Chapter 11
Epidemiology and Public Health

Learning Objectives

Chapter 11 introduces the science of epidemiology. This chapter is considered to be a key chapter in the education of students of the health care professions. Topics discussed in this chapter include epidemiologic terminology; interactions among pathogens, hosts, and the environment; the “chain of infection”; reservoirs of infection; modes of disease transmission; public health agencies; bioterrorist and biologic warfare (BW) agents; water treatment; and sewage disposal.

Terms Introduced in This Chapter

After reading Chapter 11, you should be familiar with the following terms. These terms are defined in Chapter 11 and in the Glossary.

Active carrier
Biologic warfare (BW) agents
Bioterrorist agents
Coliforms
Communicable disease
Contagious disease
Convalescent carrier
Endemic disease
Epidemic disease
Epidemiology
Fomites
Incidence
Incubatory carrier
Morbidity rate
Mortality rate
Pandemic disease
Parenteral injection
Passive carrier
Prevalence
Reservoirs of infection
Sporadic disease
Zoonosis

Review of Key Points

- Epidemiology is the study of factors that determine the frequency, distribution, and determinants of diseases in human populations, and ways to prevent, control, or eradicate diseases in populations.
- Communicable, contagious, sporadic, endemic, epidemic, and pandemic diseases are epidemiologic terms used to describe the prevalence of a disease in an area at a particular time.
- Communicable diseases are infectious diseases that can be transmitted from one human to another (i.e., person to person). Contagious diseases are communicable diseases that are *easily transmitted* from one person to another.
- Not all infectious diseases are communicable diseases.
- A sporadic disease is a disease that occurs only occasionally (sporadically) within the population of a particular geographic area, whereas an endemic disease is one that is always present within that population.
- Epidemic diseases are diseases that occur in a greater than usual number of cases in a particular region, and usually occur within a relatively short period of time.
- A pandemic disease is a disease that is occurring in epidemic proportions in many countries simultaneously—sometimes worldwide.
- Zoonotic diseases (zoonoses) are infectious diseases that humans acquire from animal sources. There are over 200 known zoonoses.
- HIV/AIDS, tuberculosis, and malaria are three of the most important infectious diseases. Collectively, they cause more than 300 million illnesses and more than 5 million deaths per year.
- Whether or not an infectious disease occurs depends on many factors, including those pertaining to the pathogen, those pertaining to the host, and those pertaining to the environment.
- The six components in the chain of infection are (1) a pathogen, (2) a reservoir of infection, (3) a portal of exit, (4) a mode of transmission, (5) a portal of entry, and (6) a susceptible host.
- The sources of pathogens are known as reservoirs of infection (or simply, reservoirs); they may be living reservoirs (e.g., humans, animals, or arthropods) or nonliving reservoirs (e.g., air, soil, dust, food, water, or inanimate objects found in the home, office, or hospital).
- A carrier is a person who is colonized with a particular pathogen, but the pathogen is not currently causing disease in that person.
- Lyme disease is the most common arthropod-borne disease in the United States.
- The principal modes of transmission of pathogens are contact (either direct or indirect contact), airborne, droplet, vehicular, and vectors.
- The primary ways in which communicable diseases are transmitted are direct skin-to-skin or mucous membrane-to-mucous membrane contact, and indirectly by airborne droplets

of respiratory secretions, contamination of food and water by fecal material, arthropod vectors, fomites, and transfusion of contaminated blood or blood products from an ill person, or by parenteral injection (injection directly into the bloodstream) using nonsterile syringes and needles.

- To eradicate certain diseases and prevent epidemics, epidemiologists must consider the virulence of the pathogens, susceptibility of the population, sanitation practices, reservoirs of infection, and ways in which pathogens are transmitted.
- Prevention and control of epidemics include measures to increase host resistance by immunizations; protect people from exposure to pathogens; segregate, isolate, and treat those with contagious infections to prevent the spread of pathogens to others; identify and control potential reservoirs and vectors of infectious diseases; and institute effective sanitation measures to control diseases transmitted through water supplies, sewage, and food.
- The World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and public health and community groups, at all levels, must work together to coordinate preventive health programs and maintain constant surveillance of sources and causes of epidemics.
- The WHO is a specialized agency of the United Nations. Its missions are to promote technical cooperation for health among nations, carry out programs to control and eradicate diseases, and improve the quality of human life.
- The overall mission of the CDC is to collaborate to create the expertise, information, and tools that people and communities need to protect their health—through health promotion, prevention of disease, injury and disability, and preparedness for new health threats.
- The four most likely potential BW or bioterrorism agents are *Bacillus anthracis*, *Clostridium botulinum*, smallpox virus (*Variola major*), and *Yersinia pestis*, the causative agents of anthrax, botulism, smallpox, and plague, respectively.
- The largest waterborne epidemic to occur in the United States was an outbreak of cryptosporidiosis in Milwaukee, Wisconsin, in 1993, which affected more than 400,000 people.
- Water is considered potable (safe to drink) if it contains 1 coliform or less per 100 mL of water.
- The major steps in water treatment are sedimentation (settling), coagulation (flocculation), filtration, and chlorination.

A Closer Look

Preparing for a Bioterrorist Attack

Perhaps you've wondered what you can do as an individual to prepare yourself and your family for a bioterrorist attack. The best thing you can do is to be aware of what's going on around you and throughout the nation. Remain vigilant and cautious, but not scared. Stay healthy by eating well and by boosting your immune system. A fully competent immune system is your best defense against pathogens of all types.

Authorities (such as the CDC) advise against purchasing gas masks and taking or stockpiling antibiotics. Prepare your home and family as you would for any natural disaster (e.g., a hurricane or tornado), by ensuring that you have emergency supplies on hand, such as a flashlight, radio, extra batteries, and plenty of food and water. Should a bioterrorist attack occur, state and federal public health authorities will advise you of what actions to take. Be sure to comply with their recommendations regarding vaccination, including the anthrax and smallpox vaccines.

Additional information may be found on the CDC Web site at http://www.bt.cdc.gov/bioterrorism/. There you will find guidelines under the headings of (1) gather emergency supplies, (2) develop a family disaster plan, (3) be informed, (4) learn how to shelter in place, (5) understand quarantine and isolation, and (6) maintain a healthy state of mind.

Increase Your Knowledge

1. Students interested in learning more about the WHO, including updated information on epidemics, should visit their Web site (www.who.int/en). If you click on "Health Topics," you can find information about many different diseases (such as AIDS, anthrax, Ebola hemorrhagic fever, malaria, tuberculosis).

2. For additional information about the CDC, including information about various infectious diseases, visit their Web site (www.cdc.gov). The "A–Z Index" contains information about many different diseases.

3. To see a list of the diseases covered by Global Alert and Response, visit the WHO Web site at www.who.int/csr/disease/en/

4. To see the latest data on nationally notifiable infectious diseases, check out the CDC's *Morbidity and Mortality Weekly Report* at www.cdc.gov/mmwR/mmwr_wk.html

5. Explore various zoonotic diseases at the National Center for Emerging and Zoonotic Diseases (NCEZID) at the Centers for Disease Control website: https://www.cdc.gov/ncezid/

6. Learn more about bioterrorism agents and the laboratory tests used to detect them: https://labtestsonline.org/conditions/bioterrorism-agents

7. Check out more information on sources of water contamination including microbes, radionuclides, inorganics, etc., at: https://www.epa.gov/ground-water-and-drinking-water

8. In the winter of 1989, an Ebola virus epidemic occurred among monkeys at an army research facility in Reston, Virginia, near Washington, D.C. A SWAT team of soldiers and scientists worked feverishly for 18 days to end the outbreak, not knowing at the time

whether the virus could infect humans. To learn more about this exciting epidemic, read *The Hot Zone*, by Richard Preston (Random House, New York, 1994).

9. To learn more about a variety of exotic and emerging pathogens that have the potential to cause widespread epidemics, read *The Coming Plague*, by Laurie Garrett (Penguin Books, New York, 1994).

10. To learn more about biologic weapons, biowarfare, and bioterrorism, read *Germs: Biological Weapons and America's Secret War*, by Judith Miller, Stephen Engelberg, and William Broad (Simon & Schuster, New York, 2001).

Critical Thinking

1. Study Figure 11-3 in Chapter 11. What are some of the ways in which the various links in the Chain of Infection could be broken?

2. The CDC is an agency of the Federal Government of the United States, and yet CDC epidemiologists travel to foreign countries to investigate epidemics. A friend of yours thinks that this is a waste of taxpayers' dollars. Explain to her why it is not.

3. Visit the CDC Web site to learn what actions have been or are being taken to protect the public from bioterrorism. Can you think of any additional actions that could be taken?

4. The cryptosporidiosis epidemic in Milwaukee, Wisconsin, in the spring of 1993, was the largest waterborne epidemic that has ever occurred in the United States. Search the Internet to learn more details about this epidemic.

Additional Chapter 11 Self-Assessment Exercises

(Note: Do not peek at the answers before you attempt to solve these self-assessment exercises.)

Matching Questions

A. communicable diseases
B. endemic diseases
C. epidemic diseases
D. pandemic diseases
E. sporadic diseases

_____ 1. Diseases that are always present in a population are known as _____.

_____ 2. Diseases that are transmissible from person to person are known as _____.

_____ 3. Diseases that occur only occasionally in a particular population are known as _____.

_____ 4. Because large numbers of cases of AIDS, malaria, and tuberculosis are presently occurring in many different countries, they are known as _____.

_____ 5. Diseases with unusually high numbers of cases that often occur in one particular geographic location are known as _____.

A. biting flies
B. bugs
C. lice
D. mosquitoes
E. ticks

_____ 1. The causative agents of dengue fever, filariasis, malaria, West Nile encephalitis, and yellow fever are all transmitted by _____.

_____ 2. _____ transmit the causative agents of babesiosis, ehrlichiosis, Lyme disease, relapsing fever, and spotted fever rickettsiosis.

_____ 3. The causative agent of American trypanosomiasis (Chagas disease) is transmitted by arthropods in a class of insects known as _____.

_____ 4. _____ transmit the causative agents of epidemic typhus and trench fever.

_____ 5. African sleeping sickness, leishmaniasis, and onchocerciasis are transmitted by various types of _____.

True/False Questions

_____ 1. Influenza is an example of a contagious disease.

_____ 2. Zoonotic diseases are diseases that humans acquire from zoo animals.

_____ 3. The largest waterborne outbreak ever to occur in the United States was caused by *Giardia lamblia*.

_____ 4. Water containing 1 coliform per 100 mL would be considered potable.

_____ 5. The most common zoonotic infection in the United States is spotted fever rickettsiosis.

_____ 6. Soil can contain the spores that cause botulism, gas gangrene, and tetanus.

_____ 7. Chlamydial genital infections and gonorrhea are the two most common nationally notifiable infectious diseases in the United States.

_____ 8. The levels of chlorine routinely used for water treatment are sufficient to kill *Giardia* cysts and *Cryptosporidium* oocysts.

_____ 9. *Yersinia pestis*, the bacterium that causes plague, is one of the pathogens most often discussed as a potential biologic weapon.

_____ 10. Gonorrhea is considered to be a communicable disease, but *not* a contagious disease.

Answers to the Additional Chapter 11 Self-Assessment Exercises

Matching Questions

1. B
2. A
3. E
4. D
5. C

1. D
2. E
3. B
4. C
5. A

True/False Questions

1. True
2. False (Zoonotic diseases can be acquired from many types of animals, not just zoo animals.)
3. False (It was caused by *Cryptosporidium parvum*.)
4. True
5. False (Lyme disease is the most common zoonotic disease in the United States.)
6. True
7. True
8. False (The levels of chlorine routinely used for water treatment will not kill *Giardia* cysts or *Cryptosporidium* oocysts.)
9. True
10. True