SHOCK

A state of ***tissue hypoxia*** due to decreased/dysregulated oxygen delivery and/or extraction

Initially reversible, but rapidly progresses: cell death → end-organ dysfunction → multi-organ failure → death

Shock can develop in the setting of ***increased tissue demand***, ***decreased oxygen supply***, or both

Metabolic Rate

Cell Damage

Tissue Demand > O_2 Supply

O_2 Content	$C_aO_2 = (1.34 \times Hgb \times S_aO_2) + (0.003 \times P_aO_2)$ C_aO_2 = Arterial oxygen content Hgb = Hemoglobin concentration S_aO_2 = Arterial oxygen saturation P_aO_2 = partial pressure of oxygen in arterial blood
Cardiac Output	$CO = HR \times SV$ CO = Cardiac Output HR = Heart rate SV = Stroke volume
MAP	$MAP = CO \times SVR = \frac{1}{3}\ SBP + \frac{2}{3}\ DBP = DBP + \frac{1}{3}\ PP$ MAP = Mean arterial pressure CO = Cardiac output SVR = systemic vascular resistance SBP = Systolic blood pressure DBP = Diastolic blood pressure PP = Pulse pressure

Clinical Manifestations

Neuro: Altered mental status

CVS: Hypotension (SBP <90 mmHg or ↓SBP >40 mmHg)

Renal: Metabolic acidosis (↑ lactate),
Oliguria (<0.5 cc/kg/hr for 12 hours **or** <0.3 cc/kg/hr for 24 hours)

Ext: Cool/Clammy vs. Warm/Flushed

Management Considerations

Resp: Intubate if needed, but have pressors available as intubation can worsen hypotension. SpO_2 often unreliable due to peripheral vasoconstriction; may require frequent ABGs

ID: If septic shock is on differential → blood cultures & start broad spectrum antibiotics within 1 hour

CVS: Titrate to MAP >65 mmHg; If cardiogenic titrate to MAP >60 mmHg

Fluids: Give as boluses (not infusion) for quick response; If sepsis, give 30 mL/kg within first 3 hours; Approximation of fluid responsiveness: improvement in BP, ↑ Urine output, ↓ Lactate

	Distributive	Hypovolemic	Cardiogenic	Obstructive
Pathophys	↓ SVR, Altered O_2 extraction *[except neurogenic]*	↓ CO → Inadequate O_2 delivery		
Extremities	Warm & Dry	Cold & Dry	Cold & Wet	Cold & Dry
CVP/PCWP	↓	↓	↑	↓ or ↑
CO or CVO_2	↑ or Normal	↓	↓↓	↓
S_VO_2	↓ *[early septic, neurogenic]* ↑ *[late septic]*	↓	↓	↓ or Normal
SVR	↓↓	↑	↑	↑
Examples	• **Inflammatory:** Infectious (sepsis), Non-infectious (pancreatitis, post-arrest) • **Reactionary:** Anaphylaxis, Toxins/Meds • **Other:** Adrenal insufficiency (AI), Thyroid disease, Liver failure, Neurogenic/spinal	• **Hemorrhagic:** GI, Retroperitoneal, Postpartum, Trauma, Hemothorax • **Hypovolemic:** Vomiting/ diarrhea, Over-diuresis/Dialysis, Burns, Drains, Open wound/ abdomen	• Myocardial infarction (MI) • Heart failure (HF) • Severe valve disease • Myocarditis • Arrhythmias	• Pulmonary embolus (PE) • Tension pneumothorax • Cardiac tamponade
Management	• **All causes:** IVF, Vasopressors • **Sepsis:** Antibiotics, Source control • **Adrenal:** Steroids (hydrocortisone ± fludricortisone) • **Anaphylaxis:** Epinephrine 0.3-0.5mg IM q5-10min • **Toxins**: Reversal agents, Dialysis	• **Ensure adequate access:** ≥ 2 large bore IVs • **Most cases:** Crystalloid fluid • **Hemorrhagic:** Transfuse, Control bleed (IR/Surgery) • **Cirrhotic (HRS):** Albumin, Octreotide, Midodrine	• **Diuresis** • **Vasopressors** • **Inotropes**	• **PE:** Heparin/Fibrinolytics/ Thrombectomy • **PTX:** Chest tube vs. Needle decompression • **Tamponade:** Pericardiocentesis