Shock

A life-threatening state of inadequate tissue perfusion leading to cellular hypoxia and organ dysfunction.

Overview and Epidemiology

- Medical emergency with high mortality if untreated (10-50% depending on type).
- Common in ICU, ED, post-surgical units.
- **Risk factors:** Trauma, infection, heart disease, pulmonary embolism, anaphylaxis.

Pathophysiology

- Decreased cardiac output (CO) or systemic vascular resistance (SVR) impairs oxygen delivery, causing lactic acidosis and organ failure.
- Compensatory mechanisms (tachycardia, vasoconstriction) fail over time.
- **Types:** Hypovolemic, Cardiogenic, Distributive (septic, anaphylactic, neurogenic), Obstructive.

Types, Causes, and Distinguishing Factors

1. Hypovolemic Shock:

Causes: Hemorrhage (trauma, GI bleed), dehydration (vomiting, diarrhea, burns).

Distinguishing Factors: Low preload, high SVR, cold/clammy skin, oliguria.

2. Cardiogenic Shock:

Causes: Myocardial infarction (MI), heart failure, arrhythmias, valvular dysfunction.

Distinguishing Factors: Pump failure, high SVR, pulmonary edema, jugular venous distension (JVD).

3. Distributive Shock:

Septic Shock: Infection (e.g., pneumonia, UTI), low SVR, warm skin (early), high lactate.

Anaphylactic Shock: Allergic reaction (e.g., food, drugs), low SVR, urticaria, bronchospasm.

Neurogenic Shock: Spinal cord injury, low SVR, bradycardia, warm/dry skin.

Distinguishing Factors: Vasodilation, variable skin findings, specific triggers.

4. Obstructive Shock:

Causes: Pulmonary embolism (PE), tension pneumothorax, cardiac tamponade.

Distinguishing Factors: Mechanical obstruction to CO, high SVR, JVD, muled heart sounds (tamponade).

Clinical Presentation and Exam Findings

- **General Symptoms:** Hypotension (SBP <90 mmHg or MAP <65 mmHg), altered mental status, oliguria, weakness.
- Exam Findings by Type:
  - **Hypovolemic:** Tachycardia, cold/clammy skin, dry mucous membranes, flat neck veins.
  - **Cardiogenic:** Tachycardia, cool skin, rales, S3 gallop, JVD, peripheral edema.
  - **Septic:** Fever, warm skin (early), tachycardia, bounding pulses (early), mottled skin (late).
  - **Anaphylactic:** Stridor, wheezing, urticaria, angioedema, tachycardia.
  - **Neurogenic:** Bradycardia, warm/dry skin, hypotension without tachycardia.
  - **Obstructive**:
    - **PE:** Tachypnea, hypoxia, right heart strain (ECG: S1Q3T3).
    - **Tamponade:** Beck's triad (JVD, muled heart sounds, hypotension), pulsus paradoxus.
    - **Tension Pneumothorax:** Tracheal deviation, absent breath sounds, hyperresonance.
- **Red Flags:** Lactate >2 mmol/L, persistent hypotension, end-organ damage (e.g., AKI, confusion).

Echocardiogram Findings

- **Hypovolemic:** Hyperdynamic left ventricle (LV), small chamber sizes, collapsible inferior vena cava (IVC) due to low preload.
- **Cardiogenic:** Reduced LV ejection fraction (EF <40%), regional wall motion abnormalities (MI), dilated LV/RV, mitral regurgitation.
- **Septic:** Hyperdynamic LV (early), normal or high EF, dilated IVC if fluid-responsive.
- **Anaphylactic:** Normal or hyperdynamic LV, no specific structural abnormalities.
- **Neurogenic:** Normal LV function, no specific changes unless secondary hypovolemia.

- Obstructive:
  - **PE:** Right ventricular (RV) dilation, RV strain (D-sign), tricuscular regurgitation.
  - **Tamponade:** Pericardial eusion, RV collapse, IVC plethora, respiratory variation in mitral inflow.
  - **Tension Pneumothorax:** Limited role; may show RV compression if severe.
- **Key Tip:** Bedside echo (point-of-care ultrasound) is critical for rapid diagnosis of obstructive and cardiogenic shock.

Diagnostic Workup

- Labs:
  - Lactate (tissue hypoxia), CBC (anemia, infection), BMP (renal function), troponin (MI), BNP (heart failure), blood cultures (sepsis), Hepatic function panel (shock liver), procalcitonin, ABG, respiratory cultures, urine cultures, etc
- Imaging:
  - **CXR:** Pulmonary edema (cardiogenic), pneumothorax, infiltrates (sepsis).
  - **CT:** PE (CTPA), intra-abdominal bleeding.
- **Echocardiogram:** See findings above.
- **Pulmonary Artery Catheter (PAC):** Rarely used; see table below for hemodynamic data.
- Other:
  - **ECG:** Arrhythmias, MI, right heart strain (PE).
  - **ABG:** Metabolic acidosis, hypoxemia.
  - **Ultrasound:** FAST exam (trauma), IVC collapsibility (hypovolemia).
- **Key Tip:** Lactate >4 mmol/L or refractory hypotension requires urgent intervention.

Treatment

- General Principles:
- **Airway/Breathing:** Secure airway if needed; O2 to maintain SpO2 >90%.
- **Circulation:** Large-bore IV access, fluid resuscitation, vasopressors if refractory.
- **Monitor:** Continuous vitals, urine output, lactate clearance.

Type-Specific Treatments:

1. Hypovolemic Shock:

- **Fluids:** 1-2 L crystalloid (normal saline or lactated Ringer's) bolus; assess response.

- **Blood Products:** PRBCs for hemorrhage (target Hgb >7 g/dL, >8 in MI); FFP/platelets if coagulopathy.
- **Source Control:** Surgery for bleeding (e.g., trauma, GI bleed).

2. Cardiogenic Shock:

- **Fluids:** Cautious (250-500 mL bolus) if no pulmonary edema; avoid if congested.
- **Inotropes/Vasopressors:** Dobutamine (5-20 mcg/kg/min) or norepinephrine (0.01-0.3 mcg/kg/min) for hypotension.
- **Afterload Reduction:** Nitroglycerin (10-20 mcg/min IV) or nitroprusside (0.3-10 mcg/kg/min) if BP allows (SBP >100 mmHg) to reduce myocardial workload.
- **Diuresis:** Furosemide (20-40 mg IV) for pulmonary edema or fluid overload; monitor renal function.
- **Cardiology Consult:** PCI for MI, manage arrhythmias, consider IABP or ECMO in refractory cases.
- **Key Tip:** Balance afterload reduction and diuresis to avoid hypotension

3. Distributive Shock:

- Septic Shock:
  - **Fluids:** 30 mL/kg crystalloid within 3 hours (Surviving Sepsis).
  - **Antibiotics:** Broad-spectrum (e.g., vancomycin + piperacillin-tazobactam) within 1 hour; de-escalate per cultures.
  - **Vasopressors:** Norepinephrine first-line if MAP <65 mmHg despite fluids.
  - **Source Control:** Drain abscesses, remove infected devices.
- Anaphylactic Shock:
  - Epinephrine: 0.3-0.5 mg IM (1:1000) q5-15 min; IV infusion if refractory.
  - **Adjuncts:** Antihistamines (diphenhydramine), steroids (hydrocortisone), albuterol for bronchospasm.
- Neurogenic Shock:
  - **Fluids:** Crystalloid bolus to restore preload.
  - **Vasopressors:** Phenylephrine or norepinephrine; atropine for bradycardia.
  - **Spinal Stabilization:** Immobilize spine, neurosurgery consult.

4. Obstructive Shock:

- **PE:** Anticoagulation (heparin), thrombolytics (tPA) for massive PE, embolectomy if unstable.
- **Tamponade:** Pericardiocentesis (ultrasound-guided), surgical consult.

- **Tension Pneumothorax:** Needle decompression (2nd intercostal space, midclavicular line), then chest tube.
    - **Fluids/vasopressors:** Titrate to MAP >65 mmHg, lactate clearance, clinical stability.
- **Key Tip:** Reassess q30-60 min; avoid fluid overload in cardiogenic shock.

Complications

- Multi-organ dysfunction syndrome (MODS), acute kidney injury (AKI), acute respiratory distress syndrome (ARDS), disseminated intravascular coagulation (DIC).
- Monitor for worsening lactate, oliguria, altered mental status.

Prognosis

- **General:** Early intervention improves outcomes; mortality varies.
- Mortality:
    - **Hypovolemic:** 10-20% (higher in uncontrolled hemorrhage).
    - **Cardiogenic:** 20-40% (highest post-MI).
    - **Septic:** 15-30% with timely treatment.
    - **Obstructive:** 10% for treated PE, near 100% for untreated tamponade.
- **Recovery:** Survivors may have prolonged fatigue, organ dysfunction; follow-up with specialists.

Key Pearls

- Lactate >4 mmol/L or persistent hypotension = urgent action.
- Echo distinguishes cardiogenic (low EF) vs. obstructive (RV strain, eusion).
- **Septic shock:** Antibiotics within 1 hour save lives.
- **Cardiogenic shock:** Use afterload reduction/diuresis cautiously.
- **Obstructive shock:** Treat cause (e.g., pericardiocentesis) immediately.

Summary table:

Type	SVR	CO	PCWP	Skin	Key Exam	Treatment
Hypovolemic	High	Low	Low (<8)	Cold/clammy	Flat veins	Fluids, blood
Cardiogenic	High	Low	High (>18)	Cool/wet	JVD, rales	Inotropes, diuresis
Septic	Low	High	Low/Normal	Warm (early)	Fever	Antibiotics, fluids
Obstructive	High	Low	Variable	Variable	JVD, muled sounds	intervention

References

Surviving Sepsis Campaign Guidelines (2021).

UpToDate: “Evaluation and Management of Shock.”

AHA Guidelines for Cardiogenic Shock (2020).

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