Fluid and Hemodynamic Disorders

Where’s my water?
- Intracellular
  - Ions
  - Ion specific gates in cell membrane
  - Cellular proteins
- Extracellular
  - Interstitial (between the cells) Lymph
  - Intravascular
    - Blood
    - Lymphatic fluid

Movement of water in the vascular system
- Hydrostatic, the pumping pressure
  - Heart
  - Skeletal muscle action
- Oncotic or osmotic, holds fluid in.
  - Proteins such as albumin
  - Cellular elements such as RBCs

Intracellular & Extracellular Water
Things can go wrong

- Heart failure
- Kidney failure
- Myocardial infarction
- Pulmonary embolus
- Tissue congestion
- Edema

Edema

- Too much extracellular fluid.
  - Swelling
    - tumor
  - Localized or
    - Generalized
  - Dependent
    - action of gravity

Tansudate or Exudate?

- Exudate
  - Inflammatory water
  - Part of the inflammatory reaction
    - Rubor, dolor, calor, tumor
  - Purposeful and intentional
  - Localized

Tansudate or Exudate?

- Transudate
  - Leakage, not part of healing
  - Increased hydrostatic pressure
    - Heart failure
    - Lymphatic obstruction
  - Decreased oncotic pressure
    - Decreased albumin

Congestive Heart Failure

Concentrated diagram of a heart and circulatory system.
Passive Congestion

Chronic Passive Congestion, Nutmeg Liver

Chronic Passive Congestion

Pulmonary Edema

Pulmonary Edema

Pulmonary Edema
Pitting Edema

Lymphedema

Papilledema

Water in Hollow Spaces
- Hydrothorax
- Hydropericardium
- Hydroperitoneum
  - Ascites

Healthy Blood Clotting
- Platelets
- Vessels
- Clotting Proteins
Healthy Clotting

Clotting Factors

Factor Activation

ANTITHROMBOTIC

PROTHROMBOTIC

Hematoma

Petechiae
Thrombosis

- A pathological clot
- A clot forming in the fixed vascular system.

Thrombosis

1. Endothelial damage
2. Stasis and clotting factor activation
3. Clotting factor abnormalities
   - Too many clotting proteins
     - Pregnancy
     - Cancers
   - Too little inhibition
   - Abnormal factors
     - Leiden Factor (abnormal V)

Thrombosis

- Arterial Side Thrombi
  - Platelet activation
  - Endothelial cell injury
- Venous Side Thrombi
  - Stasis
  - Clotting factor activation
  - Endothelial cell injury

Coronary Artery Thrombosis

- Angiogram

Acute Myocardial Infarction
Mural Thrombus

Aneurysm with Thrombus

Deep Leg Vein Thrombosis

Airplane Travel

Outcomes of a DVT

Emboli

- Space occupying mass moving in the fixed vascular system
  - Blood clot
  - Bone Fragments
  - Amniotic Fluid
  - Air
Pulmonary Embolus

Infarction

- Anemic
  - End artery supply
  - No blood
  - White
- Hemorrhagic
  - Venous occlusion
  - Loose tissues
  - Dual blood supply
  - Red

Anemic Infarct
Cerebral Infarction

Hemorrhagic Infarct

Shock

- Poor perfusion
- Tissue hypoxia
- Tissue acidosis
- Many causes
  - Poor pumping by heart
  - Low blood volume
  - Loss of fluid
  - Overwhelming infections

Types of Shock

- Cardiogenic
  - Decreased output
- Hypovolemic
  - Blood loss
  - Fluid loss
- Anaphylaxis
  - IgE and histamine
- Septic
  - Gram negative rods
  - Toxins

What Happens Next?

- Compensated
  - Fluid shifts
- Decompensated
  - Progression possible
- Irreversible
  - No recovery

The Shock Spiral
Summary

• Fluid shifts
  • Oncotic & Hydrostatic Pressures
• Excessive tissue water
  • Exudate vs. Transudate
• Clot formation
  • Vessels, platelets & proteins
• Thrombosis
  • Pathological clot
  • Arterial = endothelial damage & platelet activation.
  • Venous = stasis and factor activation

Summary

• Infarction
  • Ischemic = end artery organ
  • Hemorrhagic = venous or dual blood supply
  • Tissue vulnerability
    – Brain
    – Kidney
    – muscle