Inflammation

OBJECTIVES/RATIONALE

Inflammation is a normal response to infection or injury and is considered one of the body’s defensive mechanisms. The student will define inflammation, state its purpose, and identify the phases of response to injury.
I. The Cell

- A. Most signs of disease can be traced back to damage of individual cells and their attempts at repair - in order to understand what is happening when a person is ill, one must first comprehend the events at the basic level of the cell or sometimes in the area of biochemistry.
B. The cell is the foundation of the structure of the human body. It is seen as a self-sustaining factory that carries on all processes of life

- a. respiration
- b. use & production of energy
- c. Reproduction
- d. elimination
I. The Cell (Continued)

- **C.** large group of cells that join together for a specific activity is called *tissue*
- **D.** different tissues that join together for a specific function is called an *organ*
- **E.** organs that perform together for a specific function is called an *organ system*
- **F.** Cell Dysfunction = Organ Dysfunction = Clinical Disease
Defense Mechanisms

- Immunity - ability of the body to defend itself against infectious agents, foreign cells, and even abnormal body cells, such as cancer cells

- Immunity includes:
  - Nonspecific Defense Mechanisms
  - Specific Defense Mechanisms
Nonspecific Defense Mechanisms

- Mechanisms that are effective against any foreign agent that enters the body and are referred to as innate immunity
  - Physical and Chemical Barriers:
    - Skin
    - Tears, saliva, sweat, oil
    - Mucous membranes
    - Cilia
Nonspecific Defense Mechanisms

- Phagocytosis: leukocytes engulf and destroy bacteria and other material.
- Natural Killer Cells: type of leukocyte that recognizes body cells with abnormal membranes.
- Fever: sign the body is defending itself; phagocytes find and destroy foreign invaders; releasing substances that raise the body temp.
- Interferon: group of substances that stimulates the immune system (used with cancer).
II. Cellular Injury

A. Inflammation  the body’s response to injury
II. Cellular Injury (Continued)

- B. Limiting factor of inflammation: cannot occur in tissue that does not have a blood supply.
  
a. This factor is important in forensic medicine because evidence of inflammation in tissue confirms that an injury occurred while the individual was alive.
II. Cellular Injury

b. If no evidence exists, the pathologist can be assured that the person was dead when the injury was inflicted.

c. When Tissue is Destroyed by an Injury. The inflammatory process will only occur along borders of injury where blood supply is maintained, i.e. gangrene.
II. Cellular Injury (Continued)

D. Inflammation is designed to be a Beneficial Protective Mechanism - in some instances reaction may become so intense that it becomes harmful to tissues.
E. Inflammation vs. Infection

a. Whereas inflammation is a response to injury, infection is the invasion of living tissue by pathogens.

b. An infection causes inflammation, but tissue that is inflamed may not be infected. Therefore, inflammation may exist without the presence of microbial pathogens, i.e. sunburn.
II. Cellular Injury (Continued)

F. Inflammatory Process
   a. The cells of the immune system are widely distributed throughout the body, but if infection or tissue damage occurs it is necessary to concentrate them and their products at the site of damage.
Types of Leukocytes (cells)

- **Neutrophils - type of phagocyte**
  - Most common WBC (50-70%) and live for 4-10 hours if not activated; they die as soon as they ingest another cell
  - 1st to arrive at infection site through chemotaxis
  - Main component of pus and is whitish color and liquefy in tissue
  - After phagocytosis they release superoxide which is hypochlorous acid (chlorine bleach) to kill microbes
Types of Leukocytes

- **Monocytes** - type of phagocyte
  - 1-3% of WBC; low count indicates no infection
  - Made in bone marrow and spread in body over 1-3 days

- **Macrophages** - eat other cells and attach pathogens and foreign materials; will increase during times of infection
- **Dendrites** - antigen presenting cells because they acquire antigens and show them to T-cells so they can recognize dangerous antigens
Types of Leukocytes

- **Eosinophil** - granulocyte that is a bilobate (2 nucleus)
  - Stains red
  - 1-3% of WBC count increase with allergic reactions and parasites
Types of Leukocytes

- **Basophils** - granulocytes
  - Rare type of WBC - less than 1% of WBC
  - Stains blue
  - Can release histamine and heparin for infection
    - **Histamine** - aids in immune response and neurotransmitter; makes capillaries more permeable to WBCs
    - **Heparin** - an anticoagulant produced in liver and lungs and prevents clotting
Types of Leukocytes

- **Lymphocytes** - responsible for immune response
  - B Cells - make antibodies responsible for attacking bacteria and toxins
    - mature in the bone marrow
    - humoral immunity (antibody production)
    - enlarge and divide when antibodies are present
    - some remain dormant until reactivated by same type of antigen
Types of Leukocytes

- **T Cells** - type of lymphocyte that seek out and destroy specific targeted invaders
  - Produced in the bone marrow but mature in the thymus
  1. **Helper T Cells** - Activates and deactivates other immune cells; suppressor cells will halt immune system response when needed
  2. **Killer T Cells** - cytotoxic - kills antigens
Cells destined to become immune cells, like all blood cells, arise in the bone marrow from so called Stem Cells.
When the Immune System is lacking one or more of its components, the result is an Immunodeficiency Disorder. The HIV virus shown here destroys helper T-cells. It is harbored in macrophages as well as Helper (T4) T-cells. The AIDS virus splices its DNA into the DNA of the cell it infects; the cell is thereafter directed to create new viruses.
F. Inflammatory Process (Continued)

- b. Three major events occur during this response:
  
  1) **Congestion** phase: Initially, the capillaries become engorged and dilated with blood. This increases capillary permeability caused by the reaction of the endothelial cells. This increases amount of blood, hyperemia, causes the heat and redness associated with inflammation
F. Inflammatory Process

2) **Leakage** - Leukocytes migrate out of the capillaries into the surrounding Tissues. In the earliest stages of inflammation, neutrophils are particularly prevalent, but later monocytes and lymphocytes also migrate towards the site of infection. Neutrophils line up within the capillary wall. Monocytes will clear up the debris.

3) **Phagocytosis** - specialized cells that defend the body against invading microorganisms and speed healing by engulfing cell debris in injured tissues
Inflammatory response

- The damaged cells release histamine; this causes the capillary walls to become more permeable.
- Plasma and Neutrophils are then able to move out of the blood vessels to tissue; a process called chemotaxis.
- Plasma and WBCs that escape from capillaries makes up the inflammatory exudate (swelling).
Chemotaxis
Inflammatory response

- Polymorphs die after digesting bacteria and toxins and release a substance that liquefy into tissue—causing pus
- Monocytes—then clear up the debris
- The inflammatory exudate contains plasma protein—fibrin. Fibrin is needed for clotting.
G. Two Major Categories of Inflammation: Acute and Chronic

a. Acute inflammation– a condition of sudden onset; if resolved, lasts a relatively short time

Characteristic Signs that Accompany Acute Inflammation (referred to as *cardinal signs*)

1. Redness
2. Swelling
3. Pain
4. Increased warmth or heat
5. Loss of movement or function
G. Two Major Categories of Inflammation: Acute and Chronic

b. Chronic inflammation—refers to a long duration (weeks, months, years, or even a lifetime)

i. Example of chronic diseases: asthma, allergy or hay fever, diabetes, etc.

ii. Chronic conditions often worsen (chronic progressive diseases) as result of aging process, environment, and cumulative damage of inflammation process
H. Serous fluids associated with inflammation

- a. Serous Transudates - serum fluid that passes through membrane or tissue (very watery with low protein content)
  
  i. Due to increased hydrostatic or decreased osmotic pressure in vascular system
H. Serous fluids associated with inflammation (Continued)

ii. Example: pulmonary edema - fluid filling lungs during congestive heart failure (result of decreased osmotic pressure)

iii. Inflammatory reactions involving pleural, pericardial, and peritoneal cavities are associated with serous discharge
Pulmonary Edema
Ascites= abnormal accumulation of fluid in abdomen when fluid seeps out of bloodstream and collects in peritoneal cavity

(From Lewis SM, Collier IC, Heitkemper MM: Medical-Surgical Nursing, 4th edition, St. Louis, Mosby, 1996, page 1274.)
b. Serous Exudates - serum fluid that is cloudy, thick, protein-rich fluid
   i. created by decreased hydrostatic pressure and increased osmotic pressure
   ii. Example: most common in acute inflammations such as minor burns (resulting in formation of blisters)
   iii. Fibrinous exudate produces layer of fibrinogen, which forms a mesh of fibrin and becomes a scab
Serous Exudates

Associated with CVD

Blisters associated with sun burn
H. Serous fluids associated with inflammation (Continued)

- c. Purulent exudate – pus producing fluid
  - i. referred to as pyogenic; inflammation with pus is called suppurative
    - Abscesses, boils, styes

Bladder infection at autopsy

Image provided by http://peir.path.uab.edu
Specific Defense Mechanism

- **Acquired Immunity** - defends against specific types of microorganisms and pathogens
  - Responds specifically to future exposures to the same microorganism or pathogen
  - Immunity can be acquired naturally by infection (ex: Chicken pox)
  - Immunity can be acquired artificially; (vaccination)
Specific Defenses

- Antigens - foreign element that triggers the immune response
  - The antigen is often a protein from the microorganism or pathogen; the specificity of acquired immunity is the body’s ability to recognize these antigens.
Antigen-presenting cell

A macrophage which digests a foreign cell, but leaves the antigens intact. It then binds these antigens to MHC (Major Histocompatibility Cell-protein that tells your body it is your own cell) molecules on its cell membrane. The antigen-MHC complexes are noticed by certain lymphocytes (recognition) which promotes cell division (repeated cell divisions).
Specific Defenses

- Specific defenses against antigens include special cells and the body’s lymphatic system.
- Lymph system - removes lymph and any microorganism before it enters blood.
  - Spleen, tonsils, and adenoids.
I. Inflammatory Lesions

Inflammatory Lesions – inflammatory reactions result in production of lesion - lesions vary according to level of severity.
I. Inflammatory Lesions

- Types of lesions:
  - a. abscess- localized spherical lesion filled with pus and pyogenic bacteria (usually stphylococci)
    - usually found in many areas of body including: skin (boils: furuncles and carbuncles), teeth, appendix, bowel, breast, and lung empyema – pus that fills pleural cavity
Carbuncles - top row
Furuncles - bottom row
Tooth Abscess

Crack

Infected
dental pulp
Lung Abscess - a subacute infection in which an area of necrosis forms in the lung parenchyma.
I. Inflammatory Lesions (Continued)

- b. cellulitis – spreading, diffuse infection most commonly involving streptococcal infection of subcutaneous tissues (body is unable to confine infection to localized area) - characterized by congestion and edema
I. Inflammatory Lesions (Continued)

- c. ulcers – depressed or excavated lesions on skin or mucosa
  - may appear almost anywhere in body and may involve many types of organs
  - stomach and duodenum may be ulcerated by gastric acids
  - pressure sores (decubitus ulcers) result from wasting away of tissue in bedridden patients
J. Tissue Repair

- a. body’s attempt to return to normal; can only occur when bacteria have been destroyed

- b. Fibroblasts allow for cut tissue edges to grow back together forming scar tissue
  - Adhesions- connective tissue fibers anchoring together
  - Keloid- raised and often hard scar (benign tumor)