---SHOCK---

Due to: 1. Hypoperfusion (inadequate O2 delivery)
2. Systemic inflammation (toxic cellular insult)
Each one worsens the other
Physiology of circulation and inflammation
--Total body O2 delivery
oxygenation – ventilatory support
Hgb – transfuse
C.O. – most difficult to control; ventricular function and venous return (VR)
CVP measures R heart pressures; PCWP measures L heart pressure
Venous resistance mostly in large veins in thorax, abdomen
Thus VR decreases with: PEEP, ascites, bowel distension
--Damaged vessels 1st constrict; then vasodilation occurs & capillary permeability ↑s (exudate /edema)
PMNs (hours), Macrophages (days), Fibroblasts and Endothelial cells (max d 7-10)

Hypoperfusion

S/Sx: Tachycardia, peripheral vasoconstriction, diaphoresis, oliguria, hyperglycemia
hypotensive, supine adult = >30% (1500ml) blood loss
Renin-Ang-Aldo: more helpful for hypovolemic (not cardiogenic) hypoperfusion
↓O2→ ↓ATP, ↑Lactic acid→ ↓Na/Ca efflux→ ↑H2O into cells = 3rd spacing (=further hypoperfusion)
Resuscitation endpoints: CI >4.5, O2 deliv >600ml/min/m2, O2 use >170, SvO2 >75%
Etiologies:

1. ↓VR – hypovolemia
   #1 cause of hypotension
   d/t fluid movement into cells and increased cap. permeability
   Rx: rapid crystalloid infusion (3:1, replacement : fluid loss)
   PRBCs if Hgb ≤7 (transfuse to >8)
   No advantage to transfuse Hgb to > 10 (unless cardiac dz)
   LR may increase inflammation (especially with ischemia-reperfusion)
   Give dopamine if poor response to fluids (↓venous capacitance, ↑VR)
2. ↓VR – pericardial tamponade
   usu d/t trauma, rarely post-cardiac surgery
   must distinguish from CHF (usu NL BP, major insult to heart)
   S/Sx: JVD, muffled S1,S2, ↓BP>10 w/ inspiration, low voltage QRS
   Rx: pericardiocentesis, aggressive fluids
3. ↓VR – tension PTX
   hypotension, JVD, U/L decreased breath sounds, trachea shift
4. ↓VR – ↑ abdominal pressure (>25mmHg)
   causes ↑ intrathoracic press., ↑ venous resistance (abd. veins) = ↓VR
   Rx: aggressive fluids; open abd. if hemodynamic/resp compromise
5. Cardiogenic shock / hypoperfusion
   CI < 2.2 L/min/m2; high mortality
   The ONLY circulatory defect that is WORSENED w/ fluid administration
   Should be able to document cardiac insult, otherwise consider other czs
   May be d/t arrhythmia, ischemia, infarct
   Rx: treat arrhythmia; if none, treat like CHF by ↑CO (reverse cz, ↓ preload/afterload, ↑contractility)
   IABP
   Dobutamine (↑contractility, ↓preload, no change/↓ afterload)
   predom. B1 ag, weak B2 ag [vasodiln], a1 approx neutral

Inflammatory states

Benefits of inflamn are local; detrimental effects are systemic
Etiology: infxn, ischemia-reperfusion, trauma, burn, pancreatitis, drug or transfusion rxn
Pts at risk: 1. recent dz/injury; 2. underlying dz / recent procedure
--circulation
3rd spaced fluid: into cells, area of inflammation, bowels (d/t ileus)
↑ pulmonary vasc. resistance = ↑RA pressure = ↓VR
--cell
cytopathic hypoxia: cells perceive low O2 when O2 nl (d/t inflamn mediated changes)
e.g. lactic acidosis, ↓ cell memb fxn, ↑ intracell. Na/Ca from hypoxia OR inflamn

SIRS: shock w/o documented infxn; ≥2 of following:
T >38.5 or <36 HR >90 RR >20 WBC >12
Worse if: T <36, WBC <4, hypotensive, organ malfnxn
--S/Sx
MS change often seen before hemodynamic Sx
hypotension with warm hands (d/t inflamn, spinal cord inj, or anaphylaxis)
oliguria, ileus
positive fluid balance and resp Sx (from ARDS) [must be distinguished from CHF]
--labs
heomoconcentration (↑ Hgb) used to monitor intravasc. vol.
↓ total Ca d/t pancreatitis (correlates with severity of dz)
↓ ionized Ca = hypoperfusion or inflamn (levels correlates with severity)
hyperglycemia
--Rx
1. Rx cause (infxn #1 cz), 2. support organs, 3. inhibit inflamn
Dopamine; [low]=B1 ag, [hi]=a1 ag; also D1,D2 action = mesenteric/renal vasodilation
works best for hypovolemia
Amrinone: PDE inhib, ↑ inotropy (work even when catecholamine receptor fxn ↓d)
vasoconstrictors (NE, neo) when SVR low; esp when vessels w/ fixed stenosis (coronary or carotid a.s)
require increased BP for adequate perfusion
↓ing CI and ↑ing SVR = resolving inflamn

SUMMARY

	CI (2.4-3)	SVR (800-1200)	PCWP (8-12)
Hypovolemic	↓	↑	↓
Cardiogenic	↓	↑	↑
Obstructive	↓	↑	NL/↑
Distributive	↑	↓	NL/↓

--Rx
Hypovolemia: IVF, transfuse
Cardiogenic: monitor CVP (fluids/lasix), dobutamine, nitro
Obstructive= tension PTX, cardiac tamponade, PE: Rx specific cause
Distributive: IVF plus Rx specific cause
spinal cord inj: steroids
anaphylaxis: airway, epi, benadryl
sepsis: ABX