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 normal and injurious conditions.
- Adaptation to external stressors results in ____________________________ of structure and function.
- Examples: Growth of the ____________________________ 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
- Inflammatory reactions
- ____________________________ agents
- Nutritional factors
- ____________________________ factors

Manifestation of Cellular Injury

- When cells are injured ____________________________ is changed, causing substances to infiltrate or accumulate to an abnormal degree in cells.
- ____________________________ : the constructive or “build up” phase of metabolism
- ____________________________ : the destructive or “breaking down” phase
of metabolism

9. Cellular Swelling
   • Results from a permeable or ____________________________ cellular membrane.
   • Caused by an inability to maintain stable intra- and extracellular fluid and _________________ levels.

10. Fatty Change
    • ____________________________ invade the area of injury.
    • Occurs most commonly in vascular organs, most frequently the liver.
    • Causes a disruption of the cellular membrane and ____________________________ and interferes with the vital functions of the organ.

11. Signs and Symptoms of Cellular Change
    • ____________________________ and malaise
    • Altered appetite
    • ____________________________
    • Increased heart rate associated with fever
    • ____________________________

12. 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.

13. Cell Death (2 of 2)
    (“Cell Death ”):
    • A pathological process in which cells swell and rupture. Death of the cell _________________ necrosis:
    • Cell death over a wide area

14. Fluids and Fluid Imbalances
15. _________________ is the most abundant substance in the human body.

16. Where the Water is Found
    • ____________________________ fluid—fluid inside the cells.
    • ____________________________ fluid—all the fluid outside the body cells.
    • ____________________________ fluid—fluid within the circulatory system.
    • ____________________________ fluid—fluid outside of the cell membranes
      but not within the circulatory system.

17. Edema (1 of 4)
    • Accumulation of ____________________________ in the interstitial space due
to disruption in the forces and mechanisms that normally keep net filtration at zero.

18 Edema (2 of 4)
Excess fluid in the __________________________ space. May result from:
• A decrease in plasma oncotic force resulting from a decrease in plasma proteins
• Increased hydrostatic pressure
• Increased capillary permeability resulting from mechanisms of inflammation and immune response
• Lymphatic channel obstruction, which can result from
____________________________________ or surgical removal

19 Edema (3 of 4)
• Can be __________________________ or within a certain organ system.
• For example: Sprained ankle vs. __________________________ edema.

20 Edema (4 of 4)
• Water in interstitial spaces is not available for
____________________________________ processes.
• Edema, therefore, can cause a relative condition of
____________________________________

21 Intravenous Therapy

22 Blood Components
• Red Blood Cells: ________% of blood volume
• White Blood Cells: ________% of blood volume
• Plasma: ________% of blood volume

23 The percentage of the blood occupied by the red blood cells is termed the
____________________________________.

24 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.

25 Fluid Replacement
Hypovolemic shock:
• 1st choice: Whole __________________________
• 2nd choice: packed __________________________
• 3rd choice: plasma or plasma substitute
• 4th choice: ______________ or _____________

26 Fluid Replacement
Shock due to plasma loss (Burns):
• 1st choice: __________________________
• 2nd choice: __________________________ substitute
• 3rd choice: ____________ or ____________

27 Fluid Replacement
Dehydration:
• 1st choice: ____________ or ____________

28 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

29 Administration Set Selection
• A-Set (10 or 15gtt) is the preferred administration set for trauma and emergencies requiring fluid replacement
  – AKA “Regular Set” or “____________________________ ”
• Minidrip (60gtt) is the preferred administration set when fluid overload is a concern
  – AKA “____________________________ ”
  – Piggy back drips, __________________________ , Renal Failure, Pediatrics

30 Preferred IV Sites
• In cardiac arrest patients, never go below the ____________ space. EJ is an option
• Try to avoid:
  – Joints (except for A/C)
  – Near ______________________________ points
  – Lower extremities
• Watch for “____________________________ ” IV locations
  – Use a __________________________ if needed

31 IV Catheter Sizes (1 of 2)
• The larger the number, the ______________________________ the size
• EMS ranges from _____________ ga to _____________ ga IV catheters
• Butterflies range from _____________ ga to _____________ ga
  – Used predominately in children
  – Flush tubing
• Large bore is considered _____________ to _____________ ga
  – _____________ ga is considered medium bore to smaller large bore

32 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

33 IV Fluid Rates: TKO
• TKO (To Keep Open): used to allow access to administer fluids or
• AKA ______________ (Keep Vein Open)
• Used on patients where ______________ is not required
• Used on trauma patients and all other patients where there is no need for immediate ______________

34 □ IV Fluid Rates: Other Rates
• Wide Open (_____________): used to infuse high volume of fluids
  – Used for the treatment of __________________________ and for fluid challenges
• Volume Over Time
  – Specific __________________________ over a certain time frame
• Medicated IV Rates
  – A specific __________________________ over a certain time frame
• Parkland Burn Formula
  – Used to replace fluids in __________________________ patients

35 □ Blood Transfusion

36 □ Transfusion reactions occur when there is a discrepancy between the ______________ type of the patient and the type of the blood being transfused.

37 □ Signs and Symptoms of Transfusion Reactions

1 • ______________
  • Chills
  • Hives
  • Palpitations
  • Tachycardia
2 • Flushing of the skin
  • ______________
  • Loss of ______________
  • Nausea
  • Vomiting
  • Shortness of breath

38 □ Treatment of Transfusion Reactions (1 of 2)
• IMMEDIATELY ______________ the transfusion.
  • ______________ the substance being transfused.
  • Rapid IV ______________.

39 □ Treatment of Transfusion Reactions (2 of 2)
• Assess the patient’s mental status.
  • Administer ______________.
  • Contact medical direction.
- Be prepared to administer mannitol, diphenhydramine, or ____________________________.

40 □ Intravenous Fluids

41 □ Hemoglobin-Based Oxygen-Carrying Solutions (HBOCs)
- Commonly referred to as “blood ____________________________”
  - Compatible with all blood types
  - Do not require blood ____________________________, testing, or cross-matching
- Gaining in popularity, but now not ____________________________ in EMS

42 □ Colloids
- Colloids remain in intravascular spaces for an ____________________________ period of time and have oncotic force (will pull fluids into circulatory system).
  - Plasma protein fraction (Plasmanate)
  - Salt-poor albumin
  - ____________________________
  - Hetastarch (Hespan)

43 □ Crystalloids
- Contains no large ____________________________
- Crystalloid solutions are the ____________________________ compounds used in prehospital care.
  - Isotonic solutions
  - Hypertonic solutions
  - Hypotonic solutions

44 □ Fluids and Red Blood Cells
- The effects of hypertonic, isotonic, and hypotonic solutions on red blood cells

45 □ Common EMS Fluids
  Lactated Ringers: ____________________________ Crystalloid Solution
  Normal Saline: ____________________________ Crystalloid Solution
  D5W: ____________________________ Crystalloid Solution

46 □ Acid-Base Derangements

47 □ Respiratory Acidosis
  Caused by abnormal retention of ______________ from impaired ventilation due to problems occurring in the lungs or respiratory center of the brain.
  - Increased \( CO_2 \) = lowered pH
  \[ \downarrow \text{Respirations} \Rightarrow \uparrow CO_2 + H_2O \rightarrow \uparrow H_2CO_3 \rightarrow \uparrow H^+ + HCO_3^- \]
  - Treatment is to improve or assist ____________________________

48 □ Respiratory Alkalosis
  Caused by increased respiration and excessive elimination of ______________. The \( CO_2 \) level is decreased and the pH is increased.
Decreased CO₂ = ___________________ pH
↑Respirations=↓CO₂ + H₂O → ↓H₂CO₃ → ↓H⁺ + HCO₃⁻
• Treatment, if required, is to ___________________ CO₂ level

49 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

50 Metabolic Acidosis
• Treatment is to treat __________________________ cause, and:
• Ventilations to eliminate excess CO₂ and subsequently Hydrogen ion
• Could require __________________________ Bicarbonate

51 Compensation for metabolic acidosis begins with an __________________________ in respirations.

52 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

53 Acid Base Imbalances
• Normally, both a respiratory and __________________________ component are present in an acid-base imbalance.
• Actual determination requires __________________________ blood gas studies (ABGs)
• ABGs include pH, PaCO₂, PaO₂, bicarbonate concentration, and O₂ sats

54 Determining Acid/Base Imbalances
• 1) Look at pH
  – Low = __________________________
  – High = __________________________
• 2) Look at CO₂
  – Normal = __________________________
  – High or low = __________________________
• Most are a combination
  – Ex: Respiratory acidosis with slight metabolic acidosis

55 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?

____________________________________

56 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?

____________________________________

57 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?

__________________________________________________________________________ Alkalosis with slight Alkalosis

58 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?
    ____________________________________

59 □ Hypoperfusion

60 □ ____________________________ (shock) is inadequate perfusion of body tissues.

61 □ Shock occurs first at the ____________________________ level and progresses to the tissues, organs, organ systems, and ultimately the entire organism.

62 □ The Pathophysiology of Hypoperfusion

63 □ Causes of Hypoperfusion (1 of 2)
    Inadequate ____________________________
        • Inadequate preload.
        • Inadequate cardiac contractile strength.
        • Inadequate heart ____________________________ .
        • Excessive afterload.

64 □ Causes of Hypoperfusion (2 of 2)
    Inadequate ____________________________
        • Hypovolemia.
    Inadequate ____________________________
        • ____________________________ container without change in fluid volume (inadequate systemic vascular resistance).
        • ____________________________ in the container.

65 □ Metabolism
    • All cells must have metabolism
        – Oxygen and nutrients in; CO2 and waste out
    • Aerobic Metabolism: requires oxygen, hormones (glucose)
        – Normal metabolism
    • Anaerobic Metabolism: occurs when oxygen and/or glucose is not available
        – Produces lactic acid as waste product

66 □ Shock at the Cellular Level
    • Shock causes vary, however the ultimate outcome is impairment of cellular ____________________________ .

67 □ Impaired Use of Oxygen
    • When cells don’t receive enough oxygen or cannot use it effectively, they change from aerobic to ____________________________ metabolism.

68 □ Stages of Shock
    • ____________________________
    • ____________________________ (Progressive)
    • ____________________________
Compensation and Decompensation
• Usually the body is able to compensate for any changes. However when the various compensatory mechanisms fail, ____________________________________ develops and may progress.

Compensation Mechanisms
• The catecholamines _______________________________ 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-diuretic hormone (ADH).

Shock Variations (1 of 3)
• Compensated shock is the early stage of shock during which the body’s compensatory mechanisms are able to maintain normal ________________________________.

Shock Variations (2 of 3)
• Decompensated shock is an advanced stage of _______________________________ that occurs when the body’s compensatory mechanisms no longer maintain normal perfusion.

Shock Variations (3 of 3)
• Irreversible shock is shock that has progressed so far that the body and medical ________________________________ cannot correct it.

Types of Shock
• ________________________________
  • Hypovolemic
  • ________________________________
  • Anaphylactic
  • ________________________________

Cardiogenic Shock
• The heart loses its ability to supply all body parts with blood.
• 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 ________________________________ edema causing:
• Difficulty breathing.
• As fluid levels rise, wheezes, crackles, or ________________________________ may be heard.
• There may be a productive cough with white or pink-tinged foamy sputum.
• ________________________________.
77 [ ] Treatment (1 of 2)
- Assure an open airway.
- Administer oxygen.
- Assist ______________________ as necessary.
- Keep the patient ______________________.

78 [ ] Treatment (2 of 2)
- Elevate the patient’s ______________________ and shoulders.
- Establish IV access with ______________________ fluid administration.
- Monitor the heart rate.
- Dopamine or Dobutamine may be administered to support BP if needed.

79 [ ] Hypovolemic Shock
Shock due to loss of ______________________ fluid.
- Internal or external hemorrhage.
- ______________________.
- Long bones or open fractures.
- ______________________.
- Plasma loss from burns.
- Excessive ______________________.
- Diabetic ______________________ with resultant osmotic diuresis.

80 [ ] Evaluation
- Altered level of consciousness.
- Pale, cool, ______________________ skin.
- Blood pressure may be ______________________, then fall.
- Pulse may be normal then become rapid, finally slowing and disappearing.
- ______________________ decreases.
- Cardiac ______________________ may occur.

81 [ ] Treatment
- Airway control.
- Control severe ______________________.
- Keep the patient warm.
- Administer a bolus of ______________________ crystalloid solution for fluid replacement (NS or LR).
- ______________________ if part of local protocol.

82 [ ] Neurogenic Shock
- Results from injury to brain or spinal cord causing an interruption of nerve impulses to the arteries.
- The arteries ______________________ causing relative hypovolemia.
- ______________________ impulses to the adrenal glands are lost, preventing the release of catecholamines with their compensatory effects.
Evaluation
• Warm, dry, ____________________________ skin.
  – Especially noted above the injury site
• ____________________________ blood pressure.
• ____________________________ pulse.
• Possible priapism in males

Treatment
• Airway control.
• Maintain body temperature.
  ____________________________ of patient.
• Consider ____________________________ possible causes of shock.
• IV fluids to fill ____________________________ space
• Medications that increase peripheral vascular resistance.

Anaphylactic Shock
• A severe immune response to a foreign substance.
• Signs and symptoms most often occur within a
  ____________________________ , 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, ____________________________ 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:
  - ____________________________________, antihistamines, corticosteroids, vasopressors, inhaled beta agonists.

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

90  Evaluation
- The signs and symptoms are ____________________________________.
  - Increased to low blood pressure.
  - High fever, no fever, or ____________________________________.
  - Skin flushed, pale, or cyanotic.
  - Difficulty ____________________________________ and altered lung sounds.
  - Altered mental status.

91  Treatment
- Airway control.
- IV of ____________________________________ solution.
- Dopamine to support blood pressure.
- Monitor heart ____________________________________.

92  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 ____________________________________ later.
- ____________________________________ shock is the most common cause of MODS.
- MODS is the major cause of death following sepsis, ____________________________________, and burn injuries.

93  MODS 24 Hours After Resuscitation
- Low grade ____________________________________.
- Tachycardia.
- ____________________________________.
- Altered mental status.

94  MODS Within 24 to 72 Hours
- ____________________________________ failure begins.

95  MODS Within 7 to 10 Days
- ____________________________________ failure begins.
  - Intestinal failure begins.
• ________________________________ failure begins.

**MODS Within 14 to 21 Days**
- Renal and hepatic failure intensify.
- Gastrointestinal collapse.
- ________________________________ system collapse.

**MODS After 21 Days**
- Hematologic failure begins.
- ________________________________ failure begins.
- Altered mental status resulting from encephalopathy.
- ________________________________.