

## HYPOVOLEMIC SHOCK

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## Definitions & Etiology

- Shock: inadequate tissue perfusion 2/2 circulatory failure and drop in arterial BP
  - Obstructive
  - Cardiogenic
  - Distributive
  - Hypovolemic: Relative loss of *intravascular volume* with inability to meet metabolic needs of the body
    - Decreased blood volume: surgery, trauma, AAA, GIB..
    - Decreased plasma volume: urine, fistula, diarrhea, burns, vomiting, third-spacing..
    - Combination of both volume and blood loss is common

## Pathophysiology

- Normal intravascular volume (iVol) = 5L
- Hypovolemic shock begins when iVol drops by > 10 mL/kg, and depending on age
- Drop in preload and CO is initially compensated for by increased SVR and various microcirculatory and neurohormonal mechanisms
- When iVol loss becomes severe, body can't compensate anymore → MAP and CO drop
- Tissue hypoxia ensues, resulting in anaerobic respiration and lactic acidosis
- Ischemic organs start to fail, resulting in multiple organ dysfunction syndrome (MODS) and death

## Presentation

- Mild volume loss (< 10 mL/kg)
  - Symptoms: thirst, nausea, weakness, light-headedness..
  - Signs: mildly ↓ U/O, dark-yellow urine
- Severe volume loss (> 30 mL/kg)
  - Symptoms: agitation, confusion
  - Signs: tachycardia, tachypnea, HoTN, AMS, cold extremities, ↓ capillary refill, U/O < 0.5 mL/kg/h
  - Labs: ↑ BUN/Cr, hypernatremia, ↓ bicarb and pH, ↓ Hg and HCT in hemorrhage, ↑ in PT/INR, hyperglycemia, other labs related to organ failure

## Treatment Approach

- Main goal: Prevent or reverse organ dysfunction by improving perfusion and reversing vol. loss
- Mild vol. loss may be treated as outpatient with oral hydration
- Hospitalization is needed for severe vol. loss
  - At least two large-bore peripheral IV/IO catheters are obtained
  - ICU admission if vasopressors or intubation required
  - Intubation is preferred to control oxygenation
  - Arterial catheter (Art Line) is placed for BP monitoring
  - Source control is obtained

## Treatment Approach

1. If hemodynamically unstable (SBP <90 or MAP < 60 mmHg), administer 1-2L NS or LR over 1-2h (fluid challenge)
2. Assess if significant blood loss → 2u PRBCs
3. Reassess hemodynamic status, repeat step #1 until improves, consider adding vasopressors
4. Fine balance between under- and over-resuscitation especially in pts with HF or near pulmonary edema

### Fluid Therapy: Crystalloids

- Crystalloids Vs. Colloids
- For moderate-severe shock, crystalloids are preferred over dextrose-in-water solutions
- 1 L isotonic crystalloids expands iVol by 200-250 mL
- 0.9% NaCl (NS) and Lactated Ringer (LR) solutions are two of the most commonly used crystalloids and considered first line fluid Rx

### Fluid Therapy: Crystalloids

- 0.9% NaCl
  - 154 mEq/L of Na and Cl
  - Monitor for hypernatremia, metabolic acidosis
  - Iso-osmolar and isotonic
- Lactated Ringer
  - 130 mEq/L Na, also contains Cl, K, Ca, lactate
  - Iso-osmolar, isotonic
- Hypertonic crystalloids (3% and 7.5% NaCl)
  - Hyperosmolar, hypertonic
  - More iVol retention rate
  - Not shown superior to isotonic, safety issues

### Fluid Therapy: Colloids

- Albumin, hetastarch, dextran products
- MOA
  - Increase in intravascular oncotic pressure and subsequent drawing/retention of fluids
  - Intrinsic volume expansion 2/2 size
- Available in isotonic (ex. 5% albumin) and hypertonic (ex. 25% albumin) forms
- No difference in outcomes amongst colloids
- Expensive, not readily available everywhere
- Risk: anaphylaxis with all agents, bleeding risk and ARF with dextran products and hetastarch

### Fluid Therapy: Colloids

- Albumin
  - Available in 5% and 25%
  - Can be given as bolus or continuous infusion
  - Extracted from pooled human plasma
- Hetastarch/pentastarch
  - Both isotonic and iso-osmolar
  - Semi-synthetic starches
  - Increased risk of mortality 2/2 renal injury, not to be used in critically ill pts
- Dextran products
  - Dextran 40, 70, 75
  - Semi-synthetic glucose polymers

### Blood Products

- pRBCs, FFP, PLT, cryoprecipitate, concentrated coagulation factors
- Risks
  - Transmission of blood-borne pathogens
  - Increasing blood viscosity
  - Immunomodulatory effects with pRBCs
  - Hypocalcemia 2/2 citrate in pRBCs binding Ca
  - Transfusion-related reactions

### Blood Products

- pRBCs
  - Increase O<sub>2</sub> carrying capacity
  - 1 unit raises Hg by ~1 g/dL or HCT by 3%
  - Indicated in pts with continued deterioration after volume replacement
- Fresh Frozen Plasma (FFP)
  - Replaces clotting factors
  - Indicated in pts with ongoing hemorrhage and coagulopathy
- Platelets
  - indicated in pts with bleeding 2/2 severe thrombocytopenia or rapidly dropping PLT 2/2 bleeding

### Vasopressors

- Without volume expansion vasopressors will not work!
- Help perfuse vital organs at the expense of extremities
- Selection of vasopressor should be tailored to each patient's hemodynamic variables
- NE is considered 1<sup>st</sup> line in most cases of shock
- Vasopressin, dopamine, Epinephrine, and phenylephrine can be 1<sup>st</sup> or 2<sup>nd</sup> line agents
- Administered as continuous infusion and titrated to goal MAP

### Vasopressors

- Vasopressors can be stacked for added effect
- Mortality data is lacking with vasopressors
- At high doses, all pressors can cause peripheral ischemia and metabolic acidosis
- AEs
  - Tachycardia and arrhythmias with epi and DA
  - Splanchnic hypoperfusion with epi, VSP, and DA
  - Hyperglycemia with epi
  - Possible ↓ CO with phenylephrine and VSP