Chapter 21
Hemorrhage and Shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Objectives

- Describe how to recognize signs and symptoms of internal and external hemorrhage
- Define shock
- Outline factors needed for tissue oxygenation
- Describe how resistance vessels' diameter influences preload

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Objectives

- Describe function of blood components
- Outline changes in microcirculation during shock
- List causes of hypovolemic, cardiogenic, neurogenic, anaphylactic, septic shock
- Describe pathophysiology as basis for signs and symptoms through stages of shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Objectives

- Describe assessment findings to distinguish cause of shock state
- Outline prehospital management of shock
- Discuss how to integrate assessment and management of patients in shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Scenario

Your patient is a 15-year-old who was thrown from his horse during a jumping competition. His skin is pale and cool. Vitals are: BP-98/68, P-132/min, R-24/min. He has an abrasion from his left nipple laterally down to his pelvis. His abdomen and pelvis are are diffusely tender. He has mild difficulty breathing, and breath sounds are diminished on the left.

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Discussion

- What is the probable cause of his shock?
- Is this compensated or uncompensated shock?
- Explain how you will initiate IV therapy to gain maximum benefit for this patient.
- What other prehospital care will be needed for him?

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Hemorrhage

- Disruption or “leak” in vascular system
- External hemorrhage
- Internal hemorrhage
  - Higher morbidity and mortality than external hemorrhage

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Physiological Response to Hemorrhage

- Initial response: Stop bleeding by chemical means (hemostasis)
- Vascular reaction involves:
  - Local vasoconstriction
  - Formation of platelet plug
  - Coagulation
  - Growth of fibrous tissue into blood clot permanently closes and seals injured vessel
- If hemorrhage is severe, mechanisms may fail, resulting in shock (hypoperfusion)

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Defining Shock

- Inadequate tissue perfusion
  - Can result from variety of disease states and injuries
  - Can affect entire organism or occur at tissue or cellular level
- Not adequately defined by:
  - Pulse rate
  - Blood pressure
  - Cardiac function
  - Hypovolemia
  - Loss of systemic vascular resistance

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Tissue Oxygenation

- Adequate oxygenation of tissue cells (perfusion) depends on:
  - Heart
  - Vasculature
  - Lungs
- If any one malfunctions, decrease in cellular oxygenation may occur

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Cardiac Output

- Blood pumped by each ventricle per minute (liters per minute):
  - = Heart rate x Volume of blood ejected by each ventricle during each beat (stroke volume)
- Depends on:
  - Strength of contraction
  - Rate of contraction
  - Venous return to ventricle (preload)

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Shock

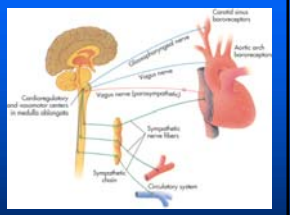
- Fick principle
- Vasculature
- Pressure gradients
- Peripheral vascular resistance
  - Afterload
- Viscosity
- Microcirculation
- Vasomotion

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Baroreceptor Reflexes

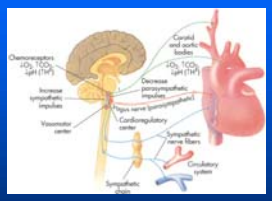
- Help control BP by two negative feedback mechanisms:
  - Lower BP in response to increased arterial pressure
  - Increase BP in response to decreased arterial pressure



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Chemoreceptor Reflexes

- Low arterial pressure stimulates peripheral chemoreceptor cells in carotid and aortic bodies
- If oxygen or pH decreases, stimulate vasomotor center of medulla



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

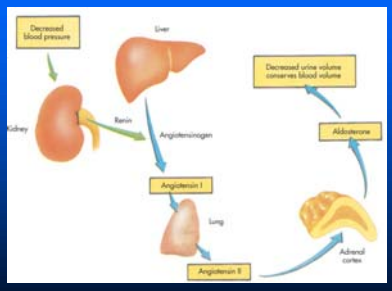
Compensatory Mechanisms

- CNS ischemic response
- Hormonal mechanisms
  - Adrenal medullary mechanism
  - Renin-angiotensin-aldosterone mechanism
  - Vasopressin mechanism
  - Atrial natriuretic factor
- Reabsorption of tissue fluids
- Splenic discharge of blood

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

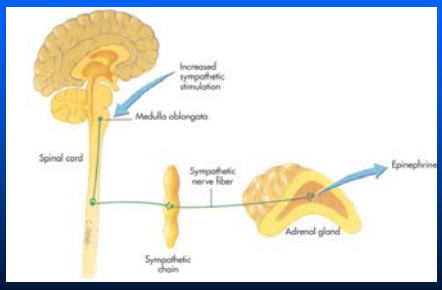
Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Role of Adrenal Medulla in Regulating BP



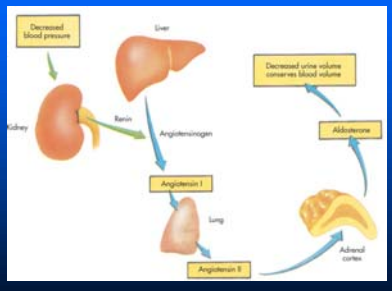
Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Renin-Angiotensin-Aldosterone Mechanism in Regulating BP



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Vasopressin (ADH) Mechanism in Regulating BP



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Lungs

- Adequate cellular oxygenation requires that adequate oxygen be available to red blood cells at the capillary membrane in the lungs
  - First component of Fick principle
  - Made possible by:
    - High pressure of oxygen in inspired air
    - Adequate depth and rate of ventilation
    - Matching of pulmonary ventilation and perfusion

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

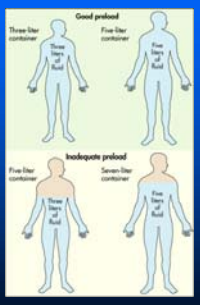
The Body as a Container

- Blood is smooth-flowing delivery system inside container
  - Container must be filled to achieve adequate preload and tissue oxygenation

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

The Body as a Container

- External size of body container is relatively constant
  - Container volume directly related to diameter of resistance vessels
  - Change in vessel diameter changes volume of fluid container holds
    - Affects preload



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

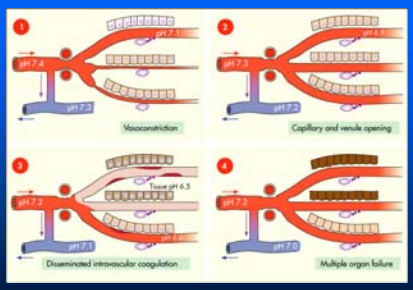
Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Capillary-Cellular Relationship in Shock

- Stage 1: Vasoconstriction
- Stage 2: Capillary and venule opening
- Stage 3: Disseminated intravascular coagulation
- Stage 4: Multiple organ failure

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Capillary-Cellular Relationship in Shock



Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Classifications of Shock

- Hypovolemic shock
- Distributive shock
  - Neurogenic shock
  - Anaphylactic shock
  - Septic shock
- Cardiogenic shock
- Obstructive shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Compensated Shock

- Signs and symptoms of early shock
- Blood pressure normal or high
- Treatment typically results in recovery

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Compensated Shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Uncompensated Shock

- Signs and symptoms of late shock
- Blood pressure abnormally low
- Treatment sometimes results in recovery

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Uncompensated Shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Irreversible Shock

- Signs and symptoms of late shock
- Blood pressure abnormally low
- Even aggressive treatment does not result in recovery

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Irreversible Shock

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Physiological Response to Shock

- Variations and determining factors
  - Age and relative health
  - Older adults
  - Children
  - General physical condition
  - Preexisting disease
  - Ability to activate compensatory mechanisms
  - Medications
  - Specific organ system affected

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Management of Shock

- Goals of prehospital care
  - Patent airway
  - Adequate oxygenation and ventilation
  - Restore perfusion

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Initial Assessment

- Airway
- Breathing
- Circulation
- Disability
- Expose body surfaces

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Differential Shock Assessment Findings

- Assumed to be hypovolemic until proven otherwise
- Cardiogenic shock
  - Differentiate from hypovolemic shock by:
    - Chief complaint
      - Chest pain
      - Dyspnea
      - Tachycardia
    - Heart rate
    - Signs of congestive heart failure
    - Dysrhythmias

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Differential Shock Assessment Findings

- Distributive shock
  - Differentiate from hypovolemic shock by:
    - Mechanism suggesting vasodilation
      - Spinal cord injury
      - Drug overdose
      - Sepsis
      - Anaphylaxis
    - Warm, flushed skin
    - Lack of tachycardia response (not reliable)

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Differential Shock Assessment Findings

- Obstructive shock
  - Differentiate from hypovolemic shock by signs and symptoms of:
    - Cardiac tamponade
    - Tension pneumothorax
    - Pulmonary embolism

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Detailed Physical Examination

- Vital signs
  - Pulse
  - Blood pressure
  - Orthostatic vital signs
- Evaluate patient's ECG

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Resuscitation

- Restore adequate tissue oxygenation by:
  - Ensuring adequate oxygenation
  - Maintaining effective volume-to-container size ratio
  - Rapid transport to appropriate medical facility

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Red Blood Cell Oxygenation

- Need adequate tissue oxygenation
- For red blood cell oxygenation:
  - Patent airway
  - Support ventilation with high FiO_2
    - If necessary, positive-pressure ventilation
  - Correct airway abnormalities that interfere with adequate ventilation

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Ratio of Volume to Container Size

- Container must be full of fluid to carry oxygen
- Accomplish by:
  - Decreasing size of container
    - Especially in shock states not associated with hemorrhage
  - Vasoactive medications in some distributive shock
  - Volume replacement may be needed

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Pneumatic Antishock Garment

- Effects
- Mechanism
- Indications
- Contraindications

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Crystalloids

- Solutions with dissolved crystals in water
  - Less osmotic pressure than colloids
  - Can equilibrate more quickly between vascular and extravascular spaces
    - 2/3 of crystalloid fluid leaves vascular space ≤ 1 hr
    - 3 mL of crystalloid replaces 1 mL of blood

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Hypertonic and Hypotonic Solutions

- Hypertonic solutions
  - Higher osmotic pressure than body cells
    - 7.5% saline
- Hypotonic solutions
  - Lower osmotic pressure than body cells
    - Distilled water
    - 0.45% sodium chloride (0.45% NaCl)

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Isotonic Solutions

- Lactated Ringer's solution
- Normal saline
- Glucose-containing solutions (e.g., D_5W)

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Colloids

- Solutions that contain molecules too large to pass through capillary membrane
- Remain within blood vessels longer
- Examples
  - Whole blood
  - Plasma
  - Packed red blood cells

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Theory of Fluid Flow

- Flow of fluid through catheter
  - Directly related to diameter (to the fourth power)
  - Inversely related to length
- Also affect fluid flow:
  - Diameter and length of tubing
  - Size of vein
  - Viscosity and temperature of fluid
    - Viscosity is affected by temperature
    - Warm fluids flow faster

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Key Principles in Managing Shock

- Open airway
- High-concentration oxygen
- Assist ventilation as needed
- Control external bleeding (if present)
- IV fluid replacement if appropriate
- Consider PASG
- Maintain body temperature
- Monitor ECG and oxygen saturation
- Reassess vital signs

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Hypovolemic Shock

- Correct circulatory deficit and its causes
  - Crystalloid fluid replacement for dehydration
  - Volume replacement for hemorrhage (controversial)
  - Definitive surgery
  - Critical care support
  - Postoperative rehabilitation

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Hypovolemic Shock

- Fluid volume replacement
- Large volume fluid replacement if:
  - Systolic BP >100 mmHg AND
  - Isolated head or extremity injuries
  - Not for penetrating trauma in urban center
- Blunt or penetrating trauma in rural area:
  - IVFs to maintain systolic BP>90 mm Hg

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Cardiogenic Shock

- Improve pumping action of heart and manage dysrhythmias
  - Fluid replacement
  - Drug therapy (if needed)
  - Cardiogenic shock due to myocardial ischemia or infarction requires:
    - Reperfusion strategies
    - Possible circulatory support
  - Manage tension pneumothorax and cardiac tamponade

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Neurogenic Shock

- Treatment similar to hypovolemia
  - Avoid circulatory overload
  - Monitor lung sounds for pulmonary congestion
- Vasopressors may be indicated

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Anaphylactic Shock

- Subcutaneous epinephrine in acute anaphylactic reactions
- Other therapy
  - Oral, IV, or IM antihistamines
  - Bronchodilators
  - Steroids reduce inflammatory response
  - Crystalloid volume replacement
  - Airway management

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Septic Shock Treatment

- Management of hypovolemia (if present)
- Correction of metabolic acid-base imbalance
- Prehospital care
  - Fluid resuscitation
  - Respiratory support
  - Vasopressors to improve cardiac output
  - Thorough history to find source of sepsis

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Integration of Patient Assessment and the Treatment Plan

- For severe hemorrhage or shock:
  - Rapid recognition
  - Initiation of treatment
  - Prevention of additional injury
  - Rapid transport to appropriate hospital
  - Advance notification to receiving facility

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.

Conclusion

The paramedic must be able to integrate history and assessment findings to form a field impression and to implement a treatment plan for the patient with hemorrhage or shock.

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Questions?

Copyright © 2007, 2006, 001, 1994 by Mosby, Inc., an affiliate of Elsevier Inc.

Mosby, Inc. items and derived items © 2007, 2006 by Mosby, Inc., an affiliate of Elsevier Inc.