Chapter 16

Infection Prevention and Control: Protective Mechanisms and Asepsis

Chapter 16

Lesson 16.1

Learning Objectives

Theory

1) List microorganisms that can cause infection in humans
2) Discuss the links in the infection process and give an example of each
3) Discuss why the elderly are more susceptible to infection
4) Explain how body's protective mechanisms work to prevent infection
5) Explain how inflammatory and immune responses protect the body

Infection

- Infection: entry into the body of an infectious agent (a microorganism) that then multiplies and causes tissue damage
- Pathogens: microorganisms capable of causing disease
- Some microorganisms produce toxins and others release endotoxins
- Infection may result in illness and disease

Organisms Causing Pathology

- Bacteria
- Prions
- Viruses
- Protozoa
- Rickettsias
- Fungi
- Helminths
- Others—mycoplasmas, Chlamydia

Bacteria

- Single-celled microorganisms lacking a nucleus
- Reproduce every few minutes up to several weeks
- Classified according to need for oxygen, shape, and gram staining

Bacteria (cont'd)

- Need for oxygen
  - Aerobic: need oxygen to grow and thrive
  - Anaerobic: can grow only without oxygen
- Gram staining
  - Gram-positive bacteria retain the stain
  - Gram-negative bacteria take up counterstain
- Shape
  - Cocci: round
  - Bacilli: rod-shaped
  - Spirochetes: spiral- or corkscrew-shaped

Bacteria (cont’d)

- Identified by chemical testing and growing cultures
- Sensitivity testing determines which antibiotic can kill the organism
- Some are drug-resistant

Bacteria (cont'd)

- Multidrug-resistant organisms
  - Methicillin-resistant *Staphylococcus aureus* (MRSA)
  - Vancomycin-resistant Enterococcus (VRE)
  - Extended-spectrum beta-lactamase–producing (ESBL) gonorrhea GNR (*Neisseria gonorrhoeae*)
  - *Clostridium difficile* (C. diff)
  - Penicillin-resistant *Streptococcus pneumoniae*

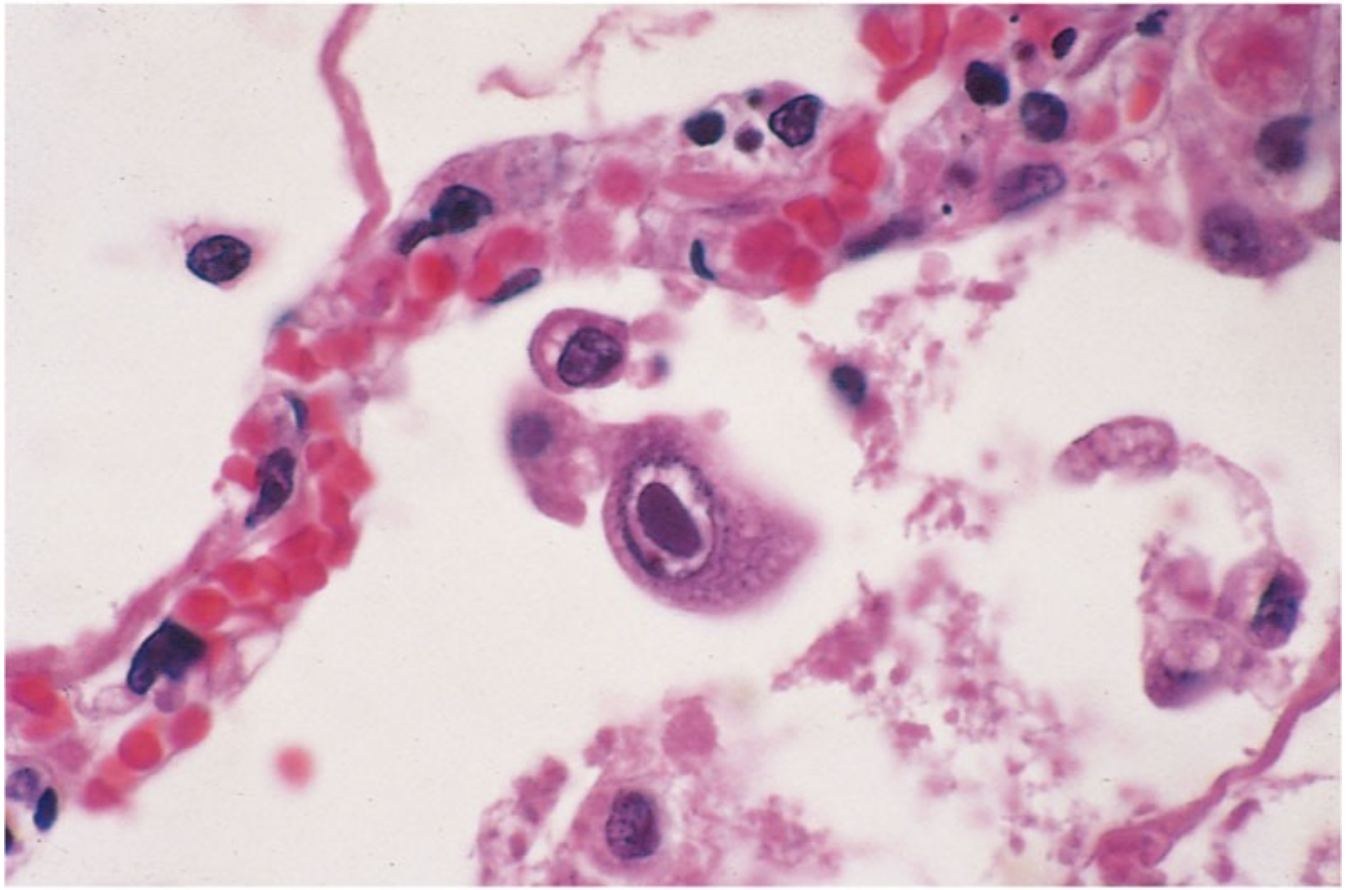
Prions

- Protein particles that lack nucleic acids and are not inactivated by usual procedures for destroying viruses
- Do not trigger an immune response
- Cause degenerative neurologic disease, such as variant Creutzfeldt-Jakob disease (mad cow disease)

Viruses

- Extremely small; seen only with an electron microscope
- Composed of particles of nucleic acids, either DNA or RNA, with a protein coat
- Grow and replicate only within a living cell; survival and replication depend on host tissue

Electron Microscope View of Viruses



From Kumar, V., Cotran, R.S., & Robbins, S.L. (2003). *Basic Pathology* (7th ed.). Philadelphia: Saunders.

Protozoa

- One-celled microscopic organisms belonging to the animal kingdom
- Examples of pathogenic protozoa
  - Plasmodium species: causes malaria
  - *Entamoeba histolytica*: causes amebic dysentery
  - Other strains capable of causing diarrhea

Rickettsia

- Small round or rod-shaped organisms
- Transmitted by the bites of fleas, lice, mites, and ticks
- Can multiply only in host cells
- Causes Rocky Mountain spotted fever and typhus

Fungi

- Tiny primitive organisms of the plant kingdom that contain no chlorophyll
- Include yeast and mold
- Feed off living animals and decaying organic matter
- Reproduce by use of spores
- Cause candidiasis and tinea pedis (athlete’s foot)

Helminths

- Parasitic worms or flukes
- Belong to the animal kingdom
- Pinworms, which mostly affect children, most common helminths worldwide
- Roundworms and tapeworms are other helminths

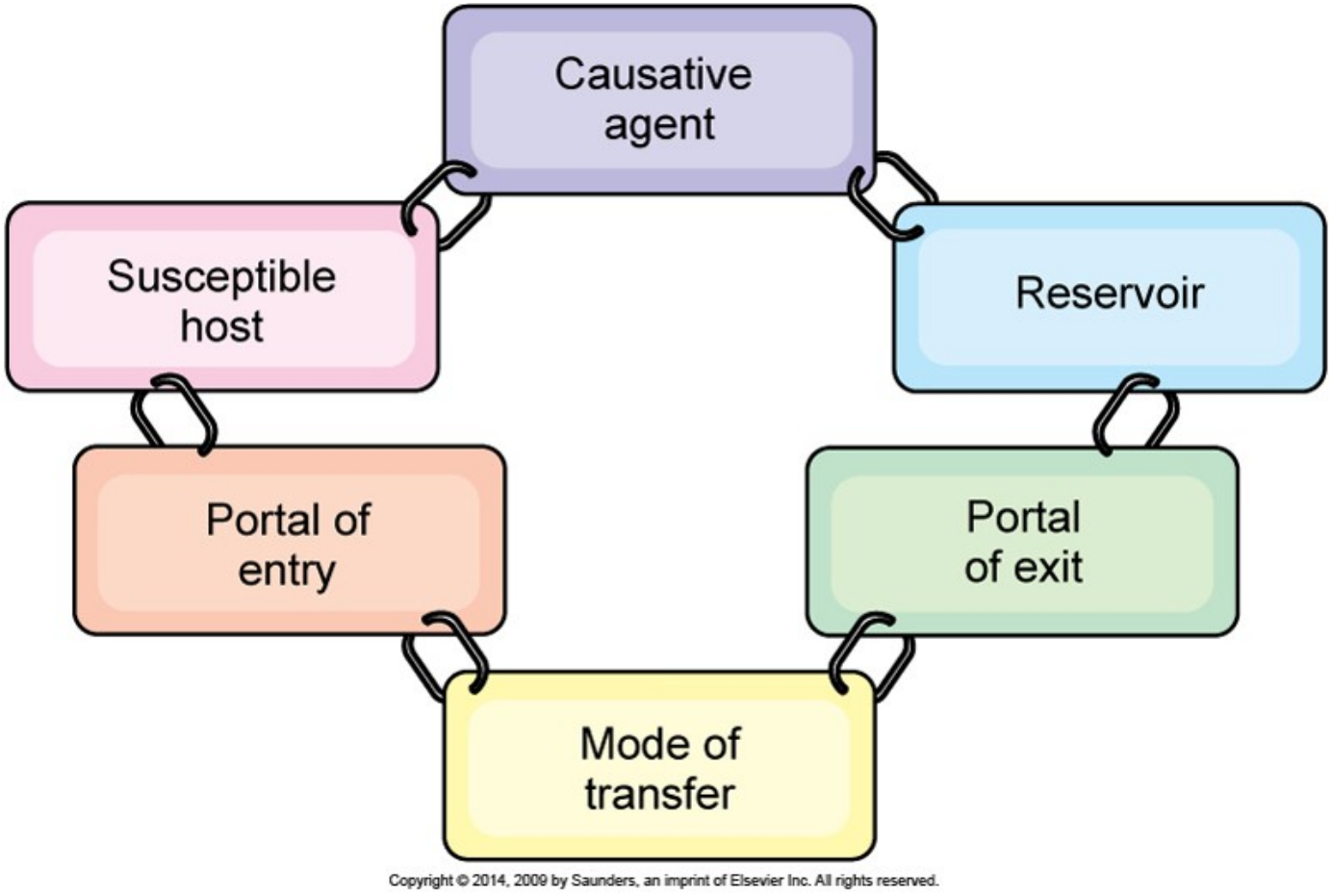
Other Infectious Agents

- Mycoplasmas
  - Very small organisms without a cell wall
  - Cause infections of respiratory or genital tract
  - Example: *Mycoplasma pneumoniae*
- Chlamydia
  - Affects the genitourinary and reproductive tracts
  - Increasingly more common in the past 20 years

Process of Infection

- An infectious disease is spread from one person to another; a continuous chain
- Chain links
  - Causative agent (link 1)
  - Reservoir (link 2)
  - Portal of exit (link 3)
  - Mode of transfer (link 4)
  - Portal of entry (link 5)
  - Susceptible host (link 6)

The Infection Chain



Causative Agent (Link 1)

- Any microorganism or biologic agent capable of causing disease
- Bacteria, viruses, protozoa, rickettsias, fungi, helminths
- Virulence of the agent is affected by its ability to:
  - Adhere to mucosal surfaces or skin
  - Penetrate mucous membranes
  - Multiply once in the body
  - Secrete harmful enzymes or toxins
  - Resist phagocytosis

Reservoir (Link 2)

- Places where microorganisms are found
  - Infected wounds, human or animal waste, animals and insects, contaminated food and water, and the person with an infection
- Precautions to prevent the spread of infection
  - Good hand hygiene
  - Sterile technique

Portal of Exit (Link 3)

- Route by which pathogen leaves its host
  - Gastrointestinal tract
    - Feces may transport the typhoid bacillus from an infected person
  - Respiratory tract
    - Microorganisms are released with coughing or sneezing
    - Measles, mumps, pulmonary tuberculosis can be transmitted by exit from the respiratory tract
  - Skin and mucous membranes
    - Open wound

Modes of Transfer (Link 4)

- Direct personal contact with body excreta or drainage from an ulcer, infected wound, boil, or chancre
- Indirect contact with contaminated inanimate objects, such as needles, eating utensils, and dressings
- Vectors, such as mosquitoes, that harbor infectious agents and transmit through bites and stings
- Droplet infection, or contamination by the aerosol route through sneezing and coughing
- Spread of infection from one body part to another

Portal of Entry (Link 5)

- Enter the body through eyes, mouth, nose, trachea, skin, mucous membranes
- To prevent entry of microorganisms:
  - Use only sterile and clean items in patient care
  - Use barrier precautions (gloves, masks, condoms)
  - Safely handle food and water
  - Use good personal hygiene
  - Avoid high-risk behaviors
  - Use protection from insect bites and stings

Susceptible Host (Link 6)

- A human host may be susceptible by virtue of:
  - Age
  - State of health
  - Broken skin
- Susceptibility can be decreased by:
  - Teaching good health and hygiene habits
  - Immunizations

Susceptibility of the Elderly

- Factors placing the elderly at risk for infection
  - Poor nutrition
  - Immobility
  - Poor hygiene
  - Chronic illness
  - Physiologic changes such as thinner skin

Body Defenses Against Infection

- Intact skin is the first line of defense against infection
  - Secretions (lysozyme) from mucous membranes lining the respiratory, gastrointestinal, and reproductive tracts
  - Cilia in the respiratory tract
  - Kupffer cells in the liver
  - Gastric secretions

Second Line of Defense

- Fever: slows growth of many pathogens until other defenses can be mobilized
- Leukocytosis
  - Leukocytes engulf the invader
- Phagocytosis
  - Phagocytes remove cellular debris, destroy bacteria and viruses, remove metabolic waste products
- Inflammation
- Interferon
  - Stimulates antiviral proteins

Inflammatory Response

- Localized protective response brought on by injury or destruction of tissue
- Blood vessels dilate, bring more blood to area, causing redness, warmth, edema
- Purposes
  - Neutralize and destroy harmful agents
  - Limit their spread to other tissues in the body
  - Prepare the damaged tissues for repair

Immune Response

- Passive acquired immunity: giving antitoxin or antiserum containing antibodies or antitoxins
- Naturally acquired passive immunity: fetus receives antibodies from the mother
- Artificially acquired immunity: immunizations
- Passive artificially acquired immunity: injecting antibodies derived from serum of infected people or animals

Question 1

Which person is at highest risk for developing a hospital-acquired (nosocomial) infection?

1) A visitor
2) An employee
3) An 80-year-old cancer patient
4) A 6-year-old getting ready for discharge from the hospital

Chapter 16

Lesson 16.2

Learning Objectives

Theory

6) Identify means for removal or destruction of microorganisms on animate and inanimate objects

7) Compare and contrast medical asepsis and surgical asepsis

8) Describe methods of disinfection and sterilization

Learning Objectives

Clinical Practice

1) Discuss surveillance, prevention, and control of infections in hospitalized patients

2) Demonstrate proper hand hygiene

3) Consistently demonstrate Standard and Transmission-Based Precautions while caring for patients

4) Prepare to teach home care patient with wound infection how to prevent the spread of infection to family members

Asepsis and Control of Microorganisms

- Asepsis: making the environment and objects free of microorganisms
- Medical asepsis: reducing number of organisms or reducing the risk of transmission of organisms
  - Prevents the spread of infection from person to person or reinfection of the same person
  - Involves cleanliness and protecting items from contamination and disinfecting contaminated items

Asepsis and Control of Microorganisms (cont'd)

- Surgical asepsis: preparing and handling instruments and materials in a way that prevents the patient's exposure to living microorganisms
  - Involves sterilization of all surgical instruments used in surgery and of supplies used to invade the body such as catheters or needles

Hand Hygiene

- One of the most effective ways to reduce number of microorganisms on the hands
- Gloves should be used to prevent contact with any body fluids
- Health care workers must perform hand hygiene before and after giving care to a patient

Nurse Using Alcohol Hand Rub to Cleanse the Hands of Microorganisms

Standard Precautions

- Hand hygiene
- Gloves
- Mask, eye protection, face shield
- Gown
- Patient care equipment
- Environmental control
- Linens
- Occupational health and blood-borne pathogens
- Patient placement

Gown

- Clean barrier gown that is impermeable to fluid
- Must be impermeable to water
- Removed after use, being careful not to contaminate the skin or clothing

Mask

- Applied before entering a room if chance of contact with an airborne pathogen or splashed body fluids
- Placed over the nose and mouth and secured by an elastic band or ties
- N95 respirator mask worn when entering area where pulmonary tuberculosis or other dangerous airborne microorganisms are present

Preformed Mask and Accordion Mask

Protective Eyewear

- To prevent fluid from entering the eye area and coming in contact with the mucosa or surface of the eye through splattering or aerosolization
- May be goggles, a face shield, or glasses with side and top pieces

Head Cover

- Worn if danger of contamination of the hair or if microorganisms resident in the hair might endanger the patient
- Remove carefully

Shoe Covers

- Shoes are covered so that pathogens are not carried out of the room
- Covers are removed when exiting the room

Gloves

- Used for Standard Precautions
- Worn when there is a chance that there will be contact with blood or body fluids, mucous membranes, nonintact skin, or secretions
- Reduce the possibility of transmission of microorganisms from the nurse to the patient

Latex Allergy

- May cause redness, local inflammation, and pruritus of the hands, and anaphylaxis
- Prevention
  - Use gloves appropriately, not for routine tasks
  - Removed directly over a trash receptacle without “snapping” them off
  - Do not use petroleum-based lotions under latex gloves

Disposal of Sharps

- Placed directly into a special red puncture-resistant sharps biohazard container immediately after use
- All needles, IV cannulas, and items that might cause a skin break are placed in the sharps container
- Figure 16-7 from text

Contaminated Waste

- Must be disposed of in sealed, impermeable plastic bags marked “Hazardous Waste” or “Biohazard”
- Includes soiled dressings, used sanitary pads, suction drainage containers, and any other item that has been in contact with body fluids

Cleaning

- Pathogens can be killed or inactivated by disinfection, sterilization, or sanitizing agents
- Clean and remove debris in cold water
- Wash and scrub in hot water; use a stiff-bristled brush
- Rinse with hot water; dry

Disinfection

- Eliminates some organisms after cleaning
- Uses compounds such as phenol, alcohol, or chlorine
- Recommended disinfectant: 1 part chlorine bleach to 10 parts water
- Uses bacteriostatic or bactericidal agents

Sterilization

- Best method for eliminating microorganisms
- Five methods of sterilization
  - Steam/moist heat
  - Dry heat/hot air
  - Ethylene oxide
  - Low-temperature gas plasma
  - Radiation

Asepsis in the Home Environment

- A 1:10 solution of chlorine bleach and water can be used on counters and bathrooms
- Run the dishwasher on the “sanitize” cycle
- Frequent “damp” dusting and vacuuming reduces microorganisms
- Forceps, scissors, and other instruments can be washed with hot water and detergent, then soaked in bleach solution

Infection Control Surveillance

- Infection control practitioner
  - Responsible for ensuring infection prevention and control measures are followed
  - Works with the health care staff to ensure they understand which patient care and environmental cleaning measures are to be used
  - Assesses for spread of infection

Question 2

The most effective way to destroy all types of microorganisms is to:

1) expose them to moist heat at a high temperature for 16 to 20 minutes.
2) expose them to dry heat at a high temperature for 5 minutes.
3) wash them thoroughly for 5 minutes.
4) wash them thoroughly for 15 minutes under warm soapy water.

Question 3

An LPN is going in for her annual review. She is told to stop by employee health to get a hepatitis B shot. This is providing the employee with what type of immunity?

1) Naturally acquired immunity
2) Passive acquired immunity
3) Naturally acquired passive immunity
4) Artificially acquired immunity

Question 4

Brenda is a student nurse observing and assisting in the operating room. In order to maintain surgical asepsis, she must include all of the following *except*:

1) perform a 5-minute hand scrub before entering the operating room.
2) use sterile protective garb such as gown, mask, and gloves.
3) sterilize all instruments and inanimate objects used in surgery.
4) maintain clean technique while in the operating room.

Question 5

Sherry is working as a home health nurse. She is teaching her patient and family about asepsis in the home environment. All of the following are true *except*:

1) precautions in the home environment are important.
2) handwashing can be modified and is not as important as in the hospital.
3) syringes are placed in a clean milk jug with bleach and water.
4) frequent dusting and vacuuming are necessary to decrease the number of microorganisms.