coagulation
  - See thrombus below…
- Occludes tear in vessel wall
Thrombosis

- Thrombus
  - Solid mass of clotted blood
    - Promoted by clotting factors and platelets
    - End product of coagulation: normally activated to prevent blood loss from disrupted vessel
  - Attaches to vessel wall
Thrombosis

- Fate
  - Depends on size, location, vessel hemodynamics
    - Some are lysed
  - Occlusive
    - Blocks blood flow
    - May be recanalized and blood flows again
  - May give rise to thromboemboli
    - Thrombus breaks off and carried by circulating blood to another site
Embolism

- **Emboli**
  - Freely movable, intravascular mass
    - Carried by blood
  - All can occlude blood vessels $\rightarrow$ interruption of blood supply to organ
    - Occlude vessel - ischemia
    - Narrow vessel - hypoxia
Embolism

- **Thromboemboli**
  - Fragments of thrombi
  - Types
    - Venous
    - Arterial
Embolism

- DVT

  - Complication — Pulmonary Embolism (PE)
    - Carried by venous blood to vena cava, right atrium and ventricle, pulmonary artery
    - Occlude pulmonary artery → acute anoxia
  
  - Symptoms
    - SOB
    - Hemoptysis
    - Calf pain and warmth
    - Dull ache
    - Sudden death
Risk Factors for DVT

- Recent surgery
- Immobility
- Oral contraceptives
- Smoking
Embolism

- **Arterial**
  - Originate in L atrium or ventricle, aorta, major arteries
  - Aortic aneurysms – often contain thrombi
  - Cerebral emboli
    - Infarcts in basal ganglia
    - Mortality is high
Embolism

- **Tumor emboli**
  - Important for metastases
Infarction

- \( \downarrow \) blood supply → area of ischemic necrosis

**Etiology**

- Thrombi or emboli
- Arterial or venous
Infarction

- Damage depends on
  - Anatomic site
  - Circulation
  - Body’s capacity for repair
- Postmitotic cells
  - Heart – replaced by fibrotic tissue
  - Brain – other tissues take over function
- Mitotic cells
  - Liver - heal with relatively few residual effects
Shock

- Circulatory system unable to maintain adequate pressure in order to perfuse organs
- Hypoperfusion of tissues with blood
  - Tissue anoxia
  - Multiple organ failure
- Etiology
  - Pump failure of heart
    - Cardiogenic
  - Loss of fluid from circulation
  - Loss of peripheral vascular tone
    - Overexpansion of peripheral vascular space and redistribution of fluids
- All etiologies lead to
  - Collapse of circulation
  - Disproportion between circulating blood and vascular space
Shock

- Series of events act synergistically
  - If uninterrupted – lead to death
- Early stages – reversible
- Later stages (serious organ failure) – irreversible
Shock - Etiology

- Cardiogenic
  - Pump failure
    - Destruction of large part of functioning myocardium
      - Loss of contractile elements
  - Similar
    - Myocarditis, endocarditis, conduction block, arrhythmia

- Hypovolemic
  - Loss of circulatory volume
  - As in
    - Massive hemorrhage
    - Water loss: burns, vomiting, diarrhea
Shock – Clinical Manifestations

- Peripheral vasoconstriction
  - Compensates for cardiac failure and resultant hypoperfusion
  - Redirects blood to vital organs, preserves critical functions
  - Anoxia of tissues

- Central pooling of blood
  - Skin pallor

- Metabolic acidosis
  - Undexcretion of metabolites

- Shock lung – ARDS

- Widespread clot formation (DIC)

- Anasarca
3 Stages of Shock

- **Compensated**
  - Tachycardia
  - Vasoconstriction of peripheral arterioles
  - Reduced urine production

- ** Decompensated shock (compensation fails)**
  - Hypotension
  - Tachypnea/SOB
  - Oliguria
  - Acidosis

- **Irreversible**
  - Hypotension
  - Respiratory distress
  - Anuria
  - DIC