Shock

“I believe that the best definition of shock is inadequate capillary perfusion. As a corollary of this broad definition, almost anyone who dies, except one who is initially destroyed must go through a stage of shock, a momentary pause in Death”

Robert M. Hardaway, professor of Surgery at Texas Tech University School of Medicine in El Paso, Texas.

Terminology

- **Cardiac Output**: the amount of blood pumped by the heart in one minute (stroke volume x heart rate).
- **Parasympathetic nervous system**: division of the autonomic nervous system that slows the bodily functions → norepinephrine
- **Sympathetic nervous system**: division of autonomic nervous system that speeds bodily functions up → epinephrine
- **Perfusion**: supply of oxygen to and removal of wastes away from the cells and tissues of the body as a result of the flow of blood through the capillaries

Terminology (cont.)

- **So What is shock???:**
  - Shock is not adequately defined by pulse rate, blood pressure, cardiac function, and it cannot be reduced to just hypovolemia.
  - Inadequate perfusion and oxygenation - at the cellular level
  - Shock may affect an entire organism (group of organ systems), or it may occur at a tissue or cellular level, even with normal hemodynamics.

Terminology (cont.)

- Many causes for shock ranging from simple syncopal episode to major trauma
- **So what’s the big deal???:** Significant because it either serves as a primary problem or becomes secondary problem to other medical conditions.
Causes may differ:
Pathophysiology remains the same

Pathophysiology
Perfusion is dependent on:
PUMP (heart)
Pipes (blood vessels)
FLUID (blood)
&
Ventilations / Respirations

Pathophysiology (cont.)
The Heart

Pathophysiology (cont.)
(heart cont.)
- Two sided muscular pump with its own electrical system
- The sympathetic and parasympathetic nervous system either speeds the heart up or slows it down through action of hormones
Stroke Volume x Heart Rate = Cardiac Output
70ml x 70bpm = 4,900ml
(average) (average) 4.9 ltrs

Pathophysiology (cont.)
Pipes
- The vascular system serves as the container for the cardiovascular system
  - Arteries: 13% of total blood volume
  - Capillaries: microscopic in size provides nutrients, O2 and removes waste products
  - Veins: brings blood back to the heart...contains 64% of total blood volume...twice the size of arteries and much less pressure filled

Pathophysiology (cont.)
Pipes (cont.)
- Arteries and veins are able to expand and contract from the autonomic nervous system...also some contraction and expansion at the local level for microcirculation to supply malnourished tissues
Pathophysiology (cont.)

Blood

- REMEMBER!!
  - RBCs (erythocytes) make up 45% & Plasma makes up 54% of total blood volume
  - Platelets – helps in clotting process
  - Leukocytes (WBCs) helps in fighting infectious process
  - Blood is needed for perfusion
  - Blood is viscous and becomes more viscous as a patient progresses in shock

Pathophysiology (cont.)

Ventilations / Respiratory System

- 500-800 ml atmospheric air is brought into the respiratory system via normal inspiration.
- As blood is pumped from the heart, it finally reaches the capillaries where the blood offloads with tissues deficient in O2 and process starts over again.

Pathophysiology (cont.)

Ventilations / Respiratory System (cont.)

- Fick principle: deals with O2 transport:
  - Adequate concentration of O2
  - Appropriate movement across the membrane into arterial bloodstream
  - Adequate number of RBCs
  - Proper tissue perfusion
  - Efficient off-loading of O2 at tissue level

Pathophysiology (cont.)

Tissue Perfusion Dependent Upon Circulatory and Respiratory Systems

- Pump-cardiac output, heart rate or excessive overload
- Pipes – dilated container without change in blood volume
- Fluid – low circulating blood volume
- Respiratory System / O2

Pathophysiology (cont.)

Shock Pathophysiology (cont.)

- Organ System Response to Hypoperfusion
  - Heart:
    1. increased HR to compensate volume needed to maintain cardiac output --> increased pulse rate occurs early...
    2. increased cardiac work can lead to reduced coronary perfusion, ischemia and decreased myocardial function --> loss of BP, arrhythmias
    3. Increased peripheral resistance to compensate for decreased cardiac output to maintain systolic BP --> cool clammy skin
Organ System Response to Hypoperfusion (cont.)

Renal System:
- Increased retention of water and sodium to maintain volume (long term decreased renal perfusion leads to renal damage and failure) → decreased urine output, thirst, renal failure

GI System:
- Decreased blood flow to stomach & bowel, increased gastric acid production → nausea & vomiting

Central Nervous System:
- Decreased mentation and neural control → altered level of consciousness

Respiratory System:
- Increased effort to reduce lactic acids and carbon dioxide found in lungs → increased respiratory rate

Endocrine System:
- Increase in circulating Antidiuretic hormone (ADH) to response of decreased BP → retention of fluids

Shock Pathophysiology

Initiation of Compensatory Mechanisms

If Cause of Shock Not Corrected, All Compensatory Mechanisms Will Fail, Eventually.

Compensated Shock (cont.)
- Heart Rate
  - Mild tachycardia
  - ↓ cardiac contractility → “thready” pulse
- Level of Consciousness
  - Lethargy, confusion, combativeness, anxious
- Respiratory
  - ↑ RR
- Skin
  - Delayed capillary refill, cool skin
- Blood Pressure
  - Normal or slightly elevated

Compensated Shock
- Associated with decreased tissue perfusion
- Sympathetic response
  - Increased heart rate and cardiac contraction
  - Bronchodilation → Respiratory rate
  - Increased peripheral vascular resistance → BP
  - Decrease capillary flow in capillary beds
  - Blood shunted to vital organs

Decompensated Shock
- Body cannot maintain systemic blood pressure
- Systolic pressure drops before the diastolic pressure because it is more dependent on blood volume
- Decrease in systolic pressure along with increased diastolic pressure can lead to “narrow pulse pressure”
- Blood becomes more viscous → ↓ blood flow
  - Compensatory mechanisms fail → Both systolic and diastolic pressure drop as well as cerebral blood flow

Stages of Shock

Stages of Shock (cont.)
### Stages of Shock (cont.)

- **Decompensated Shock**
  - **Heart Rate**
    - Marked tachycardia → bradycardia
  - **Level of Consciousness**
    - Altered level of consciousness increases → unconscious
  - **Respiratory**
    - ↓ RR
  - **Blood Pressure**
    - Begins to fall
    - Narrowed pulse pressure
    - No radial pulse
  
### Classification of Shock

- **Hypovolemic Shock**
  - Loss of intravascular fluids
  - Most common cause of shock
  - **Causes**
    - Traumatic
    - Long bone fx
    - GI → electrolyte disturbances
    - Plasma loss from burns
    - Diabetic ketoacidosis
    - Excessive sweating
    - Pregnancy

### Classification of Shock (cont.)

- **Irreversible Shock**
  - Cellular ischemia, necrosis, death of organ even with restoration of oxygen and perfusion
  - Cells and the vital organs die from lack of energy
  - Decompensation may occur suddenly or it may be delayed from one day or three weeks after onset of shock

### Classification of Shock (cont.)

- **Hypovolemic Shock (cont.)**
  - Initial response to the termination of hemorrhage is by chemical means.
  - **Vascular reactions:**
    - Local vasoconstriction
    - Formation of platelet plug
    - Coagulation
    - Growth of fibrous tissue into the blood clot that permanently closes and seals injured vessels

### Classification of Shock (cont.)

- **Internal**
  - Internal hemorrhage can result from blunt or penetrating trauma and acute/chronic medical illnesses
  - Hemodynamic instability usually occurs in one of four body cavities
    - Chest
    - Pelvis
    - Abdomen
    - Retroperitoneum

- **Hypovolemic shock (cont.)**

- **Internal hemorrhage is associated with higher morbidity and mortality rates than external hemorrhage**
- **Compensation mechanisms can prevent significant decrease in systolic BP until the patient has lost 30% of their blood volume**
Classification of Shock (cont.)
(hypovolemic shock (cont.))
- **Class I hemorrhage** (loss up to 15% - 500-750ml): minimal tachycardia, no measurable changes in BP, respiratory rate, pulse pressure or level of consciousness.
- **Class II hemorrhage** (750-1500ml): tachycardia, tachypnea, decrease in pulse pressure, anxiety, combativeness

Classification of Shock (cont.)
(hypovolemic shock (cont.))
- **Class III hemorrhage** (30-40% - 2000ml): marked tachycardia, significant changes in level of consciousness, fall in BP
- **Class IV hemorrhage** (>40%): very narrow pulse pressure, low BP, major skin signs

Classification of Shock (cont.)
Cardiogenic Shock
- Cardiac pump cannot deliver adequate circulating blood volume for tissue perfusion (usually related to left ventricle)
- Inadequate filling of the heart, poor contractility or outflow obstruction
- Occurs in 5% to 10% of patients hospitalized for MI, associated mortality rate is near to 80%
- Also consider with Congestive Heart Failure

Classification of Shock (cont.)
Cardiopulmonary collapse is imminent (also known as circling the drain!!)
- Difficult to distinguish between uncompensated and irreversible shock
- Management should focus on resuscitation since irreversible shock is more a function of time than degree

Classification of Shock (cont.)
Distributive or Neurogenic Shock:
- Loss of message between the nervous system and distributive center...inadequate peripheral resistance due to vasodilation → blood pools in capillary beds
- Causes:
  - Anaphylaxis
  - Head injury
  - Spinal injury
  - Septicemia
  - Insulin O/D

Classification of Shock (cont.)
Obstructive Shock
- Results from an obstruction of forward blood flow
- Non-cardiac etiology
- Causes include:
  - Tension pneumothorax
  - Cardiac tamponade
  - Pulmonary emboli
Factors having individual response to shock

- Age and relative health
- Older adults are less able to compensate
- Children compensate longer and deteriorate faster
- Amount of fluid loss
- General physical condition
- Preexisting disease
- Medications → Beta Blockers
- Time & environment

Assessment

- Level of consciousness – baseline & F/U
- Airway – Patent?
- Breathing – fast or slow – deep or shallow
- Circulation –
  - Pulse: fast or slow, thready or full?
  - external bleeding?
  - skin signs: cap refill?
- Disability - level of consciousness (either A, V, PU or Glasgow Coma Score), agitation
- Expose for any bleeders

Assessment (cont.)

- Review of primary assessment:
  - Which stage of shock is your patient in?
  - High degree of suspicion based on scene findings, the way your patient is presenting AND your gut instinct!
  - RAPID trauma assess < 90 seconds
- Detailed / F/U Assessment:
  - Anytime notice change in patient
  - Following any interventions
  - Every 3-5 minutes with a patient who is critical / unstable

Golden Hour

- First described in Korean War by battlefield surgeons
- Has become the standard of care
- Clock starts from when patient becomes injured and stops when patient receives definitive care
- EMS only gets 10 minute on scene times (platinum 10 minutes) with these type of patients

Treatment

- Airway!!...Airway!!...Airway!!!
  - Maintain open airway → airway adjuncts
  - High flow O2 → NRM or BVM?
  - Advanced airway → comitube, ETT
- Keep warm
- Raise lower extremities
- Treat the source of the problem
  - Stop bleeding
  - Pelvic stabilizer
  - PASG??
- Vital signs & pulse oximetry
- Evaluate & reevaluate!!
- Minimizing on scene time → doing procedures on scene for life threats
- Transport decision → golden hour → air or ground?
- ALS → cardiac monitoring, drugs
  & IV FLUID RESUSCITATION → systolic BP 90-100 mmHg

Treatment

- Pelvic sling
Pneumatic Anti-Shock Garment (PASG)

- First application in Korean war
- Garment that wraps around legs and abdomen that is designed to increase peripheral resistance in vascular system however what they have found is that it actually lowers the cardiac output
- Has velcro to hold in place, three hoses with foot pump and stopcocks to open or close compartments
- Use for patient’s in shock is extremely controversial but use for external bleeding and splinting appears useful.

Scenario

You are dispatched ALS for an unknown motor vehicle accident. Your updated information includes a reported rollover accident in which the one victim was reportedly ejected from the vehicle. The caller did not stop at the scene. It is a winter night and the outside temperature is 18°.

Your ambulance is made up of a two person EMT Basic crew. You have one more EMT-B and two Intermediate EMTs enroute to the scene and your paramedic is enroute but delayed.

You arrive to find a 28 y/o female laying in the middle of the road, she is responsive to pain and can tell you her first name and the day of the week but doesn’t know where she is at and keeps asking repetitive questions. Unknown if she was restrained.

Scenario

What are your first actions?

- C-spine control
- Airway → open
- Breathing → shallow and rapid @24 times minute
- Circulation → bleeding heavily from left upper leg…radial pulse thready @ 120. Her skin is pale, very cool and dry to touch. Bleeding is controlled with direct pressure with about 500 cc amount of blood noted on ground around her.

Scenario

What type of shock is she likely in?

- Is it compensated or uncompensated?
- What are your next actions?

Scenario

Actions:

- Rapid trauma assessment
  - Head – without crepitus, no fluids from nose, ears, teeth intact
  - Neck – without tenderness or crepitus
  - Chest – tenderness and bruising noted to right side of chest, c/o difficulty breathing, chest rise is symmetrical
  - Abdomen – without tenderness or distention
  - Pelvis – crepitus noted to right side
  - Extremities – left upper leg with large laceration but controlled with direct pressure.
Scenario

Update: You get her spinal immobilized and loaded into the ambulance. Her VS are BP 90/58, pulse 130 and respiratory rate of 28 / minute. She knows her first name but now doesn’t know where she is at or what day of the week it is.

Now what are your actions?

Scenario

Update: The EMT-I is now on scene.

What are the priorities of the Intermediate?

Update: Your patient is now unresponsive and her BP is 80/50, pulse 146, respirations 10 / minute

Scenario

- Actions:
  - high flow O2 nrm
  - warm her up!!
  - frequent VS → trending
  - rapid transport
  - And, pelvic stabilizer, consideration to PASG, raising lower extremities.

Scenario

- What stage of shock is she in?
- What are the priorities in treating her?
- As your paramedic arrives on scene, what would you expect from them?

Post Test Questions

1. Perfusion is dependent upon all of the following except:
   a. The heart
   b. The blood vessels
   c. The nervous system
   d. The ventilatory / Respiratory system

2. Arteries carry how much of the total blood supply?
   a. 13%
   b. 24%
   c. 54%
   d. 64%

3. Which of the following are signs of someone in compensated shock?
   a. An unconscious / unresponsive 54 y/o male with labored breathing.
   b. A 27 y/o pregnant patient who has been involved in a head on crash. Her VS are: BP 80/70; pulse 50 / minute; respirations 10 minute
   c. A 48 y/o burn patient with VS: BP 130/60; pulse 130; respirations 24 minute
   d. A 16 y/o male with a closed head injury. Patient is responsive to painful stimuli. VS are: BP 170/70; pulse 40; respirations erratic and 6-8 minute

4. When does the Golden Hour start and end?
   a. Starts at time EMS providers arrive on scene and ends when patient is stabilized on scene.
   b. Starts at time of injury and ends when patient receives definitive care at hospital.
   c. Starts at time of injury and ends when EMS providers start transport to the hospital.
   d. Starts at time of EMS dispatch and ends when patient receives definitive care.
5. The rapid trauma assessment should be completed in:
   a. Less than 2 minutes
   b. Less than 90 seconds
   c. Less than 3 minutes
   d. Less than 5 minutes

Contact:
Renee Anderson
509-232-8155
1-888-258-9632
andersr@inhs.org