Chapter 4, General Principles of Pathophysiology Part 1
How Normal Body Processes Are Altered By Disease and Injury

How Cells Respond to Change and Injury

Pathology & Pathophysiology
• _________________________________: the study of diseases and its causes
• _________________________________: the study of how diseases alter normal physiology

Cellular Adaptation
• Cells, tissues, organs, and organ systems can adapt to both ________________________________ and injurious conditions.
• Adaptation to external ________________________________ results in alteration of structure and function.
• Examples: Growth of the uterus during pregnancy, dilation of the left ventricle after an MI.

Types of Cellular Adaptations (1 of 2)
• ________________________________—decreased size resulting from a decreased workload.
• ________________________________—an increase in cell size resulting from an increased workload.

Types of Cellular Adaptations (2 of 2)
• ________________________________—An increase in the number of cells resulting from an increased workload.
• ________________________________—Replacement of one type of cell by another type of cell that is not normal for that tissue.
• ________________________________—A change in cell size, shape, or appearance caused by an external stressor.

Forms of Cellular Injury
• 
• Chemicals
• Infectious Agents
• ________________________________ reactions
• Physical agents
• Nutritional factors
• ________________________________ factors

Signs and Symptoms of Cellular Change
• ________________________________ and malaise
• Altered appetite
• 
• Increased heart rate associated with fever
• ________________________________
9 **Cell Death (1 of 2)**

- **(“Falling Apart”):**
  - Injured cell releases enzymes that engulf and destroy the cell.
  - Cells ____________________________ .
  - Eliminating damaged and dead cells allows tissues to repair and possibly regenerate.

10 **Cell Death (2 of 2)**

- **(“Cell Death”):**
  - A pathological process in which cells swell and rupture. Death of the cell
  - Gangrenous necrosis:
  - Cell death over a ____________________________ area

11 **Gangrene**

12 **Fluids and Fluid Imbalances**

13 **__________________________** is the most abundant substance in the human body.

14 **Edema (1 of 4)**

- Accumulation of water in the ____________________________ space due to disruption in the forces and mechanisms that normally keep net filtration at zero.

15 **Edema (2 of 4)**

- Excess fluid in the interstitial space. May result from:
  - A decrease in plasma oncotic force resulting from a decrease in plasma proteins
  - Increased ____________________________ pressure
  - Increased capillary ____________________________ resulting from mechanisms of inflammation and immune response
  - Lymphatic channel obstruction, which can result from infection or surgical removal

16 **Edema (3 of 4)**

- Can be ____________________________ or within a certain organ system.
  - For example: Sprained ankle vs. ____________________________ edema.

17 **Edema (4 of 4)**

- Water in interstitial spaces is not available for ____________________________ processes.
  - Edema, therefore, can cause a relative condition of ____________________________ .

18 **Intravenous Therapy**

19 **Intravenous Therapy**

- Intravenous (IV) therapy is the introduction of fluids and other substances into the ____________________________ side of the circulatory system.
  - Used to replace blood lost through hemorrhage, for
or fluid replacement, and for introduction of medications directly into the vascular system.

20 Fluid Replacement
Hypovolemic shock:
- 1st choice: Whole ________________
- 2nd choice: packed RBCs
- 3rd choice: plasma or plasma substitute
- 4th choice: ____________ or ____________

21 Fluid Replacement
Shock due to plasma loss (Burns):
- 1st choice: ____________________________________
- 2nd choice: plasma substitute
- 3rd choice: ____________ or ____________

22 Fluid Replacement
Dehydration:
- 1st choice: ____________ or ____________

23 Fluid Selection
- ____________ is the preferred IV fluid for cardiac related emergencies; especially pulmonary edema
  - Initially causes volume increase but rapidly leaves the vascular space
- ____________ or ____________ is the preferred IV fluid for traumatic injuries and for fluid replacement

24 Administration Set Selection
- ____________________________________ (10 or 15gtt) is the preferred administration set for trauma and emergencies requiring fluid replacement
  - AKA “__________________________________ Set” or “Macrodrip”
- ____________________________________ (60gtt) is the preferred administration set when fluid overload is a concern
  - AKA “__________________________________”
  - Piggy back drips, CHF, Renal Failure, Pediatrics

25 Preferred IV Sites
- In cardiac arrest patients, never go below the A/C space. EJ is an option
- Try to avoid:
  - ________________ (except for A/C)
  - Near pulse points
  - Lower extremities
- Watch for “positional” IV locations
  - Use a ___________________________ if needed

26 IV Catheter Sizes (1 of 2)
- The larger the ________________, the smaller the size
- EMS ranges from 22ga to 14ga IV catheters
• **Range from 21ga to 27ga**
  - Used predominately in children
  - Flush tubing
• **Bore is considered 16 to 14ga**
  - 18ga is considered medium bore to smaller large bore

### IV Catheter Sizes (2 of 2)
- For the most part, no IV smaller than a __________ ga should be started on an adult; __________ ga for traumatic patients where fluid replacement may be needed
- The larger and __________________________ the catheter, the easier it is to administer fluids and drugs

### IV Fluid Rates: TKO
- TKO (To Keep Open): used to allow access to administer fluids or drugs if needed
- AKA KVO (Keep Vein Open)
- Used on patients where __________________________ is not required
- Used on trauma patients and all other patients where there is no need for __________________________ fluids

### IV Fluid Rates: Other Rates
- __________________________ Open (WO): used to infuse high volume of fluids
  - Used for the treatment of shock and for fluid challenges
- **Volume Over Time**
  - Specific volume over a certain time frame
- **Medicated IV Rates**
  - A specific dosage over a certain time frame
- **Burn Formula**
  - Used to replace fluids in burn patients

### Blood Transfusion
- **Transfusion __________________________** occur when there is a discrepancy between the blood type of the patient and the type of the blood being transfused.

### Signs and Symptoms of Transfusion Reactions
1. **Chills**
2. **Hives**
3. **Palpitations**
4. **Flushing of the skin**
5. **Headache**
6. **Loss of __________________________**
7. **Nausea**
8. **______________________________**
● Shortness of breath

33. Treatment of Transfusion Reactions (1 of 2)
  ● IMMEDIATELY __________________________ the transfusion.
  ● Save the substance being transfused.
  ● __________________________ IV infusion.

34. Treatment of Transfusion Reactions (2 of 2)
  ● Assess the patient’s __________________________ status.
  ● Administer __________________________.
  ● Contact medical direction.
  ● Be prepared to administer mannitol, diphenhydramine, or furosemide.

35. Intravenous Fluids

36. Hemoglobin-Based Oxygen-Carrying Solutions (HBOCs)
  ● Commonly referred to as “blood substitutes”
    – Compatible with all __________________________ types
    – Do not require blood __________________________, testing, or cross-matching
  ● Gaining in popularity, but now not common in EMS

37. Colloids
  ● Colloids remain in intravascular spaces for an extended period of time and have oncotic force (will pull fluids into circulatory system).
    – Plasma protein fraction (Plasmanate)
    – Salt-poor __________________________
    – __________________________
    – Hetastarch (Hespan)

38. Crystalloids
  ● Contains no large __________________________
  ● Crystalloid solutions are the primary compounds used in prehospital care.
    – __________________________ solutions
    – Hypertonic solutions
    – Hypotonic solutions

39. Common EMS Fluids
  Lactated Ringers: __________________________ Crystalloid Solution
  Normal Saline: __________________________ Crystalloid Solution
  D5W: __________________________ Crystalloid Solution

40. Acid-Base Derangements

41. Respiratory Acidosis
  Caused by abnormal retention of __________________________ from impaired ventilation due to problems occurring in the lungs or respiratory center of the brain.
Increased CO₂ = ____________________________________ pH
↓Respirations=↑ CO₂ + H₂O → ↑ H₂CO₃ → ↑ H⁺ + HCO₃⁻
• Treatment is to improve or assist ventilations

42 Respiratory Alkalosis

Caused by _______________________________ respiration and excessive elimination of CO₂. The CO₂ level is decreased and the pH is increased.

Decreased CO₂ = ____________________________________ pH
↑Respirations=↓CO₂ + H₂O → ↓ H₂CO₃ → ↓ H⁺ + HCO₃⁻
• Treatment, if required, is to increase CO₂ level

43 Metabolic Acidosis

Results from the production of metabolic acids such as lactic acid due to __________________________ metabolism. These acids consume bicarbonate ions.
• Can be the result of dehydration, ______________________________ ________________, or medication usage.
• pH is decreased, CO₂ is normal
  ↑ H⁺ + HCO₃⁻ → ↑ H₂CO₃ → H₂O + ↑ CO₂

44 Metabolic Acidosis

• Treatment is to treat underlying ______________________________ ________________, and:
  • ______________________________ to eliminate excess CO₂ and subsequently Hydrogen ion
  • Could require Sodium Bicarbonate

45 Compensation for metabolic acidosis begins with an increase in respirations.

46 Metabolic Alkalosis

• It is usually caused by administration of ______________________________ ________________, loss of chloride ions associated with prolonged vomiting, and overzealous administration of sodium bicarbonate.
• The pH is increased and the CO₂ level is ______________________________ ________________.
  ↓ H⁺ + HCO₃⁻ → ↓ H₂CO₃ → H₂O + ↓ CO₂
• Treatment is to correct underlying problem

47 Acid Base Imbalances

• Normally, both a respiratory and metabolic component are present in an acid-base imbalance.
• Actual determination requires arterial blood gas studies (___________________________________)
  • ABGs include pH, ______________________________ ________________, PaO₂, bicarbonate concentration, and O₂ sats

48 Determining Acid/Base Imbalances

• 1) Look at ______________________________
  • Low = acidosis
  • High = alkalosis
• 2) Look at ______________________________
– Normal = metabolic
– High or low = Respiratory

Most are a ____________________________
– Ex: Respiratory acidosis with slight metabolic acidosis

49 Acid Base Example 1

● Lab values:
  – pH is 7.30
  – PaCO2 is 38
  – PaO2 is 90
● Is this acidosis, normal, or alkalosis?
  ● ____________________________
● Is CO2 high, low, or normal?
  ● ____________________________
● What is the acid/base imbalance?
  ● ____________________________

50 Acid Base Example 2

● Lab values:
  – pH is 7.58
  – PaCO2 is 44
  – PaO2 is 90
● Is this acidosis, normal, or alkalosis?
  ● ____________________________
● Is CO2 high, low, or normal?
  ● ____________________________
● What is the acid/base imbalance?
  ● ____________________________

51 Acid Base Example 3

● Lab values:
  – pH is 7.64
  – PaCO2 is 34
  – PaO2 is 88
● Is this acidosis, normal, or alkalosis?
  ● ____________________________
● Is CO2 high, low, or normal?
  ● Slightly ____________________________
● What is the acid/base imbalance?
  ● ____________________________ with slight Respiratory Alkalosis

52 Acid Base Example 4

● Lab values:
  – pH is 7.20
– PaCO2 is 49
– PaO2 is 88

- Is this acidosis, normal, or alkalosis?
- ________________

- Is CO2 high, low, or normal?
- Slightly ________________

- What is the acid/base imbalance?
- ________________

53 Hypoperfusion

54 Hypoperfusion (shock) is inadequate ___________________________ of body tissues.

55 Shock occurs first at the ___________________________ level and progresses to the tissues, organs, organ systems, and ultimately the entire organism.

56 The Pathophysiology of Hypoperfusion

57 Causes of Hypoperfusion (1 of 2)

Inadequate pump
- Inadequate ___________________________.
- Inadequate cardiac contractile strength.
- Inadequate heart rate.
- Excessive ___________________________.

58 Causes of Hypoperfusion (2 of 2)

Inadequate ___________________________.

- Hypovolemia.

- Dilated container without change in fluid volume (inadequate systemic vascular resistance).
- Leak in the container.

59 Metabolism

- All cells must have metabolism
  - Oxygen and nutrients in; ___________________________ and waste out

- ___________________________. Metabolism: requires oxygen, hormones (glucose)
  - Normal metabolism

- ___________________________. Metabolism: occurs when oxygen and/or glucose is not available
  - Produces lactic acid as waste product

60 Shock at the Cellular Level

- Shock causes vary, however the ultimate outcome is impairment of cellular
Impaired Use of Oxygen

- When cells don’t receive enough oxygen or cannot use it effectively, they change from aerobic to __________________ metabolism.

Stages of Shock

- __________________
- __________________ (Progressive)
- __________________

Compensation Mechanisms

- The __________________ epinephrine and norepinephrine may be secreted.
- Blood vessels constrict to maintain blood pressure.
- Another endocrine response by the pituitary gland results in the secretion of anti- ________________ hormone (ADH).

Types of Shock

- __________________
- Hypovolemic
- __________________
- Anaphylactic
- __________________

Cardiogenic Shock

- The heart loses its ability to supply all body parts with __________________ .
- Usually the result of __________________ ventricular failure secondary to acute myocardial infarction or CHF.
- Many patients will have __________________ blood pressures.

Evaluation

The major difference between cardiogenic shock and other types of shock is the presence of pulmonary edema causing:

- Difficulty __________________ .
- As fluid levels rise, wheezes, crackles, or __________________ may be heard.
- There may be a productive cough with white or pink-tinged foamy __________________ .
- Cyanosis.

Treatment (1 of 2)

- Assure an open airway.
- Administer oxygen.
- Assist __________________ as necessary.
- Keep the patient __________________.

Treatment (2 of 2)

- Elevate the patient’s head and shoulders.
● Establish IV access with __________________________ fluid administration.
● Monitor the heart rate.
● ________________ or Dobutamine may be administered to support BP if needed at Paramedic level.

69 Hypovolemic Shock
Shock due to loss of __________________________ fluid.
● Internal or external hemorrhage.
● Trauma.
● Long bones or open fractures.
● Dehydration.
● Plasma loss from __________________________.
● Excessive sweating.
● Diabetic ketoacidosis with resultant osmotic __________________________.

70 Evaluation
● Altered level of __________________________.
● Pale, cool, clammy skin.
● Blood pressure may be __________________________, then fall.
● Pulse may be normal then become rapid, finally slowing and disappearing.
● __________________________ decreases.
● Cardiac dysrhythmias may occur.

71 Treatment
● Airway control.
● Control severe bleeding.
● Keep the patient __________________________.
● Administer a __________________________ of isotonic crystalloid solution for fluid replacement (NS or LR).
● PASG if part of local protocol.

72 Neurogenic Shock
● Results from injury to brain or spinal cord causing an interruption of nerve impulses to the __________________________.
● The arteries dilate causing __________________________ hypovolemia.
● Sympathetic impulses to the adrenal glands are lost, preventing the release of __________________________ with their compensatory effects.

73 Evaluation
● __________________________, dry, red skin.
  – Due to sweat gland malfunction
● Low blood pressure.
● __________________________ pulse.
  – Due to lack of catecholamine release
● Possible __________________________ in males
**Treatment**

- Airway control.
- Maintain body temperature.
- __________________________________ of patient.
- Consider other possible causes of shock.
- IV fluids to __________________________________ vascular space
- Medications that increase peripheral vascular resistance such as ______________________________________________________ (Paramedic level).

**Anaphylactic Shock**

- A severe immune response to a ___________________________________ substance.
- Signs and symptoms most often occur within a minute, but can take up to an hour.
- The most rapid reactions are in response to ___________________________________ substances:
  - Penicillin injections.
  - Bees, wasps, hornets.

**Evaluation (1 of 2)**

- Because immune responses can affect different body systems, signs and symptoms vary widely:
  - Skin:
    - Flushing, itching, ____________, swelling, cyanosis.
  - Respiratory system:
    - Breathing difficulty, sneezing, coughing, ____________, stridor, laryngeal edema, laryngospasm.

**Evaluation (2 of 2)**

- Cardiovascular system:
  - _______________ , increased heart rate, decreased blood pressure.
- Gastrointestinal system:
  - Nausea, vomiting, abdominal cramping, diarrhea.
- Nervous system:
  - Altered mental status, dizziness, headache, _______________ , tearing.

**Treatment**

- Airway protection, may include endotracheal intubation.
- Establish an IV of __________________________________ crystalloid solution (NS or LR).
- Pharmacological intervention:
  - Epinephrine, antihistamines, corticosteroids, vasopressors, inhaled _______________ agonists.

**Septic Shock**

- An _____________________ that enters the bloodstream and is carried throughout the body.
The toxins released overcome the ___________________________ mechanisms.
Can cause the dysfunction of an organ system or result in multiple organ dysfunction syndrome.

Evaluation
The signs and symptoms are progressive.
- Increased to low blood pressure.
- High __________________________________, no fever, or hypothermic.
- Skin flushed, pale, or cyanotic.
- Difficulty breathing and altered ___________________________ sounds.
- Altered ___________________________ status.

Treatment
- Airway control.
- ____________________________________ of crystalloid solution.
- ____________________________________ to support blood pressure at Paramedic level.

Multiple Organ Dysfunction Syndrome
- MODS is the progressive impairment of ___________________________ or more organ systems from an uncontrolled inflammatory response to a severe illness or injury.
- Many patients who were resuscitated from shock died a few days later.
- ___________________________ shock is the most common cause of MODS
- MODS is the major cause of death following sepsis, trauma, and burn injuries

MODS 24 Hours After Resuscitation
- Low grade ___________________________.
- ___________________________.
- Dyspnea.
- Altered mental status.

MODS Within 24 to 72 Hours
- ___________________________ failure begins.

MODS Within 7 to 10 Days
- ___________________________ failure begins.
- Intestinal failure begins.
- ___________________________ failure begins.

MODS Within 14 to 21 Days
- Renal and hepatic failure ___________________________.
- Gastrointestinal collapse.
- ___________________________ system collapse.

MODS After 21 Days
- ___________________________ failure begins.
- Myocardial failure begins.
• Altered mental status resulting from encephalopathy.
• ________________________________.