Chapter 34
Shock and Resuscitation

Learning Objectives

- Discuss the anatomy and physiology of the cardiovascular system
- Discuss the stages and types of shock, including aerobic, anaerobic metabolism, ischemic, stagnant, and washout phases of shock
- Describe the etiology, history, and physical findings of hypovolemic shock

Learning Objectives (Cont'd)

- Using the patient history and physical examination findings, develop a treatment plan for the patient in hypovolemic shock
- Describe the etiology, epidemiology, history, and physical findings of cardiogenic shock
- Using the patient history and physical examination findings, develop a treatment plan for cardiogenic shock
Learning Objectives (Cont'd)

- Describe the etiology, epidemiology, history, and physical findings of distributive shock
- Using the patient history and physical examination findings, develop a treatment plan for the patient in distributive shock
- Describe the etiology, epidemiology, history, and physical findings of obstructive shock

Learning Objectives (Cont'd)

- Using the patient history and physical examination findings, develop a treatment plan for the patient in obstructive shock
- Discuss dissociative shock

Introduction

- Introduction
  - Perfusion
    - Delivery of $O_2$, other nutrients to cells
  - Shock
    - Inadequate tissue perfusion
Cardiovascular System Review

- Blood
  - Plasma
    - Nutrients, electrolytes, proteins, clotting factors, antibodies, hormones

Cardiovascular System Review (Cont'd)

- Blood
  - Red blood cells
    - 40-45% of blood volume, contain hemoglobin (binds with $O_2$)
    - Anemia
      - Low Hgb or RBCs
      - Hemorrhagic anemia
      - Hemolytic anemia: RBCs are destroyed

Cardiovascular System Review (Cont'd)

- Blood
  - White blood cells
    - Fight infection consuming pathogens and produce antibodies
  - Platelets
    - Clotting assisted by fibrinogen fibers
Cardiovascular System Review (Cont'd)

- Blood vessels
  - Arteries are conductance vessels
    - Carry blood from heart to arterioles
    - Carry blood under high pressure

Cardiovascular System Review (Cont'd)

- Blood vessels
  - Arterioles are the smallest branches of the arteries
    - Connect arteries and capillaries
    - Precapillary sphincters contract, relax to control blood flow
    - Smooth muscle in vessel walls allows diameter adjustment
    - Resistance vessels
    - Dilation decreases resistance, vice versa
Cardiovascular System Review (Cont'd)

- Blood vessels
  - Capillaries
    - Smallest blood vessels
    - Connect arterioles and venules
    - Exchange vessels
    - Cellular respiration, exchange of gases and wastes

Cardiovascular System Review (Cont'd)

- Blood vessels
  - Venules
    - Smallest branches of veins
    - Connect capillaries and veins
    - Postcapillary sphincters control blood flow from body tissues

Cardiovascular System Review (Cont'd)

- Blood vessels
  - Veins
    - Carry deoxygenated blood from body to right side of heart
    - Capacitance vessels, approximately 70% of blood stored
    - Venous blood flow depends on skeletal muscle action, respiratory movements, gravity
    - Valves in larger veins of extremities and neck arranged to allow blood flow in one direction toward the heart
Cardiovascular System Review (Cont'd)

- Heart
  - Vena cava to right atrium through tricuspid valve to right ventricle
  - Right ventricle through pulmonary valve to pulmonary arteries
  - Gas exchange in lungs, then blood flows through pulmonary veins to left atrium
  - Left atrium through mitral (bicuspid) valve to left ventricle
  - Left ventricle through aortic valve to aorta

Cardiovascular System Review (Cont'd)

- Heart
  - Atrial kick: push of blood by atria to ventricles
  - Preload: amount of blood in ventricles before contraction
  - Stroke volume: amount of blood ejected with contraction
  - Cardiac output: heart rate \( \times \) stroke volume (volume per minute)
  - Afterload: pressure in aorta, left ventricle must pump against
Shock

- Causes
  - Failure of heart, resulting in inadequate CO
  - Failure of blood vessels; significant changes in SVR
  - Inadequate blood volume
  - Inability of RBCs to deliver O₂ to tissues

Shock (Cont’d)

- Early (compensated) shock
  - ANS stimulation caused by decreased PaO₂ and increased PaCO₂
  - Epinephrine and norepinephrine
  - Rennin-angiotensin-aldosterone mechanism: potent vasoconstriction
  - Release of antidiuretic hormone (vasopressin) secreted from pituitary causing water reabsorption
  - Intracellular fluid shifts into bloodstream

Adrenal Glands
Shock (Cont’d)

Renin-Angiotensin-Aldosterone Mechanism

- Early (compensated) shock
  - Physical examination
    - Assess heart rate
    - Assess presence and volume of peripheral pulses
    - Assess adequacy of end-organ perfusions
  - Reversible if cause is identified, corrected
  - Uncorrected progresses to next stage

Shock (Cont’d)

- Late (decompensated) shock
  - Epinephrine and norepinephrine
  - Compensatory mechanisms fail
  - Liver and spleen release stored RBCs and plasma
  - Precapillary sphincters dilate, blood rushes into capillary beds
  - Postcapillary sphincters constricted causing stagnation of blood
  - Anaerobic metabolism occurs (acidosis)
Shock (Cont’d)

Decompensated Shock Cycle

Shock (Cont’d)

- Irreversible shock
  - Hypoperfusion causes anaerobic metabolism
  - Cardiac dysrhythmias decrease cardiac output
  - Exotoxins released, enter blood and spread throughout the body
  - Damaged cells result in damaged tissues
  - Organ failure
  - Multiple organ dysfunction syndrome
  - Adult respiratory distress syndrome
  - Compensatory mechanisms fail

Categories and Types of Shock

- Hypovolemic shock
  - Description and definition
    - Inadequate tissue perfusion caused by inadequate vascular volume
Categories and Types of Shock (Cont'd)

- Hypovolemic shock
  - Etiology and history
    - Hemorrhagic shock
    - Caused by severe internal, external bleeding
    - Causes of major blood loss
    - Plasma losses, third spacing (interstitial), burns, diabetes insipidus, vomiting/diarrhea

- Hypovolemic shock
  - Etiology and history
    - Blood loss of <15% generally well tolerated
    - Pediatric concerns: less total volume
      - 2 years old: 8 + (2 × age in years) = 12 kg × 70 mL/kg = 840 mL
      - Blood volume is decreased
      - Venous return is decreased (decreased preload and cardiac output)
      - Blood flow to vital organs is decreased

- Hypovolemic shock
  - Signs and symptoms (compensated)
    - Thirst, weakness
    - Normal to minimally impaired LOC
    - Peripheral vasoconstriction, skin cool, mottling
    - Mild tachycardia
    - Normal BP and pulse pressure
Categories and Types of Shock (Cont'd)

- Hypovolemic shock
  - Signs and symptoms (decompensated)
    - Altered LOC, decreased pain responses
    - Dry mucous membranes
    - Pale, mottled skin with peripheral cyanosis
    - Significant tachycardia, weak pulses
    - Low BP and pulse pressure

Categories and Types of Shock (Cont'd)

- Hypovolemic shock
  - Signs and symptoms (irreversible)
    - Extreme lethargy to unresponsive
    - Limp muscle tone
    - Severe tachypnea to agonal
    - Skin cool, mottling, central cyanosis
    - Marked tachycardia deteriorating to bradycardia
    - Severe hypotension

Categories and Types of Shock (Cont'd)

- Hypovolemic shock
  - Therapeutic Interventions
    - ABCs, high concentration of O₂, ET if needed
    - Position supine, monitor vitals
    - ECG monitor, pulse oximetry, capnography
    - Inf fluids to maintain perfusion (pressors?)
    - Consider fluid bolus (check lung sounds)
    - May need to repeat bolus
    - Recheck patient response
Categories and Types of Shock (Cont’d)

Normal Circulation and Hypovolemic Shock

Hypovolemic shock

- Pneumatic antishock garment (PASG)
  - Uses: pelvic fractures, internal hemorrhage
  - Absolute contraindications
  - Relative contraindications

PASG
Categories and Types of Shock (Cont'd)

Applying PRSG

Categories and Types of Shock (Cont'd)

- Cardiogenic shock
  - Impaired pump, decreased cardiac output and increased tissue perfusion
  - History
    - AMI
    - CHF
    - CPR
    - Aneurysm
    - Rupture

Categories and Types of Shock (Cont'd)

- Cardiogenic shock
  - Possible causes
    - MI
    - Prolonged cardiac surgery
    - Ventricular aneurysm
    - Ventricular wall rupture
    - Cardiac dysrhythmias
    - Rupture of ventricular septum
    - Myocarditis
    - Cardiomyopathy
    - Myocardial trauma
    - Heart failure
    - Hypothermia
    - Severe electrolyte/acid-base imbalance
    - Severe CHD
Categories and Types of Shock (Cont'd)

Normal Circulation and Cardiogenic Shock

- Cardiogenic shock
  - Physical findings
    - Decreased LOC
    - Crackles
    - Decreased BP
    - JVD
    - Weak/rapid peripheral pulses (narrowed pulse pressure)
    - Skin: cool/pale/mottled/cyanotic
    - Muffled heart sounds (Beck’s triad)

Categories and Types of Shock (Cont’d)

- Cardiogenic shock
  - Differential diagnoses
    - Cardiovascular causes:
      - ACS
      - Aortic dissection
      - Myocardial rupture
      - Myocarditis
    - Respiratory causes:
      - Pulmonary embolism
    - Other causes:
      - Hypovolemia
      - Sepsis
Categories and Types of Shock (Cont'd)

- **Cardiogenic shock**
  - **Therapeutic interventions**
    - ABCs, high concentration O₂
    - IV, ECG monitor, pulse oximeter/capnography
    - Treat dysrhythmias and shock
    - Check response and vitals
    - Maintain ABCs and IV administration

Categories and Types of Shock (Cont'd)

- **Distributive shock**
  - Generalized vasodilation increases size of vessels causing pressure to drop
  - Decrease in pressure reduces preload, stroke volume, and cardiac output

Categories and Types of Shock (Cont'd)

- **Distributive shock**
  - *Septic shock*
    - **Description and definition**
      - Sepsis with hypotension despite adequate fluid resuscitation, along with presence of perfusion abnormalities
      - May include lactic acidosis, decreased urine output, sudden change in mental status
Categories and Types of Shock (Cont'd)

- Distributive shock
  - Septic shock
    - Septis epidemiology and demographics
    - Age extremes
    - Compromised immune system
    - Malnourishment
    - Long-term antibiotic or steroid use
    - 20-35% with severe sepsis, 40-60% with shock die within 30 days.

Categories and Types of Shock (Cont'd)

Normal Circulation and Distributive Shock

Categories and Types of Shock (Cont'd)

- Distributive shock
  - Septic shock
    - History
      - Cardiovascular causes
      - Hemorrhagic shock
      - Acute MI, myocardial rupture
      - Respiratory
      - Pulmonary embolus
      - Endocrine
      - DKA, hyperthyroidism
      - Other: acute renal failure, adrenal crisis, anaphylaxis, ASA toxicity, DIC, heatstroke
Categories and Types of Shock (Cont'd)

- Distributive shock
  - Septic shock
    - Physical findings (early)
      - Warm skin, dry and flushed
      - Tachycardia and tachypnea
      - Normal blood pressure or widened pulse pressure
      -Bounding peripheral pulses
    - Physical findings (late)
      - Mottled, cool extremities
      - Diminished or absent peripheral pulses
      - Altered mental status
      - Tachycardia

Categories and Types of Shock (Cont'd)

- Distributive shock
  - Septic shock
    - Differential diagnosis
      - Cardiovascular causes
      - Respiratory causes
      - Endocrine causes
      - Other causes

Categories and Types of Shock (Cont'd)

- Distributive shock
  - Septic shock
    - Therapeutic interventions (Obj. 8)
      - ABCs, O2, IV, ECG
      - Vital signs, pulse oximetry, capnography
      - Positioning
      - Fluid challenge 20 mL/kg (check lung sounds)
      - Check response and vital signs (lung sounds)
      - If needed, give another fluid challenge
Categories and Types of Shock (Cont’d)

- Anaphylactic shock/anaphylaxis
  - Description and definition
    - Body exposed to substance that produces severe allergic reaction

- Etiology/causes
  - Dust, pollen, mold, animal dander
  - Foods: milk, eggs, nuts, shellfish, beans
  - Latex/rubber products
  - Blood components
  - Antibiotics
  - Insect venom (hymenoptera)
  - Local anesthetics
  - Vitamins
  - NSAIDs (ASA, ibuprofen), IV contrast dyes
  - Radiocontrast media
  - Aspirin

Allergic Reaction Effects
Categories and Types of Shock (Cont'd)

Anaphylaxis Effects

- Anaphylactic shock/anaphylaxis
  - First exposure
    - Sensitization caused by antigen/allergen
    - Immune system responds by forming IgE antibodies
    - Antibodies attach to mast cells creating sensitized mast cells

Categories and Types of Shock (Cont'd)

- Anaphylactic shock/anaphylaxis
  - Secondary exposure to same antigen that causes histamine release
    - Vasodilation
    - Capillary permeability
    - Edema, erythema (redness), pruritis (itching)
    - IgE is stimulated and binds to antigen
    - Histamine is released by mast cells
    - Irritated nerve endings
    - Constriction of larynx and bronchioles
Categories and Types of Shock (Cont'd)
- Anaphylactic shock/anaphylaxis
  - Neurological findings
    - Angioedema
    - Inability to speak, tightness in throat, stridor, DIB, wheezing, hoarseness, cough
    - Retractions, accessory muscle use, decreased breath sounds
    - Tachycardia, decreased BP
    - Diaphoresis, urticaria/flushing, pruritis, pallor/cyanosis
    - N/V/D, abdominal pain/cramps, incontinence
    - Anxiety, restlessness and feeling of impending doom

Categories and Types of Shock (Cont'd)
- Anaphylactic shock/anaphylaxis
  - Cardiovascular findings
    - ACS
    - Aortic dissection
    - Cardiogenic shock
    - Dysrhythmias
    - Hemorrhagic shock

Categories and Types of Shock (Cont'd)
- Anaphylactic shock/anaphylaxis
  - Respiratory findings
    - Foreign body airway obstruction (FBAO)
    - Pulmonary embolism
    - Reactive airway disease
    - Tension pneumothorax
    - Endocrine
    - Insulin reaction
    - Other
    - Panic attack
    - Vasovagal syncope
Categories and Types of Shock (Cont'd)

- Anaphylactic shock/anaphylaxis
  - Skin
    - Diaphoresis
    - Urticaria
    - Flushing
    - Pruritis
    - Angioedema
    - Pallor
    - Cyanosis

- Gastrointestinal and genitourinary findings
  - Nausea, vomiting, and diarrhea
  - Abdominal pain
  - Cramping
  - Incontinence

- Differential diagnosis
  - Cardiovascular causes
  - Respiratory causes
  - Endocrine causes
  - Other causes
Categories and Types of Shock (Cont'd)

- Anaphylactic shock/anaphylaxis
  - Therapeutic intervention
    - ABCs, oxygen, ET as needed, IV, ECG monitor
    - Vitals, pulse oximetry, capnography
    - IV access, fluid challenge
    - Epinephrine SQ or IV
    - Benadryl IV, steroid, pressors
    - Check vitals and patient response, vitals, glucose
    - Reassess vitals

Categories and Types of Shock (Cont'd)

- Neurogenic shock
  - Disruption in ANS sympathetic system
  - Results in massive vasodilation

Categories and Types of Shock (Cont'd)

- Neurogenic shock
  - Etiology and history
    - General anesthetics
    - Spinal anesthesia
    - Ingestion of barbiturates or phenothiazines
    - Injury to head or spinal cord (above T6)
    - Loss of sympathetic tone below injury
  - History
    - Spinal cord injury is the most common cause
Categories and Types of Shock (Cont’d)

- Neurogenic shock
  - Physical findings
    - Assess for pain, paresthesia, loss of LOC
    - Vasodilation occurs below injury
    - Widened pulse pressure with eventual decrease in BP
    - Pulse normal to bradycardic (parasympathetic)
    - Increased respirations
    - Skin pale, mottled, cyanotic

- Obstructive shock
  - Description and definition
    - Cardiac tamponade
    - Tension pneumothorax
    - Massive pulmonary embolism
    - Obstruction of blood flow to heart
Categories and Types of Shock (Cont'd)

- Obstructive shock
  - Etiology
    - Cardiac tamponade results from fluid (blood) in the pericardial sac
    - Excess fluid buildup compresses heart
    - Heart’s ability to relax and fill during diastole is impaired
    - Impaired filling reduces cardiac output and preload
    - Tension pneumothorax caused by air in pleural space
    - Pulmonary embolus results in ventilation/perfusion mismatch
    - Left ventricular rupture occurs due to AMI/cardiac tamponade

Categories and Types of Shock (Cont'd)

- Tension Pneumothorax
  - Image of lungs and mediastinum
    - Air trapped outside the lungs
    - Rib cage and mediastinum

Categories and Types of Shock (Cont'd)

- History
  - Shortness of breath
  - Sudden chest pain, may radiate to shoulder
  - Anxious
  - Impending doom
  - Restless
  - Chest tightness
  - Dizziness
  - Pericarditis
  - End-stage renal disease
Categories and Types of Shock (Cont'd)

- Obstructive shock
  - Physical findings
    - Dyspnea
    - Anxiety
    - Tachycardia and tachypnea
    - Affected breath sounds (tension)
    - Muffled heart tones (tamponade)
    - Altered mental status
    - Diaphoresis
    - Beck's triad (tamponade)
    - JVD

Categories and Types of Shock (Cont'd)

- Obstructive shock
  - Differential diagnosis
    - Cardiovascular causes
    - Respiratory causes

Categories and Types of Shock (Cont'd)

- Obstructive shock
  - Therapeutic interventions
    - Pericardial tamponade
    - Pericardial centesis
    - Tension pneumothorax
    - Seal open wounds with occlusive dressings
    - Provide a one-way valve to allow air to exit
    - If patient's condition worsens, release dressing to allow the escape of air in pleural space, then reseal after exhalation
    - If necessary, perform pleural decompression
Categories and Types of Shock (Cont'd)

- Dissociative shock
  - Heart, volume, and container are intact
  - Caused by inability of O₂ to reach cells
  - CO₂ toxicity

Special Considerations

- Hydration
  - Dehydrated patients have decreased fluid reserve

- Age
  - Pediatric patients have less blood volume and reserve than adults
  - Geriatric patients have decreased fluid reserves

Special Considerations (Cont'd)

- Drugs
  - Drugs for HTN affect ability to compensate (beta blockers and ACE inhibitors)
Chapter Summary

- The five primary types of shock are hypovolemic, cardiogenic, distributive, obstructive, and dissociative
- Shock is a sign, not a diagnosis
  - If not reversed, it results in death

Chapter Summary (Cont'd)

- Three primary stages of shock are early (compensatory), late (progressive/decompensated), and irreversible
- Treatment goals for shock include reperfusing tissue with oxygenated blood and repairing/stopping cause

Chapter Summary (Cont'd)

- Definitive care for hypovolemic shock is not provided in the prehospital setting; patient should be transported to the closest appropriate medical facility, trauma center
- IV fluids can increase perfusion pressures in shock but also can increase anemia, stop clotting, and lower body temperature
Chapter Summary (Cont’d)

- Age, drugs, existing medical conditions, and overall health status can affect the body’s ability to compensate for shock

Questions?