Diagnosis and Management of Shock
Objectives

- Identify the main categories of shock
- Discuss goals of resuscitation in shock
- Summarize principles of shock management
- Describe effects of vasopressor and inotropic agents
- Discuss the differential diagnosis of oliguria
Case Study

- 25-year-old with productive cough
- Heart rate 129/min, blood pressure 112/68 mm Hg, respirations 27/min, temperature 101.8°F (38.8°C)

Does this patient have shock?
Shock

- Syndrome of impaired tissue oxygenation and perfusion

- Mechanisms
  - Absolute/relative decrease in oxygen delivery
  - Ineffective tissue perfusion
  - Ineffective utilization of delivered oxygen
Case Study

- 25-year-old with productive cough
- Heart rate 129/min, blood pressure 112/68 mm Hg, respirations 27/min, temperature 101.8°F (38.8°C)

What other clinical and laboratory findings would suggest the presence of shock?
Clinical Manifestations

- Hypoperfusion/inadequate oxygenation
  - Hypotension
  - Altered mental status
  - Oliguria

- Compensatory mechanisms
  - Vasoconstriction
  - Tachycardia

- Specific etiology
  - Metabolic acidosis
  - ↑Lactate
  - Abnormal creatinine, transaminases, etc
Case Study

- Heart rate 129/min, blood pressure 112/68 mm Hg, respirations 27/min, temperature 101.8°F (38.8°C)
- SpO₂ 90% on nonrebreather mask (NRBM)
- Skin warm and dry
- Lactate 4.2 mg/dL
- White blood cell count 22,000/mm³

What type of shock does this patient likely have?
Classification of Shock

Cardiogenic
- Myopathic
- Mechanical
- Arrhythmic

Hypovolemic
- Hemorrhagic
- Nonhemorrhagic

Distributive
- Septic
- Adrenal crisis
- Neurogenic
- Anaphylactic

Obstructive
- Massive pulmonary embolism
- Cardiac tamponade
- Tension pneumothorax
- Constrictive pericarditis
## Classification of Shock

<table>
<thead>
<tr>
<th></th>
<th>Cardiac output</th>
<th>Filling pressures</th>
<th>Vascular resistance</th>
<th>ScvO\textsubscript{2} \textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiogenic</strong></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Hypovolemic</strong></td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Distributive</strong></td>
<td>↑ or N</td>
<td>↓ or N</td>
<td>↓</td>
<td>↑ or N</td>
</tr>
<tr>
<td><strong>Obstructive</strong></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>
Case Study

- Blood pressure 88/40 mm Hg (↓)
- Heart rate 135/min (↑)
- Respirations 32/min (↑)
- SpO₂ 90% (NRBM)
- Lactate 4.2 mg/dL

What initial interventions are needed to treat shock in this patient?
Treatment of Shock

- Restore tissue perfusion and oxygenation
- Treat specific etiology
- Monitor
- Provide supportive care
Case Study

- BP 88/40 mm Hg
- HR 135/min
- RR 32/min
- Temperature 101.8°F (38.8°C)
- SpO₂ 90% (NRBM)
- Lactate 4.2 mg/dL

What interventions would increase oxygen delivery?

What interventions would decrease oxygen consumption?
Oxygen Delivery

Determinants
- Blood pressure
- Cardiac output
- Oxygen content

Interventions
- Fluids
- Vasoactive agents
- Blood transfusion
- Supplemental oxygen
Case Study

- Patient is intubated and sedated
- Chest radiograph → pneumonia
- Blood pressure 88/40 mm Hg
- Heart rate 135/min
- Hemoglobin 12 g/dL

Which fluids would you administer?

- Crystalloids
- Colloids
- Blood
Case Study

- Patient is intubated and sedated
- Chest radiograph → pneumonia
- Blood pressure 88/40 mm Hg (MAP 56)
- Heart rate 135/min

How much fluid is needed?

- Fluid boluses recommended
- Correct hypotension then perfusion
- Monitor oxygenation
Case Study

- Normal saline solution 4 L administered
- Blood pressure 92/44 mm Hg (MAP 60)
- Heart rate 120/min
- SpO₂ 91% on 80% oxygen

What is the next intervention for shock?
## Vasoactive Agents

<table>
<thead>
<tr>
<th>Agents</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dopamine</td>
<td>Vasopressor</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>Inotropic</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Vasodilator</td>
</tr>
<tr>
<td>Vasopressin</td>
<td></td>
</tr>
<tr>
<td>Dobutamine</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

Which agent(s) is/are recommended in septic shock?
Supplemental O₂ ± endotracheal intubation and mechanical ventilation

Central venous and arterial catheterization

Sedation, paralysis (if intubated), or both

CVP
<8 mm Hg
Crystalloid

8–12 mm Hg

MAP
<65 mm Hg
Vasoactive Agents

≥65 and ≤90 mm Hg

ScvO₂
<70%
Transfusion of red cells until hematocrit ≥30%

≥70%

Goals Achieved
≥70%
Inotropic Agents

Yes
No
Continue to reassess

≥65 and ≤90 mm Hg

≥70%

≥70%
Case Study

- Normal saline solution 4 L administered
- Norepinephrine at 0.3 \( \mu \text{g/kg/min} \)
- Blood pressure 98/48 mm Hg (MAP 65)
- Heart rate 110/min

What other interventions might be considered?
Management of Shock

How would fluid and vasoactive agent use differ in other types of shock?

- Hypovolemic shock
- Cardiogenic shock
- Obstructive shock
Case Study

- 24 hours later norepinephrine stopped
- Normal saline solution at 150 mL/h
- Blood pressure 110/60 mm Hg (MAP 77)
- Urine output 25 mL/h
- Creatinine 1.8 mg/dL, BUN 28 mg/dL

Should fluid infusion be increased to improve urine output and renal function?

What evaluations would be helpful?
<table>
<thead>
<tr>
<th>Test</th>
<th>Prerenal</th>
<th>ATN</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN/creatinine ratio</td>
<td>&gt;20</td>
<td>10-20</td>
</tr>
<tr>
<td>Urine specific gravity</td>
<td>&gt;1.020</td>
<td>&gt;1.010</td>
</tr>
<tr>
<td>Urine osmolality (mOsm/L)</td>
<td>&gt;500</td>
<td>&lt;350</td>
</tr>
<tr>
<td>Urine Na (mmol/L)</td>
<td>&lt;20</td>
<td>&gt;40</td>
</tr>
<tr>
<td>Fractional excretion of Na (%)</td>
<td>&lt;1</td>
<td>&gt;2</td>
</tr>
</tbody>
</table>
Management of Oliguria

- Volume challenge
- Loop diuretic for fluid management
- Fluid balance
- Dosage adjustment of medications
- Avoid nephrotoxic drugs
- Renal replacement therapy
Questions
Key Points

- Shock is characterized by impaired tissue oxygenation and hypoperfusion.
- Types of shock are hypovolemic, distributive, cardiogenic, and obstructive.
- Manifestations of shock result from inadequate tissue oxygenation, compensatory responses, and the specific etiology.
- Intervention goals are adequate blood pressure and cardiac output, optimal oxygen content, and decreased oxygen demand.
Key Points

- Initial therapy for most types of shock is volume replacement.
- Vasoactive agents should be chosen based on desired hemodynamic effect and pharmacologic profile.
- Reversible causes of oliguria should be excluded and intravascular volume optimized.