Understanding Shock

Shock is a physiologic state characterized by a significant, systemic reduction in tissue perfusion. Tissue perfusion is determined by SVR (systemic vascular resistance), and cardiac output. SVR is governed by vessel length, blood viscosity and the inverse vessel diameter. Cardiac output is equal to heart rate times stroke volume. Stroke volume depends upon preload (volume of blood in the ventricle prior to contraction), myocardial contractility and afterload (the pressure against which the heart must pump).

Shock can develop from a variety of conditions that result from:

- Insufficient circulatory blood volume (preload)
- Changes in vascular resistance (afterload)
- Heart failure (contractility)
- Obstruction to blood flow

The effects of decreased tissue perfusion include:

- Poor perfusion of vital organs resulting in impaired function, decreased mental state and decreased urine output
- Lactic acid accumulates as cells switch to anaerobic metabolism resulting in metabolic acidosis
- Hypoperfusion initiates inflammatory events that cause micro ischemia and cell damage.

There are three stages of shock:

1. Preshock – Sometimes called warm or compensated shock. In preshock the body mechanisms rapidly compensate for the diminished perfusion.
2. Shock – Regulatory mechanisms are overwhelmed and signs and symptoms of organ dysfunction appear. These include tachycardia, tachypnea, metabolic acidosis, decreased urine output, cool and clammy skin and restlessness. These symptoms usually correspond to one of the following:
   - 20 – 25 percent reduction in blood volume
   - Decrease in cardiac index to less than 2.5L/min
   - Activation of innumerable mediators of the sepsis syndrome
3. End-organ dysfunction – During this stage, progressive end-organ dysfunction leads to irreversible organ damage and death:
   - Decreased urine output leads to anuria (the absence of urine production)
   - Restlessness progresses to agitation, obtundation and coma
   - Acidosis from decreased cardiac output alters cellular metabolic processes
   - Multi-system organ failure proceeds to cause demise of the patient

Classifications of Shock

Hypovolemic Shock
Hypovolemic shock results from decreased preload. Since preload is one of the determinants of stroke volume, cardiac output falls when preload drops. It is caused by either hemorrhage or fluid loss (diarrhea, vomiting, heat stroke, burns and “third spacing.”)

Cardiogenic Shock
Cardiogenic shock results from pump failure. Causes include:

- Cardiomyopathies
- Arrhythmias
- Mechanical abnormalities (i.e. aortic stenosis, mitral valve regurgitation, dissecting aortic aneurysm, ruptured papillary muscle)
Obstructive Shock
Obstructive shock results from mechanical factors that interfere with the filling or emptying of the heart or great vessels. Mechanisms interfering with ventricular filling include: tension pneumothorax, vena cava compression, cardiac tamponade, atrial tumor or clot. Mechanisms interfering with ventricular emptying include: pulmonary emboli

Distributive Shock
Distributive or vasodilatory shock results from decrease in SVR producing increased blood flow to skin and a wide pulse pressure. Causes of distributive shock include:
- Anaphylaxis
- Sepsis
- Toxic Shock Syndrome
- Drug or toxin reaction
- Addisonian crisis
- Myxedema coma
- Central nervous system or spinal cord injury – sudden loss of sympathetic tone

Pathophysiology Profile of Shock State

<table>
<thead>
<tr>
<th>Physiologic state</th>
<th>Preload</th>
<th>Cardiac Output</th>
<th>Afterload</th>
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</thead>
<tbody>
<tr>
<td>Hypovolemic</td>
<td>decreased</td>
<td>decreased</td>
<td>increased</td>
</tr>
<tr>
<td>Cardiogenic</td>
<td>increased</td>
<td>decreased</td>
<td>increased</td>
</tr>
<tr>
<td>Obstructive</td>
<td>decreased</td>
<td>decreased</td>
<td>increased</td>
</tr>
<tr>
<td>Distributive</td>
<td>decreased or unchanged</td>
<td>increased</td>
<td>decreased</td>
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</tbody>
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Clinical Presentation
The patient’s clinical presentation varies with the type and cause of their particular shock, but there are several symptoms common amongst them all:
- Hypotension - Cool and clammy skin
- Oliguria – decreased urine output
- Change in mental status
- Metabolic acidosis

Initial assessment and history will help determine the specific type of shock. A patient may have more than one type of shock, such as a child with cardiogenic shock from SVT who is also hypovolemic because he has been unable to drink or someone with underlying cardiomyopathy who is septic.

Patterns that may be helpful:
- Hypovolemic: History of volume loss, narrow pulse pressure, signs of poor perfusion, small or normal heart on x-ray
- Septic: History of fever or immunocompromised, wide pulse pressure, variable peripheral perfusion, purpuric rash
- Anaphylactic: History of exposure to an allergen, stridor or wheezing, wide pulse pressure, vasodilation, urticaria, facial edema, abdominal cramping
- Neurogenic: History of trauma, decreased blood pressure with wide pulse pressure, normal heart rate or bradycardia
Cardiogenic  History of heart disease, central cyanosis, signs of heart failure, heart murmur, decreased pulse or BP in lower extremities

Obstructive  History of major chest injury, recent surgery or long bone fracture, narrow pulse pressure.

**Approach to the Classification of Undifferentiated Shock**

1. Signs and symptoms of shock
   - History of trauma
     - Yes
       - Hemorrhagic shock
         - Obstructive shock (tension pneumothorax, cardiac tamponade)
         - Cardiogenic shock (myocardial injury)
         - Neurogenic shock (spinal cord injury)
     - No
       - History of fluid loss:
         - Vomiting
         - Diarrhea
         - Polyuria (as in DKA)
         - Hematemesis
         - Hematochezia

2. Hypovolemic shock:
   - Gastroenteritis
   - DKA
   - Third space losses (as in bowel obstruction or toxins such as iron)
   - Nontraumatic hemorrhage (as with GI bleeding)

3. Fever
   - Hypothermia
   - Immunocompromise

4. Septic shock
   - Abnormal cardiac exam

5. Cardiogenic shock:
   - Arrhythmia
   - Congenital heart disease
   - Myocarditis
   - Cardiomyopathy
   - Ingestion (such as calcium channel blocker)
   - Nontraumatic cardiac tamponade

6. Exposure to allergen
   - Wheezing
   - Urticaria

7. Anaphylaxis

Other causes:
- Nontraumatic tension pneumothorax
- Massive pulmonary embolus
- Adrenal insufficiency
Management

The overall management for a patient in any shock state is to correct the underlying problem. The paramedic must have good assessment skill as well as a comprehensive understanding of pathophysiology related to shock states in order to rapidly identify the specific cause, halt its progression, and begin aggressive treatment. The general management of all shock states is to provide generalized supportive care while trying to identify the cause. Generalized shock management includes ensuring the patient has a patent airway, adequate oxygenation, ventilation, perfusion and body temperature while identifying and correcting the underlying cause. Once the underlying cause and the shock state have been identified, your treatment plan will be altered to meet the needs of this specific patient:

Hypovolemic Shock
Treatment for hypovolemic shock is fluid resuscitation. Pharmacologic agents should only be used once fluid replacement has been assured.

Obstructive Shock
Treatment for Obstructive shock targets correcting the impedance of the circulatory flow.
- Tension pneumothorax = needle decompression
- Pericardial tamponade = fluid bolus until pericardiocentesis can be performed.
- Compression of great vessels = Reposition patient (i.e., pregnant patients)

Cardiogenic Shock
Treatment is aimed at restoring cardiac output by increasing SV and contractility of the heart. Dopamine starting at 5mcg/kg/min; may slowly titrate up to 20mcg/kg/min until systolic BP is maintained about 90 or MAP greater than 60.

Distributive Shock
Sepsis - Treatment is supportive and includes the use of fluid boluses and Dopamine 10mcg/kg/min titrated to max of 20mcg/kg/min
- Anaphylactic shock – Treatment is aimed at stopping and reversing the reaction and includes:
  - Epinephrine 1:10,000 titrated in 0.1mg increments every 1 minute up to max dose of 1mg IVP/IO
  - Fluid boluses to attain a systolic BP of 90 or greater
  - Diphenhydramine 50mg IVP/IO
  - Albuterol 2.5mg & Ipratropium 0.5mg/HHN if wheezing
- If SBP remains < 90: Dopamine IVPM 10mcg/kg/min titrated as needed to max of 20mcg/kg/min

Neurogenic Shock – Treatment includes:
- Fluid boluses in consecutive 200ml increments up to a total of 2 liters to maintain and systolic BP >90
- Atropine 0.5mg rapid IVP. May repeat every 3 minutes to a maximum of 3mg IVP
- If unresponsive to fluids and Atropine administer Dopamine 10mcg/kg/min titrated as needed up to max dose of 20mcg/kg/min.

Remember it is imperative when fluid resuscitating a patient, to reassess them after every 200ml bolus.
1. Tissue perfusion is determined by __________________ and __________________.

2. Stroke volume is dependent on:
   A. __________________
   B. __________________
   C. __________________

3. List and define the 3 stages of shock.
   A. __________________
   B. __________________
   C. __________________

4. Match the classification of shock with its cause:
   Hypovolemic ______ A. Results from pump failure
   Cardiogenic ______ B. Results from a mechanical obstruction
   Distributive ______ C. Results from decrease in SVR
   Obstructive ______ D. Results from decreased preload

5. Fill in the effects that each of the 4 shock classifications has on preload, cardiac output and afterload.

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6. You are called to the scene of a 38 year old male who fell off a ladder onto his left side. Patient complains of severe pain to his left ribs. You note he is pale with increased work of breathing and unequal chest rise. You check lung sounds and note them to be absent on the left. VS: BP 86/70, HR 132 RR 36. You suspect the patient to be in:
   A. Neurogenic (distributive) shock
   B. Obstructive shock
   C. Hypovolemic shock
   D. Cardiogenic shock

7. You arrive on the scene to find a 6y.o. female. Her parents tell you she has not been acting herself. She is lethargic with VS BP 72/34 HR 128 RR 40. Mother tells you earlier in the day she complained of chills and had a temperature of 101.2. You notice a petechial rash to both her lower extremities and she is hot to the touch. You suspect the child to be in:
   A. Septic shock
   B. Hypovolemic shock
   C. Obstructive shock
   D. Anaphylactic shock

8. The goal of treating a patient you suspect to be in cardiogenic shock is:
   A. Replacing fluid volume
   B. Correcting the impedance of the circulatory flow
   C. Restoring cardiac output by increasing SV and contractility of the heart
   D. Stopping and reversing the reaction of an allergen

9. The first line drug for treating neurogenic shock once you have begun fluid resuscitation and the patients heart rate remains below 60 is:
   A. Epinephrine 1:10,000 0.1mg IVP every one minute until response
   B. Dopamine 10mcg/kg/min titrated if needed to max dose of 20mcg/kg/min
   C. Atropine 0.5mg rapid IVP. May repeat every 3 minutes to a maximum of 3mg IVP
   D. Dopamine 5 mcg/kg/min drip

10. Even though we know it may take up to 2 liters of fluid to resuscitate a patient in septic shock, it is imperative we reassess the patient including lung sounds after every 200 ml bolus.
    A. True
    B. False

IF YOU ARE NOT A MEMBER OF THE MCHENRY WESTERN LAKE COUNTY EMS SYSTEM, PLEASE INCLUDE YOUR ADDRESS ON EACH OPTIONAL QUIZ TURNED INTO OUR OFFICE. WE WILL FORWARD TO YOUR HOME ADDRESS VERIFICATION OF YOUR CONTINUING EDUCATION HOURS.
IF YOU ARE A MEMBER OF OUR EMS SYSTEM, YOUR CREDIT WILL BE ADDED TO YOUR IMAGE TREND RECORD. PLEASE REFER TO IMAGE TREND TO SEE YOUR LIST OF CONTINUING EDUCATION CREDITS.
ANY QUESTIONS REGARDING THIS CAN BE ADDRESSED TO THE EMS OFFICE AT 815/759-8040. THANK YOU.