NOTES
SHOCK

SHOCK

osms.it/shock

PATHOLOGY & CAUSES

- Global inadequate tissue perfusion
  - Extremely low blood pressure (BP) → end-organ failure

TYPES

- Hypovolemic shock, cardiogenic shock, obstructive shock, distributive shock

Hypovolemic Shock

- General clinical manifestations
  - Reduced preload with suspected cause
- Variable presentation based on etiology of fluid loss
- Hemorrhage, evidence of trauma
  - Internal bleeding into thoracic/peritoneal/retroperitoneal space
- Nonhemorrhagic fluid loss
  - Decreased tissue perfusion
  - Elevated blood urea nitrogen, serum creatinine concentration (non-specific, i.e. seen in all forms of shock)
  - Abnormal potassium levels
  - Metabolic acidosis/alkalosis
  - Hematocrit, serum albumin concentration → reduction in plasma volume increases concentration

Cardiogenic Shock

- General clinical manifestations
  - Hypotension, manifestations of pulmonary edema
- Subtypes of cardiogenic shock
  - *Myopathic:* find specific cause via ECG/lab values/chest radiograph
  - *Arrhythmogenic:* caused by arrythmia

Obstructive Shock

- General clinical manifestations
  - Low preload; obstruction of blood flow outside the heart
  - Cardiac tamponade, pulmonary embolism, tension pneumothorax

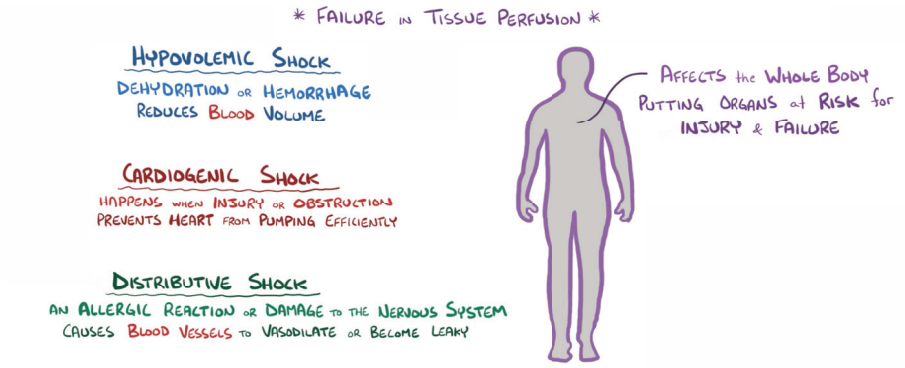

Figure 18.1 Illustration summarizing the causes and effects of hypovolemic, cardiogenic, and distributive shock.

Distributive Shock

- General clinical manifestations
  - Hypotension without reduced preload, fluid overload
- Subtypes of distributive shock
  - *Septic*: caused by infection
  - *Anaphylactic:* allergic reaction → respiratory distress, vomiting, abdominal pain, chest pain, dysrhythmia, collapse
  - *Neurogenic:* pain at site of spinal fracture, evidence of spinal injury (loss of sensation, paralysis, loss of reflexes)
  - *Endocrine:* adrenal crisis (nonspecific symptoms, eg. anorexia, nausea, vomiting, abdominal pain, fatigue, lethargy, weakness, fever, confusion, coma); confirmation of adrenal insufficiency

RISK FACTORS

- Dependent upon type
- Septic shock most common in United States, followed by cardiogenic, hypovolemic, other forms of distributive/obstructive shock
- Hypovolemic shock from gastrointestinal (GI) losses/dehydration most common in low-income countries

STAGING

Initial

- Cellular, not clinically apparent

Compensatory

- Neural, hormonal, biochemical compensation to maintain homeostasis; inadequate perfusion → autonomic nervous system attempts to compensate
  - Sympathetic nervous system

CAUSES OF SHOCK

	SUB-TYPE	PHYSIOLOGIC CHANGE	CAUSE
HYPOVOLEMIC	Hemorrhagic	Low preload	Trauma
	Non-hemorrhagic	Low preload	Vomiting, pancreatitis, diarrhea bowel obstruction, severe burns, fistula drainage, diabetes insipidus
CARDIOGENIC	Myopathic	Low contractility	Myocardial infarction, acute decompensation of any etiology of chronic heart failure, blunt cardiac injury, myocarditis
	Arrhythmogenic	Low HR, Low preload	Arrhythmia
OBSTRUCTIVE	Obstructive	Low preload	Cardiac tamponade, pulmonary embolism, tension pneumothorax
DISTRIBUTIVE	Septic	Low SVR	Infection
	Neurogenic	Low SVR, Low HR	Trauma
	Anaphylactic	Low SVR	Allergic reactions: insect bites or stings, drugs, allergies, IV contrast
	Endocrine/hypoadrenal	Low SVR, Low preload	Adrenal insufficiency

vasoconstriction, ↑ contractility
    - Release of catecholamines, vasopressin, angiotensin II → ↑ vasoconstriction, ↑ retention water, sodium → ↑ SVR, ↑ blood volume → ↑ BP → ↑ perfusion

Progressive

- Compensation fails, requires aggressive interventions to prevent multiple organ dysfunction syndrome

Irreversible

- Decreased perfusion (vasoconstriction, decreased cardiac output) → anaerobic metabolism; profound hypotension, hypoxemia, organ failure; recovery unlikely

SIGNS & SYMPTOMS

- Altered mental state, decreased peripheral pulse, tachycardia, hypotension
- Varies by type and subtype of shock (see table below)

DIAGNOSIS

DIAGNOSTIC IMAGING

Chest radiography

- Clear in hypovolemic/obstructive shock from pulmonary embolism
- Pneumonia
    - Septic shock
- Pneumothorax
    - Obstructive shock
- Pulmonary edema
    - Cardiogenic shock/ARDS

Pulmonary artery catheterization

- Hemodynamic measurements can be helpful
- Measure cardiac output, systemic vascular resistance, pulmonary artery occlusion pressure, right atrial pressure, mixed venous oxyhemoglobin saturation
- Rarely necessary to identify etiology of shock

Ultrasound/echocardiography

- Allows visualization of altered cardiac function
- Preserved/hyperdynamic left ventricle = distributive shock
- Point-of-care ultrasond
    - Examination of heart → cause of cardiogenic shock, obstructive shock

Focused assessment and sonography for trauma (FAST)

- Fast ultrasound examination for hemopericardium, intra-abdominal bleeding; rule out/in hypovolemic shock

Hemodynamic monitoring

- Via central venous catheters
- Elevated central venous pressure, low mixed venous oxygen saturation = cardiogenic shock

LAB RESULTS

Elevated serum lactate

- Early indicator, reflective of poor tissue perfusion

Renal, liver function tests

- Elevated blood urea nitrogen (BUN), creatinine, transaminases indicate end-organ damage
    - May help point to cause (acute hepatitis, chronic cirrhosis)

Coagulation studies, D-dimer level

- Elevated fibrin split products, elevated D-dimer level, low fibrinogen level = severe shock

Cardiac enzymes, natriuretic peptides

- Elevated troponin, creatine phosphokinase, N-terminal pro-brain natriuretic peptide, brain natriuretic peptide = cardiogenic shock due to ischemia/pulmonary embolism

Complete blood count, differential

- High hematocrit
    - Hemoconcentration from non-hemorrhagic hypovolemic shock
- Anemia, bleeding
    - Hemorrhagic shock
- Elevated eosinophil
    - Allergy, anaphylactic shock
- Leukocytosis
    - Septic shock, not specific; more common

in septic shock, may also occur in other types of shock as sign of poor prognosis

Coagulation studies, D-dimer level

- Elevated prothrombin time, international normalized ratio, activated partial thromboplastin time
  - Septic shock, other issues (e.g. sepsis, systemic inflammatory response syndrome); elevated D-dimer levels common in septic shock

Peripheral O_2 sat via pulse oximetry

- Hypoxemia
  - Obstructive, cardiogenic shock

Urinalysis

- Infection, septic shock

Material gram stain from infection sites

- Septic shock

Blood culture

- identifies causative microbe in case of septic shock; directs targeted antibiotic therapy

OTHER DIAGNOSTICS

History & physical

- Low blood pressure, tachycardia, tachypnea, signs of poor end-organ perfusion (low urine output, confusion, loss of consciousness), weak pulse, cool skin, metabolic acidosis, hyperlactatemia

Shock index

- Heart rate divided by systolic pressure
  - Normal range 0.5–0.8
  - If index higher, increased suspicion of underlying state of shock
  - Most useful for isolated hypotension/tachycardia

ECG

- Arrhythmia, ST segment changes consistent with ischemia
- Low-voltage ECG
  - Pericardial effusion
- Arrhythmia
  - Arrhythmogenic cardiogenic shock
- Ischemia
  - Myopathic cardiogenic shock

BLOOD PRESSURE CHANGES IN SHOCK

	PRELOAD (PWP)	PUMP FUNCTION (CO)	SVR	TISSUE PERFUSION (S_vO_2)
HYPOVOLEMIC	↓	↓	↑	↓
CARDIOGENIC	↑	↓	↑	↓
DISTRIBUTIVE	↓	↑ (early), ↓ (late)	↓	↑
OBSTRUCTIVE (PULMONARY EMBOLISM, HYPERTENSION, TENSION PNEUMOTHORAX)	↓	↓	↑	↓
OBSTRUCTIVE (PERICARDIAL TAMPONADE)	↑	↓	↑	↓

MNEMONIC: ABCDE

Treatment for shock

Airway: ensure clear airway, possibly intubate

Breathing: assist individual in breathing, mechanical ventilation/sedation

Circulation: administer fluids (e.g. isotonic crystalloid)

Delivery of oxygen: monitor lactate levels

Endpoint resuscitation (specific to septic shock)

TREATMENT

- See chart for a detailed summary of treatments for different forms of shock

OTHER INTERVENTIONS

Surviving sepsis campaign guidelines

- End resuscitation when urine output 0.5ml/kg/hr, central venous pressure (CVP) 8–12 mmHg, mean arterial pressure (MAP) 65–90mmHg, central venous oxygen concentration > 70%, normalize lactate levels
  - CVP 8–12mmHg (recent literature shows CVP poorly predicts fluid responsiveness, poor marker of adequate resuscitation)

TREATMENTS FOR SHOCK

	SUB-TYPE	TREATMENT
HYPOVOLEMIC	Non-hemorrhagic	- Fluid resuscitation - Prevent hypothermia caused by fluid resuscitation
	Hemorrhagic	- Same treatment as non-hemorrhagic shock - Packed red blood cell transfusion
CARDIOGENIC	Cardiogenic	- Diuretics - Inotropes - Intra-aortic balloon pump - ACE inhibitors - Hydralazine
	Obstructive	- Treat underlying cause
DISTRIBUTIVE	Septic	- Antibiotics - Fluid resusitation - Vasopressors
	Anaphylactic	- Epinephrine - Antihistamines - Fluid resusitation
	Neurogenic	- Fluid resusitation - Vasopressors - Corticosteroids
	Endocrine/hypoadrenal	- Corticosteroids