15 Infection Control

CHAPTER OBJECTIVES

After completing this chapter, you should be able to:

- Identify five classes of microorganisms by describing the characteristics of each class
- List the six components of the chain of infection
- Differentiate between antisepsis, disinfection, and sterilization
- Define bioterrorism and identify at least four ways to prepare for a bioterrorism attack
- Wash hands following aseptic technique
- Observe standard precautions while working in the laboratory or clinical area
- Wash, wrap, and autoclave instruments, linen, and equipment
- Operate an autoclave with accuracy and safety
- Follow basic principles on chemical disinfection
- Clean instruments with an ultrasonic unit
- Open sterile packages with no contamination
- Don sterile gloves with no contamination
- Prepare a sterile dressing tray with no contamination
- Change a sterile dressing with no contamination
- Don and remove a transmission-based isolation mask, gloves, and gown
- Relate specific basic tasks to the care of a patient in a transmission-based isolation unit
- Define, pronounce, and spell all key terms

KEY TERMS

acquired immune deficiency syndrome (AIDS)
aerobic
airborne precautions
anaerobic
antisepsis *(ant"-ih-sep'-sis)*
asepsis *(a-sep'-sis)*
autoclave
bacteria
bioterrorism
cavitation *(kav"-ih-tay'-shun)*
chain of infection
chemical disinfection
clean
communicable disease
contact precautions
contaminated
disinfection

KEY TERMS (CONT.)

droplet precautions
endogenous
epidemic
exogenous
fomites
fungi *(fun' -guy)*
helminths
hepatitis B
hepatitis C
infectious agent
microorganism *(my-crow-or' -gan-izm)*
mode of transmission
nonpathogens
nosocomial
opportunistic
pandemic
pathogens *(path' -oh-jenz')*
personal protective equipment (PPE)
portal of entry
portal of exit
protective (reverse) isolation
protozoa *(pro-toe-zo' -ah)*
reservoir
rickettsiae *(rik-et' -z-ah)*
standard precautions
sterile
sterile field
sterilization
susceptible host
transmission-based isolation precautions
ultrasonic
viruses

15:1 Understanding the Principles of Infection Control

Science OBRA

Understanding the basic principles of infection control is essential for any health care worker in any field of health care. The principles described in this unit provide a basic knowledge of how disease is transmitted and the main ways to prevent disease transmission.

A **microorganism**, or microbe, is a small, living organism that is not visible to the naked eye. It must be viewed under a microscope. Microorganisms are found everywhere in the environment, including on and in the human body. Many microorganisms are part of the normal flora (plant life adapted for living in a specific environment) of the body and are beneficial in maintaining certain body processes. These are called **nonpathogens**. Other microorganisms cause infection and disease and are called **pathogens**, or germs. At times, a microorganism that is beneficial in one body system can become pathogenic when it is present in another body system. For example, a bacterium called *Escherichia coli (E. coli)* is part of the natural flora of the large intestine. If *E. coli* enters the urinary system, however, it causes an infection.

To grow and reproduce, microorganisms need certain things. Most microorganisms prefer a warm environment, and body temperature is ideal. Darkness is also preferred by most microorganisms, and many are killed quickly by sunlight. In addition, a source of food and moisture is needed. Some microorganisms, called **aerobic** organisms, require oxygen to live. Others, called **anaerobic** organisms, live and reproduce in the absence of oxygen. The human body is the ideal supplier of all the requirements of microorganisms.

Classes of Microorganisms

There are many different classes of microorganisms. In each class, some of the microorganisms are pathogenic to humans. The main classes include:

- **Bacteria:** These are simple, one-celled organisms that multiply rapidly. They are classified by shape and arrangement. *Cocci* are round or spherical in shape (Figure 15-1). If cocci occur in pairs, they are diplococci. Diplococci bacteria cause diseases such as gonorrhea, meningitis, and pneumonia. If cocci occur in chains, they are streptococci. A common streptococcus causes a severe sore throat (strep throat) and rheumatic fever. *Streptococcus pyogenes,* also called *Strep A* or flesh-eating strep, causes necrotizing fasciitis that destroys tissues and can result in amputation and/or death (Figure 15-2). If cocci occur in clusters or groups, they are staphylococci. These are the most common pyogenic (pus-producing) microorganisms. Staphylococci cause infections such as boils, urinary tract infections, wound infections, and toxic shock. Rod-shaped bacteria are called *bacilli* (Figure 15-3). They can occur singly, in pairs, or in chains. Many bacilli contain flagella, which are threadlike projections that are similar to tails and allow the organisms to move. Bacilli also have the ability to form spores, or thick-walled capsules, when conditions for growth are poor. In the spore form, bacilli are extremely difficult

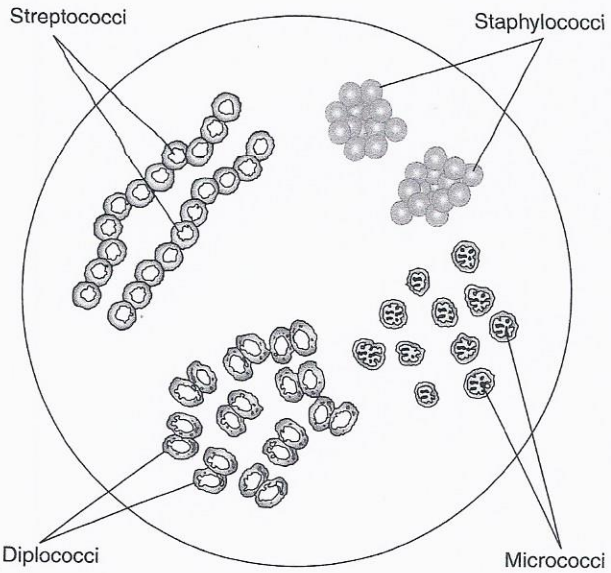

FIGURE 15-1 Kinds of cocci bacteria.

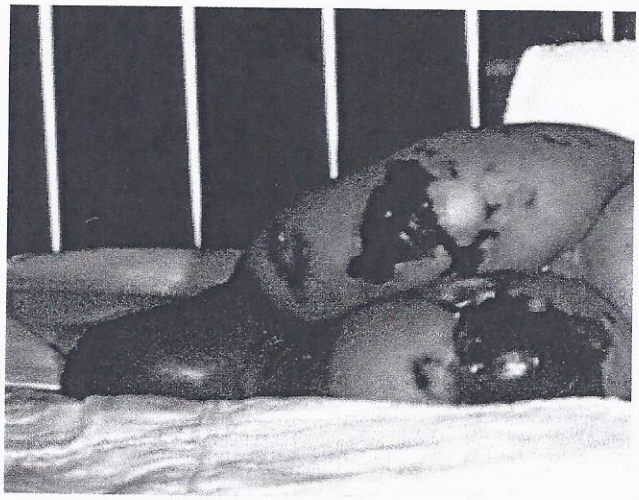

FIGURE 15-2 ***Streptococcus pyogenes,*** **also called** ***Strep A*** **or flesh-eating strep, causes necrotizing fasciitis that destroys tissues and can result in amputation and/or death if not treated immediately.** Courtesy CDC

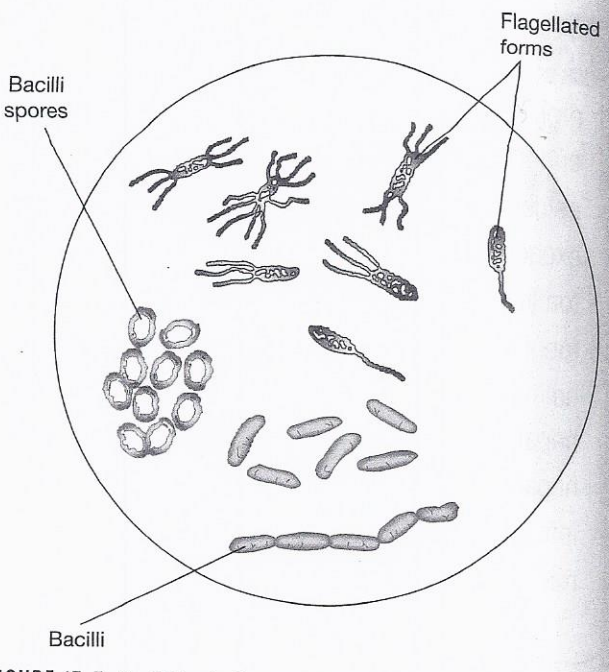

FIGURE 15-3 Bacilli bacteria.

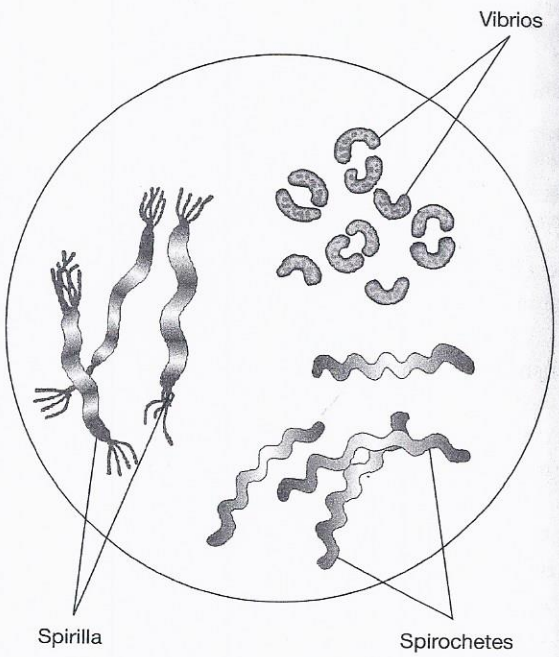

FIGURE 15-4 Spirilla bacteria.

to kill. Diseases caused by different types of bacilli include tuberculosis, tetanus, pertussis (whooping cough), botulism, diphtheria, and typhoid. Bacteria that are spiral or corkscrew in shape are called *spirilla* (Figure 15-4). These include the comma-shaped vibrio and the corkscrew-shaped spirochete. Diseases caused by spirilla include syphilis and cholera. Antibiotics are used to kill bacteria. However, due to the overuse and misuse of antibiotics, some strains of bacteria have become antibiotic-resistant, which means that the antibiotic is no longer effective against the bacteria. If a bacterium becomes resistant to several drugs, it is called multidrug resistant, or a "superbug." Methicillin-resistant staphylococcus aureas (MRSA) is an example. It causes a severe staph infection that is difficult to treat because it is resistant to many different antibiotics. Vancomycin-resistant enterococcus (VRE) is a bacterium that is resistant to vancomycin and several other drugs. Because no single antibiotic can eliminate VRE, drug combinations

FIGURE 15-5 An intestinal protozoan, *Giardia intestinalis*, is the blue stained mass in the center of the photo. Courtesy CDC/DPDx-Melanie Moser

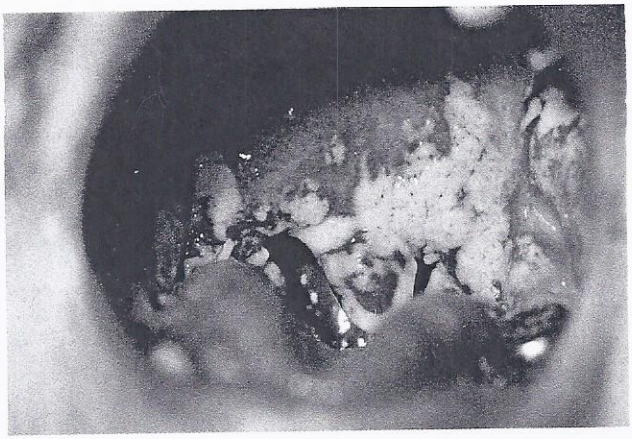

FIGURE 15-6 The yeast (fungus) called *thrush* causes these characteristic white patches on the tongue and in the mouth. Courtesy CDC

are often used to treat it. Multidrug-resistant *acinetobacter baumannii* (MRAB) is an example of a bloodstream infection that is difficult to treat due to drug resistance. In some cases, *A baumannii* has been resistant to all drugs tested. Carbapenem-resistant enterobacteriaceae (CRE) are resistant to most antibiotics and can cause pneumonia, kidney and bladder disease, and septicemia (pathogenic organisms in the bloodstream). A major campaign has been launched to push for less antibiotic use, unless specifically indicated, to help prevent drug resistance.

- **Protozoa**: These are one-celled animal-like organisms often found in decayed materials, animal or bird feces, insect bites, and contaminated water (Figure 15-5). Many contain flagella, which allow them to move freely. Some protozoa are pathogenic and cause diseases such as malaria, amebic dysentery (intestinal infection), trichomonas, and African sleeping sickness.
- **Fungi**: These are simple, plantlike organisms that live on dead organic matter. Yeasts and molds are two common forms that can be pathogenic. They cause diseases such as ringworm, athlete's foot, histoplasmosis, yeast vaginitis, and thrush (Figure 15-6). Antibiotics do not kill fungi. Antifungal medications are available for many of the pathogenic fungi, but they are expensive, must be taken internally for a long period, and may cause liver damage.
- **Rickettsiae**: These are parasitic microorganisms, which means they cannot live outside the cells of another living organism. They are commonly found in fleas, lice, ticks, and mites, and are transmitted to humans by the bites of these insects. Rickettsiae cause diseases such as typhus fever and Rocky Mountain spotted fever. Antibiotics are effective against many different rickettsiae.
- **Viruses**: These are the smallest microorganisms, visible only using an electron microscope (Figures 15-7A and B). They cannot reproduce unless they are inside another living cell. They are spread from human to human by blood and other body secretions. It is important to note that viruses are more difficult to kill because they are resistant to many disinfectants and are not affected by antibiotics. Viruses cause many diseases including the common cold, measles, mumps, chicken pox, herpes, warts, influenza, and polio. New and different viruses emerge constantly because viruses are prone to mutating and changing genetic information. In addition, viruses that infect animals can mutate to infect humans, often with lethal results. There are many examples of these viruses. *Severe acute respiratory syndrome (SARS)* is caused by a variant of the coronavirus family that causes the common cold. It is characterized by flu-like symptoms that can lead to respiratory failure and death. *West Nile virus (WNV)* is a mosquito-borne flavivirus that first infected birds but now infects humans. In some individuals, it causes only a mild febrile illness. In other individuals who are older or have poor immune systems, it can cause severe neurologic illnesses such as encephalitis or meningitis, which can lead to death. *Monkeypox*, a hantavirus that affects monkeys, other primates, and rodents, mutated and spread to humans. Infection usually occurs after contacting body secretions or excretions (urine and stool) of infected animals or ingesting food that has been contaminated by fluids from infected animals. A major outbreak

OBRA

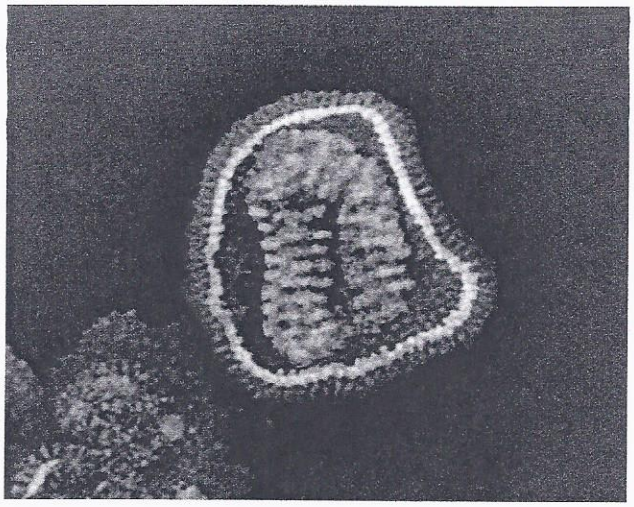

FIGURE 15-7A Electron micrograph of the influenza virus.
Courtesy CDC/Erskine L. Palmer, Ph.D.; M.L. Martin. Photo credit: Frederick Murphy

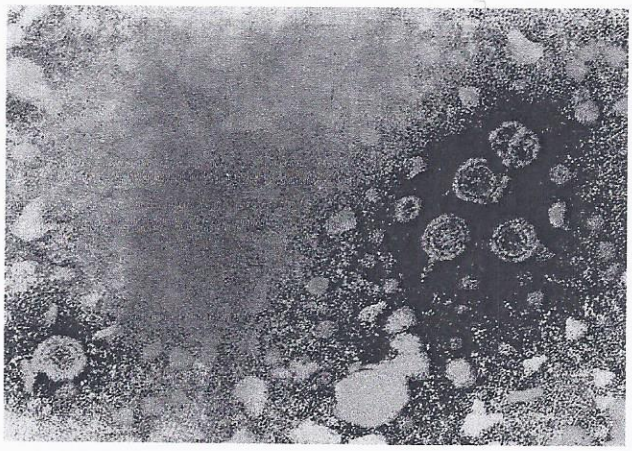

FIGURE 15-7B Electron micrograph of the hepatitis B virus.
Courtesy CDC/Dr. Erskine Palmer.

occurred in the American Southwest when infected prairie dogs contaminated food with fecal material. Monkeypox is similar to smallpox. It causes severe flu-like symptoms, lymphadenopathy (disease of the lymph nodes), and pustules that cause severe scarring of the skin. If the eyes are infected, blindness can occur. It can be prevented and/or treated with a smallpox vaccination. Filoviruses such as *Ebola* and *Marburg* first affected primates and then spread to humans. These viruses cause hemorrhagic fever, a disease that begins with fever, chills, headache, myalgia (muscle pain), and a skin rash. It quickly progresses to jaundice, pancreatitis, liver failure, massive hemorrhaging throughout the body, delirium, shock, and death. Most outbreaks of hemorrhagic fever have been in Africa, but isolated cases have appeared in other parts of the world when individuals were in contact with infected primates. The *H5N1* virus that causes avian or bird flu has devastated bird flocks in many countries. The infection has appeared in humans, but most cases have resulted from contact with infected poultry or contaminated surfaces. The spread from one person to another has been reported only rarely. However, because the death rate for bird flu is between 50 and 60 percent, a major concern is that the *H5N1* virus will mutate and spread more readily. *H1N1*, or swine flu, was declared a global pandemic in 2009. The virus spreads quickly and causes flu-like symptoms. In severe cases, it results in pneumonia, respiratory distress or failure, and in some cases, death. As with the bird flu, it rarely spreads from one person to another. Most cases result from contact with infected hogs. In addition to these viruses, there are three other viral diseases of major concern to the health care worker: hepatitis B, hepatitis C, and acquired immune deficiency syndrome (AIDS). **Hepatitis B**, or serum hepatitis, is caused by the HBV virus and is transmitted by blood, serum, and other body secretions. It affects the liver and can lead to the destruction and scarring of liver cells. A vaccine has been developed to protect individuals from this disease. The vaccine is expensive and involves a series of three injections. Under federal law, employers must provide the vaccination at no cost to any health care worker with occupational exposure to blood or other body secretions that may carry the HBV virus. An individual does have the right to refuse the vaccination, but a written record must be kept proving that the vaccine was offered. **Hepatitis C** is caused by the hepatitis C virus, or HCV, and is transmitted by blood and blood-containing body fluids. Many individuals who contract the disease are asymptomatic (display no symptoms); others have mild symptoms that are often diagnosed as influenza or flu. In either case, HCV can cause serious liver damage. At present, there is no preventive immunization, but a vaccine is being developed. Both HBV and HCV are extremely difficult to destroy. These viruses can even remain active for several days in dried blood. Health care workers must take every precaution to protect themselves from hepatitis viruses. **Acquired immune deficiency syndrome** is caused by the human immunodeficiency virus (HIV) and suppresses the immune system. An individual with AIDS cannot fight off many cancers and infections that would not affect a healthy person. Presently, there is no cure and no vaccine is available, so it is important for the health care worker to take precautions to prevent the spread of this disease.

FIGURE 15-8 Hookworms attached to the mucosal lining of the intestine are one type of helminth. Courtesy CDC.

- **Helminths**: These are multicellular parasitic organisms commonly called *worms* or *flukes*. They are transmitted to humans when humans ingest the eggs or larvae in contaminated food, ingest meat contaminated with the worms, or get bitten by infected insects. Some worms can also penetrate the skin to enter the body. Examples of helminths include: hookworms, which attach to the small intestine and can infect the heart and lungs (Figure 15-8); ascariasis, which live in the small intestine and can cause an obstruction of the intestine; trichinella spiralis, which causes trichinosis and is contracted by eating raw or inadequately cooked pork products; enterobiasis, which is commonly called *pinworm* and affects mainly young children; and taenia solium or pork tapeworm, which is contracted by eating inadequately cooked pork.

Types of Infection

Pathogenic microorganisms cause infection and disease in different ways. Some pathogens produce poisons, called *toxins*, which harm the body. An example is the bacillus that causes tetanus, which produces toxins that damage the central nervous system. Some pathogens cause an allergic reaction in the body, resulting in a runny nose, watery eyes, and sneezing. Other pathogens attack and destroy the living cells they invade. An example is the protozoan that causes malaria. It invades red blood cells and causes them to rupture.

Infections and diseases are also classified as endogenous, exogenous, nosocomial, or opportunistic. **Endogenous** means the infection or disease originates within the body. These include metabolic disorders, congenital abnormalities, tumors, and infections caused by microorganisms within the body. **Exogenous** means the infection or disease originates outside the body. Examples include pathogenic organisms that invade the body, radiation, chemical agents, trauma, electric shock, and temperature extremes. A **nosocomial** infection, also known as a *hospital-acquired* or *healthcare-associated infection* (HAI), is one acquired by an individual in a health care facility such as a hospital or long-term care facility. Nosocomial infections are usually present in the facility and transmitted by health care workers to the patient. Many of the pathogens transmitted in this manner are antibiotic-resistant and can cause serious and even life-threatening infections in patients. Common examples are staphylococcus, pseudomonas, and enterococci. Infection-control programs are used in health care facilities to prevent and deal with nosocomial infections. The infection control professionals that run these programs are called *infection preventionists*, according to the Association for Professionals in Infection Control and Epidemiology (APIC). Their job is to reduce the incidence of HAIs. **Opportunistic** infections are those that occur when the body's defenses are weak. These diseases do not usually occur in individuals with intact immune systems. Examples include the development of a yeast infection called *candidiasis*, Kaposi's sarcoma (a rare type of cancer), or *Pneumocystis jiroveci* pneumonia in individuals with AIDS.

Chain of Infection

For disease to occur and spread from one individual to another, certain conditions must be met. These conditions are commonly called the **chain of infection** (Figure 15-9). The parts of the chain include:

- **Infectious agent**: a pathogen, such as a bacterium or virus that can cause a disease
- **Reservoir**: an area where the infectious agent can live; some common reservoirs include the human body, animals, the environment, and **fomites**, or objects contaminated with infectious material that contains the pathogens. Common fomites include doorknobs, bedpans, urinals, linens, instruments, and specimen containers.
- **Portal of exit**: a way for the infectious agent to escape from the reservoir in which it has been growing. In the human body, pathogens can leave the body through urine, feces, saliva, blood, tears, mucous discharge, sexual secretions, and draining wounds.
- **Mode of transmission**: a way that the infectious agent can be transmitted to another reservoir or host where it can live. The pathogen can be transmitted

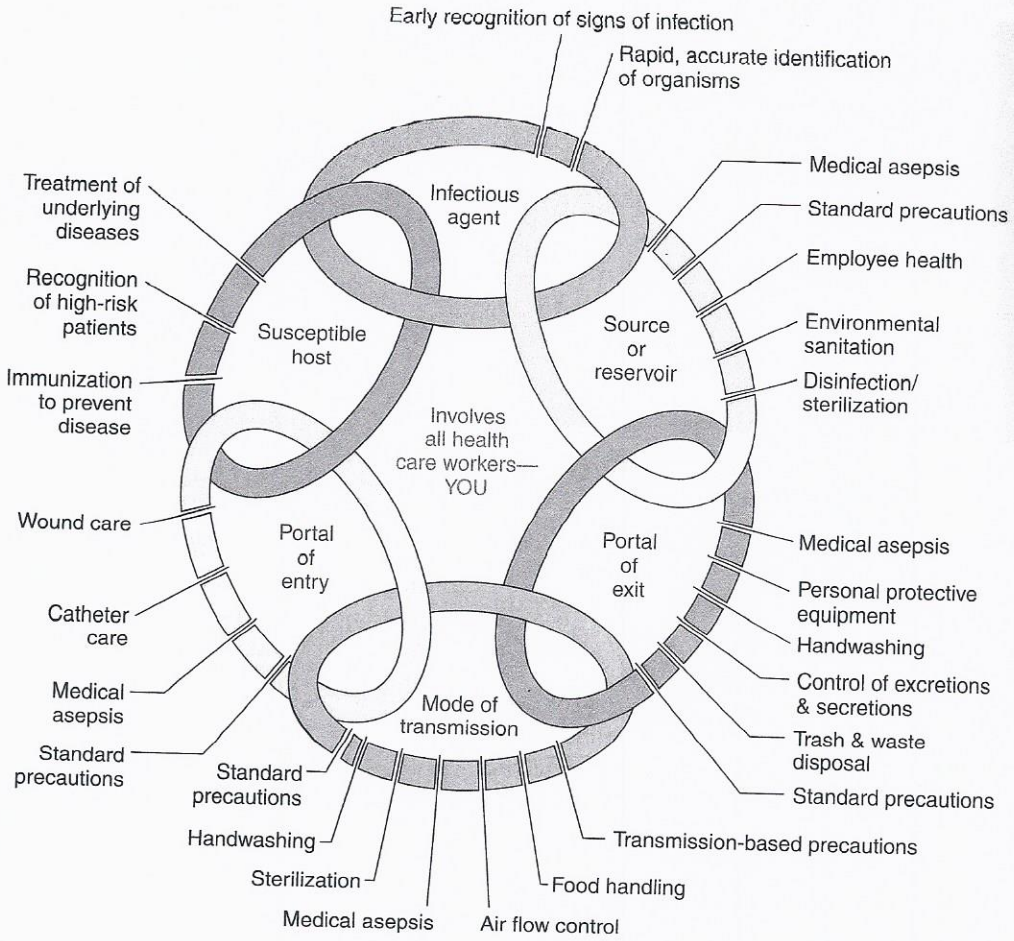

FIGURE 15-9 Note the components in the chain of infection and the ways in which the chain can be broken.

in different ways. One way is by *direct contact,* which includes person-to-person contact (physical or sexual contact) or contact with a body secretion containing the pathogen. Contaminated hands are one of the most common sources of direct contact transmission. Another way is by *indirect contact,* when the pathogen is transmitted from contaminated substances such as food, air, soil, insects, feces, clothing, instruments, and equipment. Examples include touching contaminated equipment and spreading the pathogen on the hands, breathing in droplets carrying airborne infections, and contacting *vectors* (insects, rodents, or small animals), such as being bitten by an insect carrying a pathogen.

- **Portal of entry:** a way for the infectious agent to enter a new reservoir or host. Some ways pathogens can enter the body are through breaks in the skin, breaks in the mucous membrane, the respiratory tract, the digestive tract, the genitourinary tract, and the circulatory system. If the defense mechanisms of the body are intact and the immune system is functioning, a human can frequently fight off the infectious agent and not contract the disease. Body defenses include:

Mucous membrane: lines the respiratory, digestive, and reproductive tracts and traps pathogens
Cilia: tiny, hairlike structures that line the respiratory tract and propel pathogens out of the body
Coughing and sneezing: expels pathogens out of the body
Hydrochloric acid: destroys pathogens in the stomach
Tears in the eye: contain bacteriocidal (bacteria-killing) chemicals
Fever: high temperatures destroy some pathogens
Inflammation: leukocytes, or white blood cells, destroy pathogens
Immune response: body produces antibodies, which are protective proteins that combat pathogens, and protective chemicals secreted by cells, such as interferon and complement.

- **Susceptible host:** a person likely to get an infection or disease, usually because body defenses are weak.

Health care workers must constantly be aware of the parts in the chain of infection. If any part of the chain is eliminated, the spread of disease or infection will be stopped. A health care worker who is aware of this can follow practices to interrupt or break this chain and prevent the transmission of disease. It is important to remember that pathogens are everywhere and that preventing their transmission is a continuous process.

Aseptic Techniques

A major way to break the chain of infection is to use aseptic techniques while providing health care. **Asepsis** is defined as the absence of disease-producing microorganisms, or pathogens.

Sterile means free from all organisms, both pathogenic and nonpathogenic, including spores and viruses. **Contaminated** means that organisms and pathogens are present. Any object or area that may contain pathogens is considered to be contaminated. Aseptic techniques are directed toward maintaining cleanliness and eliminating or preventing contamination. Common aseptic techniques include handwashing, good personal hygiene, use of disposable gloves when contacting body secretions or contaminated objects, proper cleaning of instruments and equipment, and thorough cleaning of the environment.

Various levels of aseptic control are possible. These include:

- **Antisepsis**: Antiseptics prevent or inhibit growth of pathogenic organisms but are not effective against spores and viruses. They can usually be used on the skin. Common examples include alcohol and betadine.
- **Disinfection**: This is a process that destroys or kills pathogenic organisms. It is not always effective against spores and viruses. Chemical disinfectants are used in this process. Disinfectants can irritate or damage the skin and are used mainly on objects, not people. Some common disinfectants are bleach solutions and zephirin.
- **Sterilization**: This is a process that destroys all microorganisms, both pathogenic and nonpathogenic, including spores and viruses. Steam under pressure, gas, radiation, and chemicals can be used to sterilize objects. An autoclave is the most common piece of equipment used for sterilization.

In the sections that follow, correct methods of aseptic techniques are described. It is important for the health care worker to know and use these methods in every aspect of providing health care to prevent the spread and transmission of disease.

STUDENT: Go to the workbook and complete the assignment sheet for 15:1, Understanding the Principles of Infection Control.

15:2 Bioterrorism

Introduction

Bioterrorism is the use of microorganisms, or biologic agents, as weapons to infect humans, animals, or plants. Throughout history, microorganisms have been used in biologic warfare. Some examples include:

- The Tartar army throwing bodies of dead plague victims over the walls of a city called Caffa in 1346, causing an epidemic of plague in the city
- The British army providing Delaware Indians with blankets and handkerchiefs contaminated with smallpox in 1763, resulting in a major outbreak of smallpox among the Indian population
- The Germans using a variety of animal and human pathogens in World War I
- The Japanese military using prisoners of war to experiment with many different pathogens in World War II
- The United States, Canada, the Soviet Union, and the United Kingdom developing biologic weapons programs until the late 1960s
- The release of sarin gas in Tokyo in 1995
- The mail attack with anthrax by an unknown individual or individuals in the United States in 2001

Today, there is a major concern that these biologic agents will be used not only in wars, but also against unsuspecting civilians.

Biologic Agents

Many different microorganisms can cause diseases in humans, animals, and plants. However, only a limited number are considered to be ideal for bioterrorism. Six characteristics of the "ideal" microorganism include:

- Inexpensive and readily available or easy to produce
- Spread through the air by winds or ventilation systems and inhaled into the lungs of potential victims, or spread by ingesting contaminated food or water
- Survives sunlight, drying, and heat
- Causes death or severe disability
- Easily transmitted from person to person
- Difficult to prevent and/or has no effective treatment

FIGURE 15-10 Smallpox is a highly contagious infectious disease caused by a variola virus. Courtesy CDC/Dr. Michael Schwartz.

The Centers for Disease Control and Prevention (CDC) has identified and classified major bioterrorism agents. High-priority agents that have been identified include:

- *Smallpox:* Smallpox is a highly contagious infectious disease that is caused by a variola virus (Figure 15-10). A smallpox vaccination can provide protection against some types of smallpox, but one type, hemorrhagic smallpox, is usually fatal. Until the 1970s, people were vaccinated against smallpox. However, after many years with no reported cases, the vaccinations were no longer required. Now, with the threat of a smallpox bioterrorism attack, the U.S. government has started a new vaccination program. The program encourages first responders, police, fire department, and health care personnel to be vaccinated.
- *Anthrax:* Anthrax is an infectious disease caused by the spores of bacteria called *Bacillus anthracis*. The spores are highly resistant to destruction and can live in soil for years. Grazing animals such as cattle, sheep, and goats eat the contaminated soil and become infected. Humans develop anthrax by exposure through the skin (cutaneous) (Figure 15-11), by eating undercooked or raw infected meat (gastrointestinal), or by inhaling the spores (pulmonary). Cutaneous and gastrointestinal anthrax are usually treated successfully with antibiotics, but some victims die. Inhalation anthrax causes death in more than 80 percent of its victims. An anthrax vaccine is available for prevention. The military has an active vaccination program.

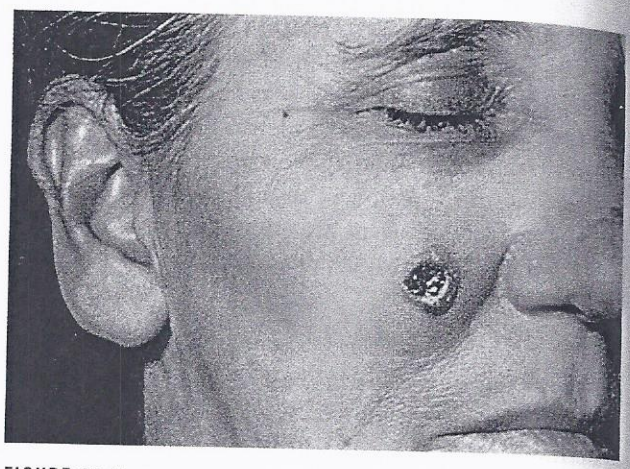

FIGURE 15-11 Cutaneous (skin) anthrax is usually treated successfully with antibiotics. Courtesy CDC.

- *Plague:* This is an infectious disease that is caused by bacteria called *Yersinia pestis*. Usually plague is transmitted by the bites of infected fleas. In some cases, the organism enters the body through a break in the skin or by contact with tissue of an infected animal (bubonic plague). Rats, rock squirrels, prairie dogs, and chipmunks are the most common sources for plague in the United States. If the disease is not treated immediately with antibiotics, the infection spreads to the blood (septicemic plague) and lungs (pneumonic plague), and causes death. No vaccine for plague is available in the United States.
- *Botulism:* Botulism is a paralytic illness caused by a nerve toxin produced by bacteria called *Clostridium botulinum*. Three main types of botulism exist. One type is caused by eating foods that contain the toxin. A second type is caused by the presence of the toxin in a wound or injury to the skin. A third type occurs in infants who eat the spores that then grow in the intestine and release the toxin. The toxin rapidly causes muscle paralysis. If it is not treated with an antitoxin, the paralysis spreads to the respiratory muscles and causes death.
- *Tularemia:* This is an infectious disease caused by bacteria called *Francisella tularensis*. This bacteria is commonly found in animals such as rats, rabbits, and insects (ticks and deerflies). Humans get the disease through the bite of an infected animal or insect, by eating contaminated food, by drinking contaminated water, or by breathing in the bacteria. The disease causes death if it is not treated with appropriate antibiotics. Currently, the

Food and Drug Administration (FDA) is reviewing a vaccine, but it is not available in the United States.

- *Hemorrhagic fever:* This is an infectious disease caused by a filovirus. Two filoviruses have been identified. They are the Ebola virus and the Marburg virus. The source of the viruses is still being researched, but the common belief is that the viruses are transmitted from animals such as bats. Once the viruses affect a human, the disease is spread rapidly from person to person by contact with body fluids. No effective treatment exists, and 50–90 percent of infected individuals die.

Many other pathogenic microorganisms can be used in a bioterrorism attack. In fact, any pathogenic organism could be used in a bioterrorism attack. For this reason, health care workers must be constantly alert to the threat of infection with a biologic agent.

Preparing for Bioterrorism

A bioterrorism attack could cause an epidemic and public health emergency. Large numbers of infected people would place a major stress on health care facilities. Fear and panic could lead to riots, social disorder, and disregard for authority. For these reasons, the Bioterrorism Act of 2002 was passed by Congress and signed into law in June 2002. This act requires the development of a comprehensive plan against bioterrorism to increase security in the United States.

Preparing for bioterrorism will involve government at all levels—local, regional, state, and national (Figure 15-12). Some of the major aspects of preparation include:

- Community-based surveillance to detect early indications of a bioterrorism attack
- Notification of the public when a high-risk situation is detected
- Strict infection-control measures and public education about the measures
- Funding for studying pathogenic organisms, developing vaccines, researching treatments, and determining preventive actions
- Strict guidelines and restrictions for purchasing and transporting pathologic microorganisms
- Mass immunization, especially for military, first responders, police, fire department, and health care personnel
- Increased protection of food and water supplies
- Training personnel to properly diagnose and treat infectious diseases
- Establishing emergency management policies
- Criminal investigation of possible threats
- Improving the ability of health care facilities to deal with an attack by increasing emergency department space, preparing decontamination areas, and establishing isolation facilities
- Improving communications so information on bioterrorism is transmitted quickly and efficiently

Every health care worker must constantly be alert to the threat of bioterrorism. In today's world, it is likely that an attack will occur. Careful preparation and thorough training can limit the effect of the attack and save the lives of many people.

STUDENT: Go to the workbook and complete the assignment sheet for 15:2, Bioterrorism.

FIGURE 15-12 Response to a bioterrorism attack involves preparing and training emergency personnel at all government levels—local, regional, state, and federal. Courtesy U.S. Army/Photo by Lt. Col. Richard Goldenberg.

15:3 Washing Hands


Precaution


OBRA

Handwashing is a basic task required in any health care occupation. The method described in this unit has been developed to ensure that a thorough cleansing occurs. An aseptic technique is a method followed to prevent the spread of germs or pathogens. *Handwashing is the most important method used to practice aseptic technique* (Figure 15-13). Handwashing is also the most effective way to prevent the spread of infection.

The hands are a perfect medium for the spread of pathogens. Thoroughly washing the hands helps prevent and control the spread of pathogens from one person to another. It also helps protect the health worker from disease and illness.

The Centers for Disease Control and Prevention (CDC) published the results of handwashing research and new recommendations for hand hygiene in 2002.

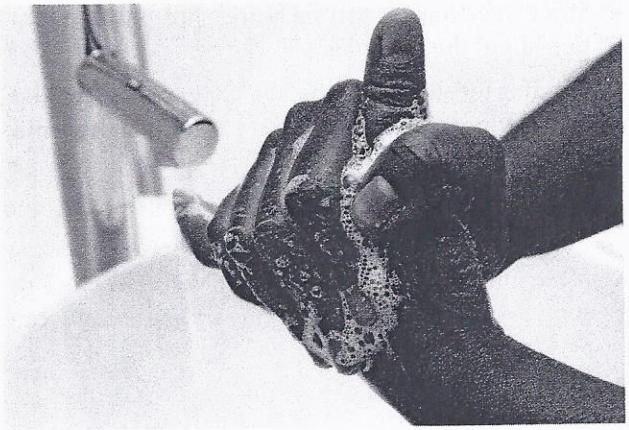

FIGURE 15-13 Handwashing is the most important method used to practice aseptic technique. © iStockphoto/Jo Unruh.

The recommendations call for regular handwashing using plain soap and water, antiseptic handwashing using an antimicrobial soap and water, and antiseptic hand rubs (waterless handwashing) using alcohol-based hand cleaners. Regular handwashing is recommended for routine cleansing of the hands when the hands are visibly dirty or soiled with blood or other body fluids. Antiseptic handwashing is recommended before invasive procedures, in critical care units, while caring for patients on specific organism transmission-based precautions, and in specific circumstances defined by the infection-control program of the health care facility. Antiseptic hand rubs are recommended if the hands are not visibly dirty or are not soiled with blood or body fluids.

Handwashing should be performed frequently. The World Health Organization (WHO) has developed guidelines for handwashing called *My 5 Moments for Hand Hygiene*. The five essential times for handwashing include:

- Before touching a patient
- Before a clean or aseptic procedure
- After body fluid exposure or risk of exposure
- After touching a patient
- After touching the patient's surroundings

In addition, handwashing should be done:

- When you arrive at the facility and immediately before leaving the facility
- After contact with a patient's intact skin (for example, after taking a blood pressure)
- Before moving from a contaminated body site to a clean body site during patient care (for example, before washing the patient's hands after removing a bedpan)
- Any time the hands become contaminated during a procedure
- Before applying and immediately after removing gloves
- Any time gloves are torn or punctured
- Before and after handling any specimen
- After contact with any soiled or contaminated item
- After picking up any item off the floor
- After personal use of the bathroom
- After you cough, sneeze, or use a tissue
- Before and after any contact with your mouth or mucous membrane, such as eating, drinking, smoking, applying lip balm, or inserting or removing contact lenses

The recommended method for handwashing is based on the following principles; they should be observed whenever hands are washed:

- Soap is used as a cleansing agent because it aids in the removal of germs through its sudsy action and alkali content. Pathogens are trapped in the soapsuds and rinsed away. Liquid soap from a dispenser should be used whenever possible because bar soap can contain microorganisms.
- Warm water should be used. This is less damaging to the skin than hot water. It also creates a better lather with soap than does cold water.
- Friction must be used in addition to soap and water. This action helps rub off pathogens from the surface of the skin.
- All surfaces on the hands must be cleaned. This includes the palms, the backs/tops of the hands, and the areas between the fingers.
- Fingertips must be pointed downward. The downward direction prevents water from getting on the forearms and then running down to contaminate the clean hands.
- Dry paper towels must be used to turn the faucet on and off. This action prevents contamination of the hands from pathogens on the faucet. A dry towel must be used because pathogens can travel more readily through a wet towel.

Nails also harbor dirt and pathogens, and must be cleaned during the handwashing process. An orange/cuticle stick can be used. Care must be taken to use the blunt end of the stick because the pointed end can injure the nailbeds. A brush can also be used to clean the nails. If a brush or orange stick is not available or the nails are not visibly dirty, the nails can be rubbed against the palm of the opposite hand to get soap under the nails. Most health care facilities prohibit the use of artificial nails and require that nails be kept short, usually less than ¼-inch long. Artificial or long nails can harbor organisms and

increase the risk for infection for both the patient and health care worker. In addition, long nails can puncture or tear gloves.

Waterless hand cleaning with an alcohol-based gel, lotion, or foam has been proved safe for use during routine patient care. Its use is recommended when the hands are not visibly dirty and are not contaminated with blood or body fluids (Figure 15-14). Most waterless hand cleaning products contain alcohol to provide antisepsis and a moisturizer to prevent drying of the skin. It is important to read the manufacturer's instructions before using any product. Usually a small amount of the alcohol-based cleaner is applied to the palm of the hands. The hands are then rubbed vigorously so the solution is applied to all surfaces of the hands, fingers, nails, and wrists. The hands should be rubbed until they are dry, usually at least 15 seconds. Most manufacturers recommend that the hands be washed with soap and water after 6–10 cleanings with the alcohol-based product. In addition, if the hands are visibly soiled, or if there has been contact with blood or body fluid, the hands must be washed with soap and water.

Every health care facility has written policies for hand hygiene as a part of their standard precautions manual. Health care workers must become familiar with and follow these policies to prevent the spread of infection.

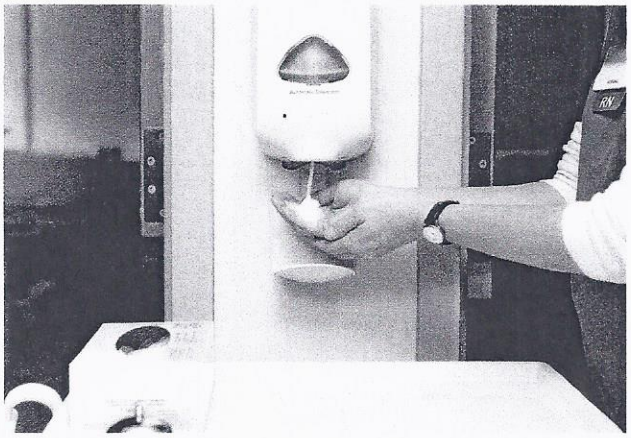

FIGURE 15-14 Waterless handwashing using an alcohol-based hand cleaner is an effective way of cleaning hands that are not visibly soiled. © iStockphoto/Nancy Louie.

STUDENT: Go to the workbook and complete the assignment sheet for 15:3, Washing Hands. Then return and continue with the procedure.

PROCEDURE 15:3

Washing Hands

Equipment and Supplies

Paper towels, running water, waste container, hand brush or orange/cuticle stick, soap

Procedure

1. Assemble all equipment. Stand back slightly from the sink so you do not contaminate your uniform or clothing. Avoid touching the inside of the sink with your hands since it is considered contaminated. Remove any rings and push your wristwatch up above your wrist.
2. Turn the faucet on by holding a paper towel between your hand and the faucet (Figure 15-15A). Regulate the temperature of the water and let water flow over your hands. Discard the towel in the waste container.

   NOTE: Water should be warm.

   Safety **CAUTION:** Hot water will burn your hands.
3. With your fingertips pointing downward, wet your hands.

   NOTE: Washing in a downward direction prevents water from getting on the forearms and then running back down to contaminate hands.
4. Use soap to get a lather on your hands.
5. Put the palms of your hands together and rub them using friction and a circular motion for at least 15 seconds.
6. Put the palm of one hand on the back of the other hand. Rub together several times. Repeat this after reversing position of hands (Figure 15-15B).
7. Interlace the fingers on both hands and rub them back and forth (Figure 15-15C).
8. Encircle your wrist with the palm and fingers of the opposite hand. Use a circular motion to clean the front, back, and sides of the wrist. Repeat for the opposite wrist.
9. Clean the nails with an orange/cuticle stick and/or hand brush if they are visibly dirty or if this is the first hand cleaning of the day (Figures 15-15D and E). If the nails are not visibly dirty, they can be cleaned by rubbing them against the palm of the opposite hand.

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PROCEDURE 15:3 (CONT.)

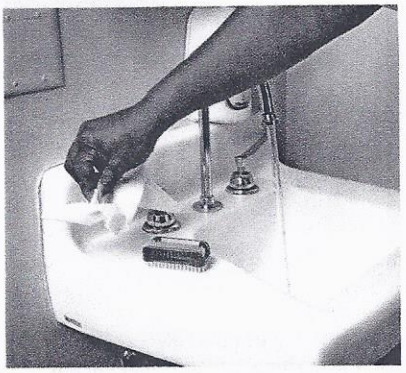

FIGURE 15-15A Use a dry towel to turn the faucet on.

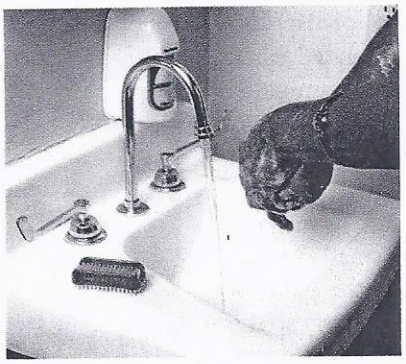

FIGURE 15-15B Point the fingertips downward and use the palm of one hand to clean the back of the other hand.

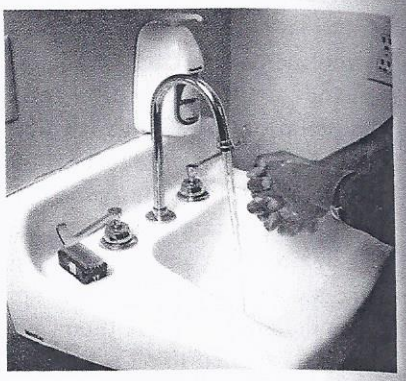

FIGURE 15-15C Interlace the fingers to clean between the fingers.

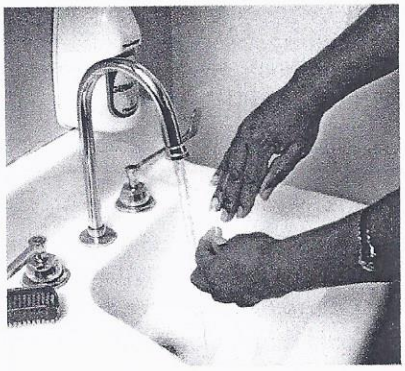

FIGURE 15-15D The blunt end of an orange stick can be used to clean the nails.

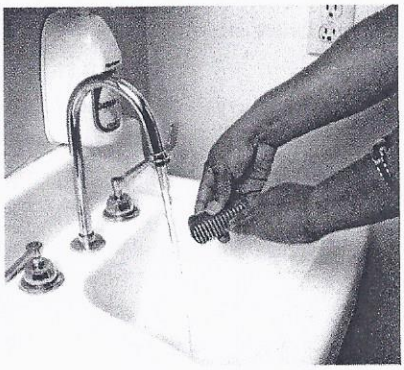

FIGURE 15-15E A hand brush can also be used to clean the nails.

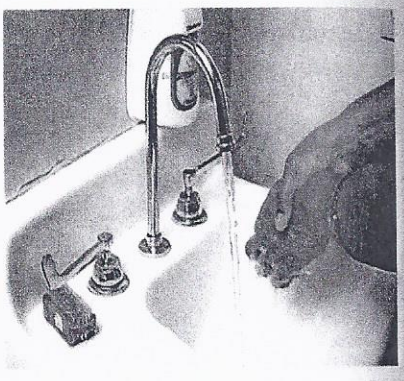

FIGURE 15-15F With the fingertips pointing downward, rinse the hands thoroughly.

Safety **CAUTION:** Use the blunt end of orange/cuticle stick to avoid injury.

NOTE: Steps 3 through 9 ensure that all parts of both hands are clean.

NOTE: Some health care facilities require washing the hands for 40–60 seconds. This is equivalent to singing the "Happy Birthday" song twice.

10. Rinse your hands from the forearms down to the fingertips, keeping fingertips pointed downward (Figure 15-15F).
11. Use a clean paper towel to dry hands thoroughly, from tips of fingers to wrist. Discard the towel in the waste container.
12. Use another dry paper towel to turn off the faucet.

Safety **CAUTION:** Wet towels allow passage of pathogens.

13. Discard all used towels in the waste container. Leave the area neat and clean.
14. Apply a water-based hand lotion if desired.

PRACTICE: **Go to the workbook and use the evaluation sheet for 15:3, Washing Hands, to practice this procedure. When you believe you have mastered this skill, sign the sheet and give it to your instructor for further action.**

Check **FINAL CHECKPOINT:** Using the criteria listed on the evaluation sheet, your instructor will grade your performance.

15:4 Observing Standard Precautions

To prevent the spread of pathogens and disease, the chain of infection must be broken. The standard precautions discussed in this unit are an important way health care workers can break this chain.

Bloodborne Pathogens Standard

One of the main ways that pathogens are spread is by blood and body fluids. Three pathogens of major concern are the hepatitis B virus (HBV), the hepatitis C virus (HCV), and the human immunodeficiency virus (HIV), which causes AIDS. Consequently, extreme care must be taken at all times when an area, object, or person is contaminated with blood or body fluids. In 1991, the Occupational Safety and Health Administration (OSHA) established *Bloodborne Pathogen Standards* that must be followed by all health care facilities. The employer faces civil penalties if the regulations are not implemented by the employer and followed by the employees. These regulations require all health care facility employers to:

- Develop a written exposure control plan, and update it annually, to minimize or eliminate employee exposure to bloodborne pathogens.
- Identify all employees who have occupational exposure to blood or potentially infectious materials such as semen, vaginal secretions, and other body fluids.
- Provide hepatitis B vaccine free of charge to all employees who have occupational exposure, and obtain a written release form signed by any employee who does not want the vaccine.
- Provide **personal protective equipment (PPE)** such as gloves, gowns, lab coats, masks, and face shields in appropriate sizes and in accessible locations.
- Provide adequate handwashing facilities and supplies.
- Ensure that the worksite is maintained in a clean and sanitary condition, follow measures for immediate decontamination of any surface that comes in contact with blood or infectious materials, and dispose of infectious waste correctly.
- Enforce rules of no eating, drinking, smoking, applying cosmetics or lip balm, handling contact lenses, and mouth pipetting or suctioning in any area that can be potentially contaminated by blood or other body fluids.
- Provide appropriate containers that are color coded (fluorescent orange or orange-red) and labeled for contaminated sharps (needles, scalpels) and other infectious or biohazard wastes.
- Post signs at the entrance to work areas where there is occupational exposure to biohazardous materials. Label any item that is biohazardous with the red biohazard symbol (Figure 15-16). The label must show both the symbol and the word "biohazard."
- Provide a confidential medical evaluation and follow-up for any employee who has an exposure incident. Examples might include an accidental needlestick or the splashing of blood or body fluids on the skin, eyes, or mucous membranes.
- Provide training about the regulations and all potential biohazards to all employees at no cost during working hours, and provide additional education as needed when procedures or working conditions are changed or modified.

FIGURE 15-16 The universal biohazard symbol indicates a potential source of infection.

Needlestick Safety Act

In 2001, OSHA revised its Bloodborne Pathogen Standards in response to Congress passing the *Needlestick Safety and Prevention Act* in November 2000. This act was passed after the Centers for Disease Control and Prevention (CDC) estimated that 600,000 to 800,000 needlesticks occur each year, exposing health care workers to bloodborne pathogens. Employers are required to:

- *Identify and use effective and safer medical devices.* OSHA defines safer devices as sharps with engineered injury protections and includes, but is not limited to, devices such as syringes with a sliding sheath that shields the needle after use, needles that retract into a syringe after use, shielded or retracting catheters that can be used to administer intravenous medications or fluids, and intravenous systems that administer medication or fluids through a catheter port or connector site using a needle housed in a protective covering (Figure 15-17). OSHA also encourages the use of needleless systems, which

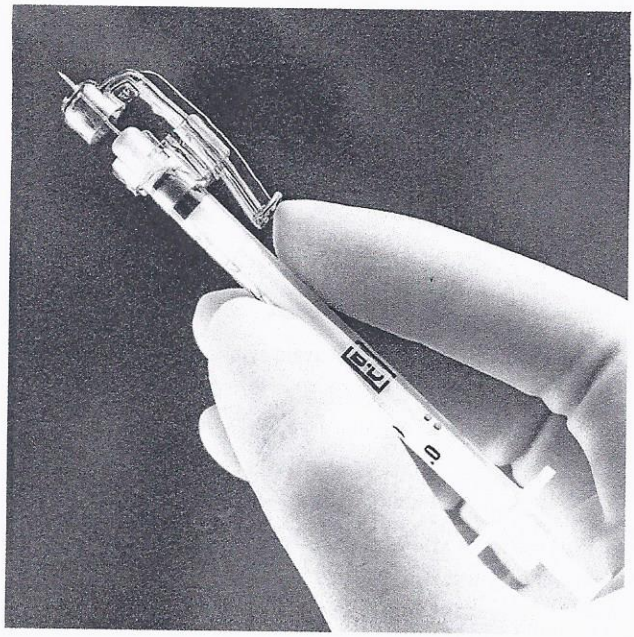

FIGURE 15-17 The Safety-Glide syringe is one example of a safer device to prevent needlesticks. Photo reprinted courtesy of BD [Becton, Dickinson and Company].

include, but are not limited to, intravenous medication delivery systems that administer medication or fluids through a catheter port or connector site using a blunt cannula or other non-needle connection, and jet injection systems that deliver subcutaneous or intramuscular injections through the skin without using a needle.

- *Incorporate changes in annual updates of exposure control plan.* Employers must include changes in technology that eliminate or reduce exposure to bloodborne pathogens in the annual update and document the implementation of any safer medical devices.
- *Solicit input from nonmanagerial employees who are responsible for direct patient care.* Employees who provide patient care, and are exposed to injuries from contaminated sharps, must be included in a multidisciplinary team that identifies, evaluates, and selects safer medical devices, and determines safer work practice controls.
- *Maintain a sharps injury log.* Employers with more than 11 employees must maintain a sharps injury log to help identify high-risk areas and evaluate ways of decreasing injuries. Each injury recorded must protect the confidentiality of the injured employee, but must state the type and brand of device involved in the incident, the work area or department where the exposure injury occurred, and a description of how the incident occurred.

Standard Precautions

Employers are also required to make sure that every employee uses standard precautions at all times to prevent contact with blood or other potentially infectious materials. **Standard precautions** (Figure 15-18) are rules developed by the CDC to prevent the spread of infection. According to standard precautions, every body fluid must be considered a potentially infectious material, and all patients must be considered potential sources of infection, regardless of their disease or diagnosis. Standard precautions must be used in any situation where health care providers may contact:

- Blood or any fluid that may contain blood
- Body fluids, secretions, and excretions, such as mucus, sputum, saliva, cerebrospinal fluid, urine, feces, vomitus, amniotic fluid (surrounding a fetus), synovial (joint) fluid, pleural (lung) fluid, pericardial (heart) fluid, peritoneal (abdominal cavity) fluid, semen, and vaginal secretions
- Mucous membranes
- Nonintact skin
- Tissue or cell specimens

The basic rules of standard precautions include:

- *Handwashing:* Hands must be washed before and after contact with any patient. If hands or other skin surfaces are contaminated with blood, body fluids, secretions, or excretions, they must be washed immediately and thoroughly with soap and water. If hands are not visibly soiled, an alcohol-based hand rub can be used. Hands must always be washed immediately before donning and immediately after removal of gloves.
- *Gloves:* Gloves (Figure 15-19) must be worn whenever contact with blood, body fluids, secretions, excretions, mucous membranes, tissue specimens, or nonintact skin is possible; when handling or cleaning any contaminated items or surfaces; when performing any invasive (entering the body) procedure; and when performing venipuncture or blood tests. Rings must be removed before putting on gloves to avoid puncturing the gloves. Gloves must be changed after contact with each patient and even between tasks or procedures on the same patient if there is any chance the gloves are contaminated. Hands must be washed immediately after removal of gloves. Care must be taken while removing gloves to avoid contamination of the skin. Gloves must *not* be washed or disinfected for reuse because washing may allow penetration of liquids through undetected holes, and disinfecting agents may cause deterioration of gloves.

STANDARD PRECAUTIONS

Assume that every person is potentially infected or colonized with an organism that could be transmitted in the healthcare setting.

Hand Hygiene

Avoid unnecessary touching of surfaces in close proximity to the patient.

When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with soap and water.

If hands are not visibly soiled, or after removing visible material with soap and water, decontaminate hands with an alcohol-based hand rub. Alternatively, hands may be washed with an antimicrobial soap and water.

Perform hand hygiene:

- Before having direct contact with patients.
- After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings.
- After contact with a patient's intact skin (e.g., when taking a pulse or blood pressure or lifting a patient).
- If hands will be moving from a contaminated-body site to a clean-body site during patient care.
- After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient.
- After removing gloves.

Personal protective equipment (PPE)

Wear PPE when the nature of the anticipated patient interaction indicates that contact with blood or body fluids may occur.

Before leaving the patient's room or cubicle, remove and discard PPE.

Gloves

Wear gloves when contact with blood or other potentially infectious materials, mucous membranes, nonintact skin, or potentially contaminated intact skin (e.g., of a patient incontinent of stool or urine) could occur.

Remove gloves after contact with a patient and/or the surrounding environment using proper technique to prevent hand contamination. Do not wear the same pair of gloves for the care of more than one patient.

Change gloves during patient care if the hands will move from a contaminated body-site (e.g., perineal area) to a clean body-site (e.g., face).

Gowns

Wear a gown to protect skin and prevent soiling or contamination of clothing during procedures and patient-care activities when contact with blood, body fluids, secretions, or excretions is anticipated.

Wear a gown for direct patient contact if the patient has uncontained secretions or excretions.

Remove gown and perform hand hygiene before leaving the patient's environment.

Mouth, nose, eye protection

Use PPE to protect the mucous membranes of the eyes, nose and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions.

During aerosol-generating procedures wear one of the following: a face shield that fully covers the front and sides of the face, a mask with attached shield, or a mask and goggles.

Respiratory Hygiene/Cough Etiquette

Educate healthcare personnel to contain respiratory secretions to prevent droplet and fomite transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections.

Offer masks to coughing patients and other symptomatic persons (e.g., persons who accompany ill patients) upon entry into the facility.

Patient-care equipment and instruments/devices

Wear PPE (e.g., gloves, gown), according to the level of anticipated contamination, when handling patient-care equipment and instruments/devices that are visibly soiled or may have been in contact with blood or body fluids.

Care of the environment

Include multi-use electronic equipment in policies and procedures for preventing contamination and for cleaning and disinfection, especially those items that are used by patients, those used during delivery of patient care, and mobile devices that are moved in and out of patient rooms frequently (e.g., daily).

Textiles and laundry

Handle used textiles and fabrics with minimum agitation to avoid contamination of air, surfaces and persons.

SPR

FIGURE 15-18 **Standard precautions must be observed while working with all patients.** Reprinted with Permission from Brevis Corporation [www.brevis.com].

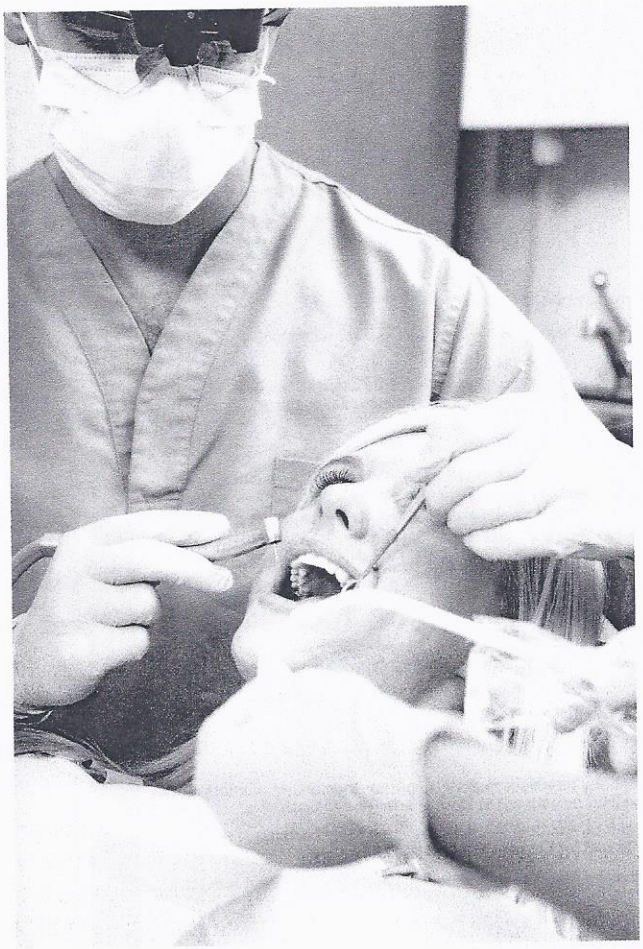

FIGURE 15-19 Gloves must be worn whenever contact with blood, body fluids, secretions, excretions, mucous membranes, or nonintact skin is possible. © Tyler Olson/www.Shutterstock.com.

FIGURE 15-20 Gloves, a gown, a mask, and protective eyewear must be worn during any procedure that may produce droplets or cause splashing of blood, body fluids, secretions, or excretions. © Yuri Arcurs/www.Shutterstock.com.

- *Gowns:* Gowns must be worn during any procedure that may cause splashing or spraying of blood, body fluids, secretions, or excretions. This helps prevent contamination of clothing or uniforms. Contaminated gowns must be handled according to agency policy and local and state laws. Wash hands immediately after removing a gown.
- *Masks and Eye Protection:* Masks and protective eyewear or face shields (Figure 15-20) must be worn during procedures that may produce splashes or sprays of blood, body fluids, secretions, or excretions. Examples include irrigation of wounds, suctioning, dental procedures, delivery of a baby, and surgical procedures. This prevents exposure of the mucous membranes of the mouth, nose, and eyes to any pathogens.

  Masks must be used once and then discarded. In addition, masks should be changed every 30 minutes or anytime they become moist or wet. They should be removed by grasping the ties or elastic strap. Hands must be washed immediately after the mask is removed. Protective eyewear or face shields should provide protection for the front, top, bottom, and sides of the eyes. If eyewear is not disposable, it must be cleaned and disinfected before it is reused.
- Legal *Sharps:* To avoid accidental cuts or punctures, extreme care must be taken while handling sharp objects. Whenever possible, safe needles or needleless devices must be used. Disposable needles must never be bent or broken after use. They must be left uncapped and attached to the syringe and placed in a leakproof puncture-resistant sharps container (Figure 15-21). The sharps container must be labeled with a red biohazard symbol. Surgical blades, razors, and other sharp objects must also be discarded in the sharps container.

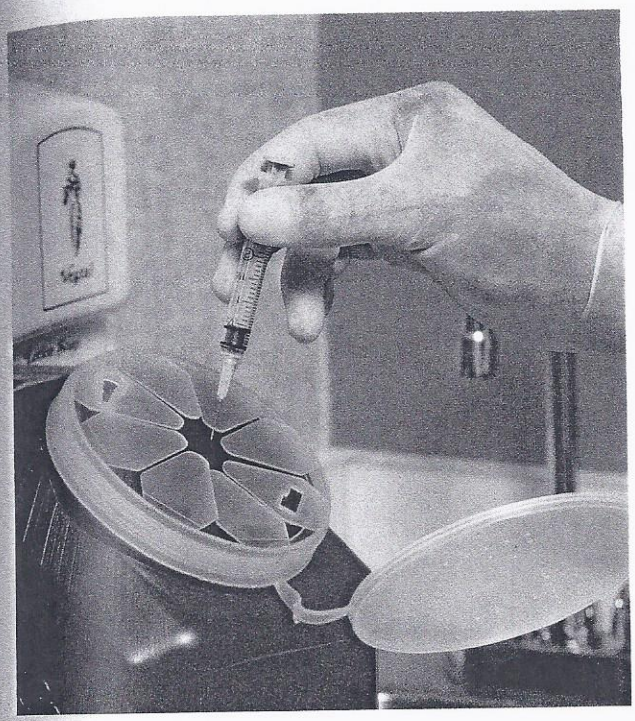

FIGURE 15-21 All needles and sharp objects must be discarded immediately in a leakproof puncture-resistant sharps container.

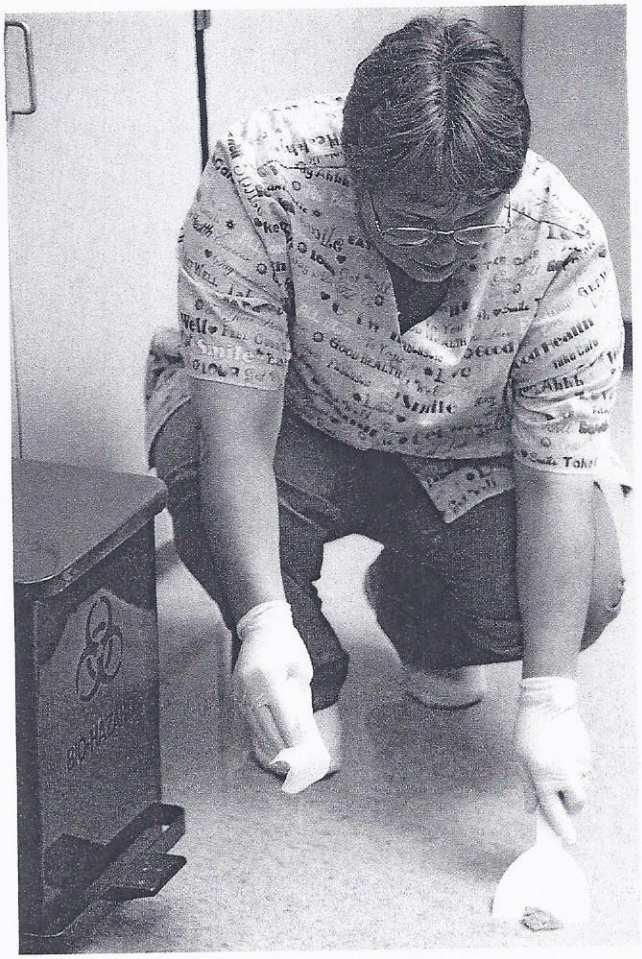

FIGURE 15-22 An absorbent powder may be used to soak up a spill of blood, body fluids, secretions, or excretions. Gloves must be worn while picking up the solidified spill.

Legal

The sharps containers must *not* be emptied or reused. Federal, state, and local laws establish regulations for the disposal of sharps containers.

- *Spills or Splashes:* Spills or splashes of blood, body fluids, secretions, or excretions must be wiped up immediately. Gloves must be worn while wiping up the area with disposable cleaning cloths. The area must then be cleaned with a disinfectant solution such as a 10-percent bleach solution. Furniture or equipment contaminated by the spill or splash must be cleaned and disinfected immediately. For large spills, an absorbent powder may be used to soak up the fluid. After the fluid is absorbed, it is swept up and placed in an infectious waste container (Figure 15-22).
- *Resuscitation Devices:* Mouthpieces or resuscitation devices should be used to avoid the need for mouth-to-mouth resuscitation. These devices should be placed in convenient locations and be readily accessible for use.
- *Waste and Linen Disposal:* Health care workers must wear gloves and follow the agency policy developed according to law to dispose of waste and soiled linen. Infectious wastes such as contaminated dressings; gloves; urinary drainage bags; incontinence pads; vaginal pads; disposable emesis basins, bedpans, and/or urinals; and body tissues must be placed in special infectious waste or biohazardous material bags (Figure 15-23) according to law. Other trash is frequently placed in plastic bags and incinerated. The health care worker must dispose of waste in the proper container (Figure 15-24) and know the requirements for disposal. Soiled linen should be placed in laundry bags to prevent any contamination. Linen soiled with blood, body fluids, or excretions is placed in a special bag for contaminated linen and is usually soaked in a disinfectant prior to being laundered. Gloves must be worn while handling any contaminated linen, and any bag containing contaminated linen must be clearly labeled and color coded.
- *Injuries:* Any cut, injury, needlestick, or splashing of blood or body fluids must be reported immediately. Agency policy must be followed to deal with the injury or contamination. Every health care facility must have a policy stating actions that must be taken immediately when exposure or injury occurs, including reporting any injury, documenting any exposure incident, recording the care given, noting follow-up to the exposure incident, and identifying ways to prevent a similar incident.

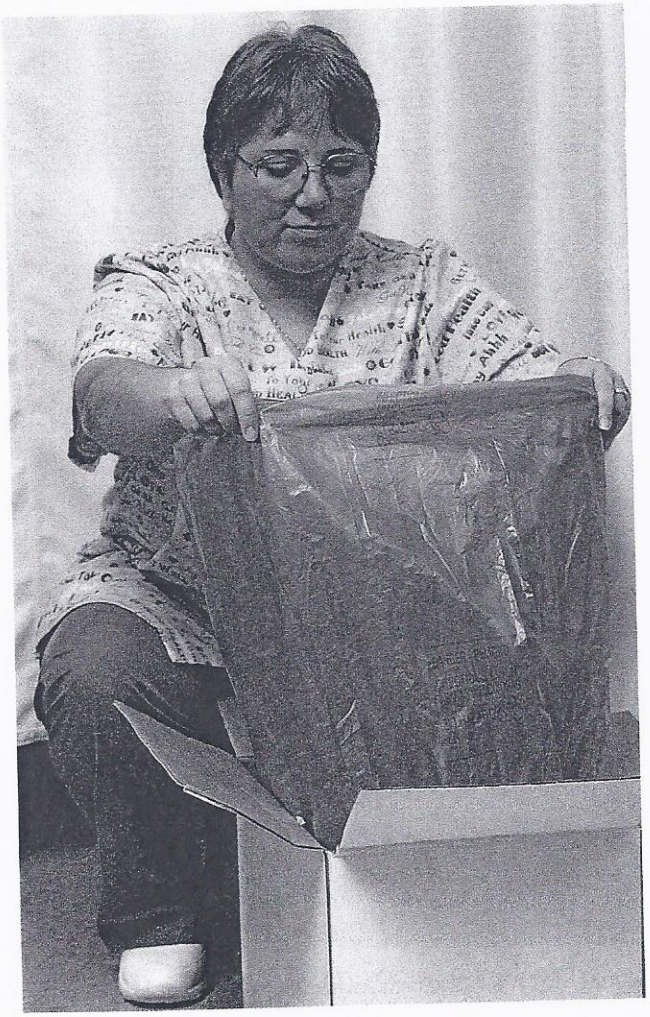

FIGURE 15-23 All infectious wastes must be placed in special infectious waste or biohazardous material bags.

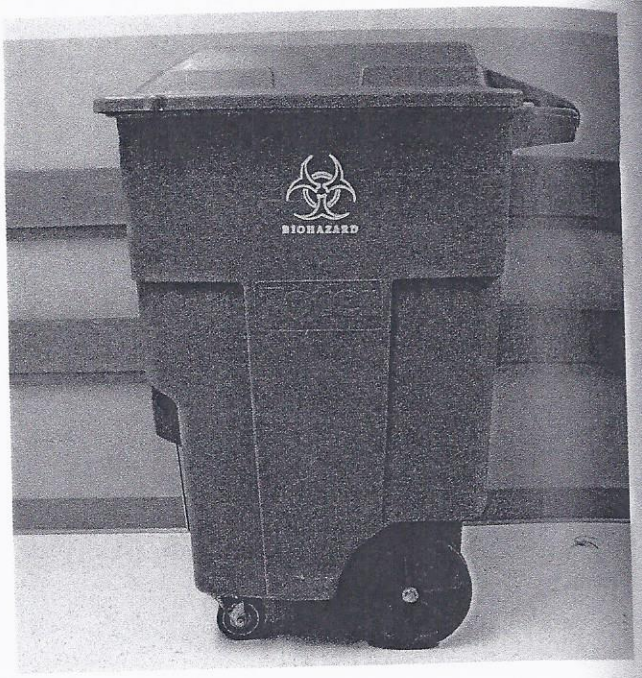

FIGURE 15-24 The health care worker must know the requirements for disposal of waste materials and dispose of wastes in the proper containers.

Standard precautions must be followed at all times by all health care workers. By observing these precautions, health care workers can help break the chain of infection and protect themselves, their patients, and all other individuals.

STUDENT: Go to the workbook and complete the assignment sheet for 15:4, Observing Standard Precautions. Then return and continue with the procedure.

PROCEDURE 15:4

Observing Standard Precautions

Equipment and Supplies

Disposable gloves, infectious waste bags, needle and syringe, sharps container, gown, masks, protective eyewear, resuscitation devices

Precaution **NOTE:** This procedure will help you learn standard precautions. It is important for you to observe these precautions at all times while working in the laboratory or clinical area.

Procedure

1. Assemble equipment.
2. Review the precautions in the information section for Observing Standard Precautions. Note points that are not clear, and ask your instructor for an explanation.
3. Practice handwashing according to Procedure 15:3. Identify at least six times that hands must be washed according to standard precautions.
4. Name four instances when gloves must be worn to observe standard precautions. Put on a pair of disposable gloves. Practice removing the gloves without contaminating the skin. With a gloved hand, grasp the cuff of the glove on the opposite hand, handling only the outside of the glove (Figure 15-25A). Pull the glove down and turn it inside out while removing it (Figure 15-25B). Take care not to touch the skin with the gloved hand. Grasp the contaminated glove in the palm of the gloved hand (Figure 15-25C). Using the ungloved hand, slip the fingers under the cuff of the glove on the opposite hand (Figure 15-25D). Touching only the inside of the glove and taking care not to touch the skin, pull the glove down and turn it inside out while

PROCEDURE 15:4 (CONT.)

FIGURE 15-25A To remove the first glove, use a gloved hand to grasp the outside of the glove on the opposite hand.

FIGURE 15-25B Pull the glove down and turn it inside out while removing it.

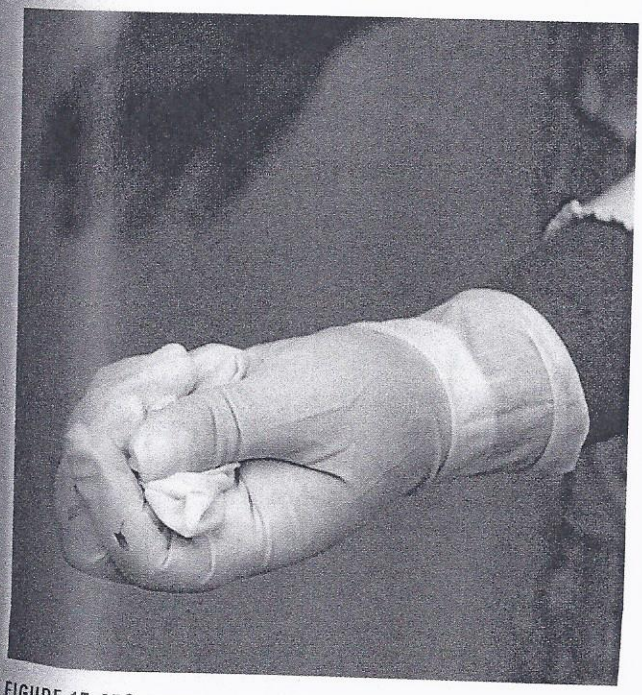

FIGURE 15-25C Grasp the contaminated glove in the palm of the gloved hand.

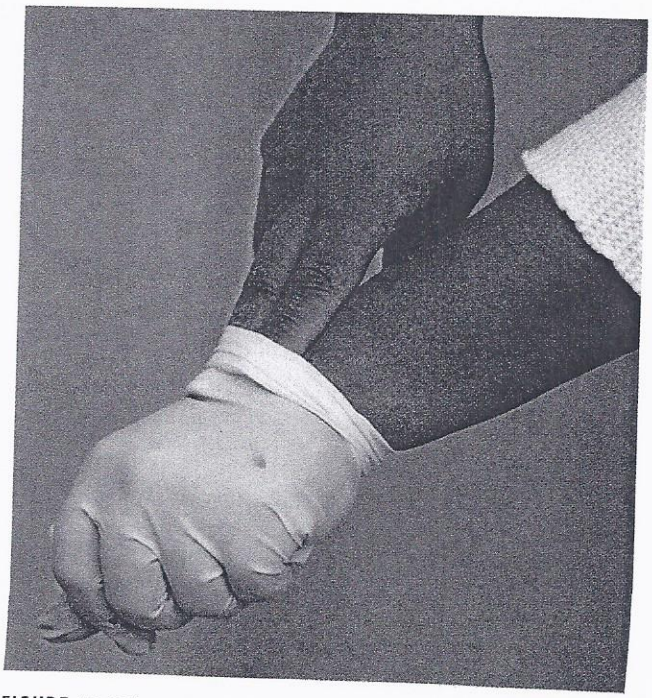

FIGURE 15-25D To remove the second glove, slip the fingers of the ungloved hand inside the cuff of the glove.

(continues)

PROCEDURE 15:4 (CONT.)

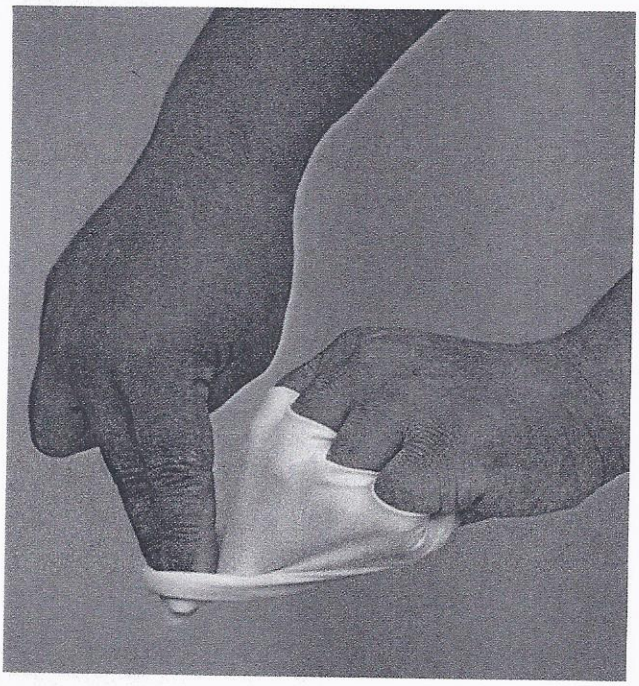

FIGURE 15-25E **Touch only the inside of the glove while pulling it down and turning it inside out.**

FIGURE 15-25F **Place the gloves in an infectious waste container and wash your hands immediately.**

removing it (Figure 15-25E). Place the gloves in an infectious waste container (Figure 15-25F). Wash your hands immediately.

5. Practice putting on a gown. State when a gown is to be worn. To remove the gown, touch only the inside. Fold the contaminated gown so the outside is folded inward. Roll it into a bundle and place it in an infectious waste container if it is disposable, or in a bag for contaminated linen if it is not disposable.


Safety

CAUTION: If a gown is contaminated, gloves should be worn while removing the gown.

NOTE: Folding the gown and rolling it prevents transmission of pathogens.

6. Practice putting on a mask and protective eyewear. To remove the mask, handle it by the ties only. Clean and disinfect protective eyewear after use.

7. Practice proper disposal of sharps. Uncap a needle attached to a syringe, taking care not to stick yourself with the needle. Place the entire needle and syringe in a sharps container. State the rules regarding disposal of the sharps container.

8. Spill a small amount of water on a counter. Pretend that it is blood. Put on gloves and use disposable cloths or gauze to wipe up the spill. Put the contaminated cloths or gauze in an infectious waste bag. Use clean disposable cloths or gauze to wipe the area thoroughly with a disinfectant agent (Figure 15-26). Put the cloths or gauze in the infectious waste bag, remove your gloves, and wash your hands.

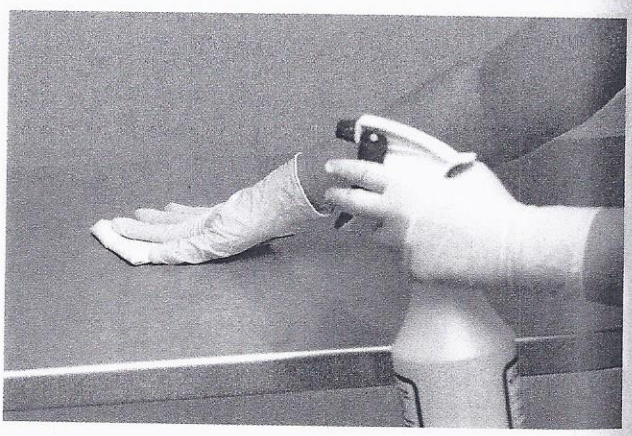

FIGURE 15-26 **Wear gloves to spray the contaminated counter with a disinfectant. Then wipe the counter clean with a disposable cloth or gauze.**

9. Practice handling an infectious waste bag. Fold down the top edge of the bag to form a cuff at the top of the bag. Wear gloves to close the bag after contaminated wastes

PROCEDURE 15:4 (CONT.)

FIGURE 15-27 **After folding down the top edge of the infectious waste bag, tie or tape it securely.**

have been placed in it. Put your hands under the folded cuff and gently expel excess air from the bag. Twist the top of the bag shut and fold down the top edges to seal the bag. Secure the fold with tape or a tie according to agency policy (Figure 15-27).

10. Examine mouthpieces and resuscitation devices that are used for resuscitation. You will be taught to use these devices when you learn cardiopulmonary resuscitation (CPR).
11. Discuss the following situations with another student and determine which standard precautions should be observed:
    - A patient has an open sore on the skin and pus is seeping from the area. You are going to bathe the patient.
    - You are cleaning a tray of instruments that contains a disposable surgical blade and needle with syringe.
    - A tube of blood drops to the floor and breaks, spilling the blood on the floor.
    - Drainage from dressings on an infected wound has soiled the linen on the bed you are changing.
    - You work in a dental office and are assisting a dentist while a tooth is being extracted (removed).
12. Replace all equipment used.

PRACTICE: Go to the workbook and use the evaluation sheet for 15:4, Observing Standard Precautions. When you believe you have mastered this skill, sign the sheet and give it to your instructor for further action.

Check **FINAL CHECKPOINT:** Using the criteria listed on the evaluation sheet, your instructor will grade your performance.

15:5 Sterilizing with an Autoclave

Sterilization of instruments and equipment is essential in preventing the spread of infection. In any of the health fields, you may be responsible for proper sterilization. The following basic principles relate to sterilization methods. The autoclave is the safest, most efficient sterilization method.

An **autoclave** is a piece of equipment that uses steam under pressure or gas to sterilize equipment and supplies (Figure 15-28). It is the most efficient method of sterilizing most articles, and it will destroy all microorganisms, both pathogenic and nonpathogenic, including spores and viruses.

Autoclaves are available in various sizes and types. Offices and health clinics usually have smaller units, and hospitals or surgical areas have large floor model units. A pressure cooker can be used in home situations.

Before any equipment or supplies are sterilized in an autoclave, they must be prepared properly. All items must be washed thoroughly and then rinsed. Oily substances can often be removed with alcohol or ether. Any residue left on articles will tend to bake and stick to the article during the autoclaving process.

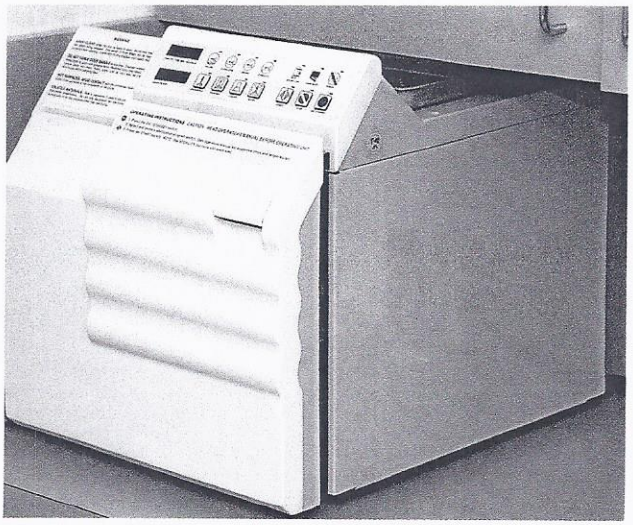

FIGURE 15-28 **An autoclave uses steam under pressure to sterilize items.**

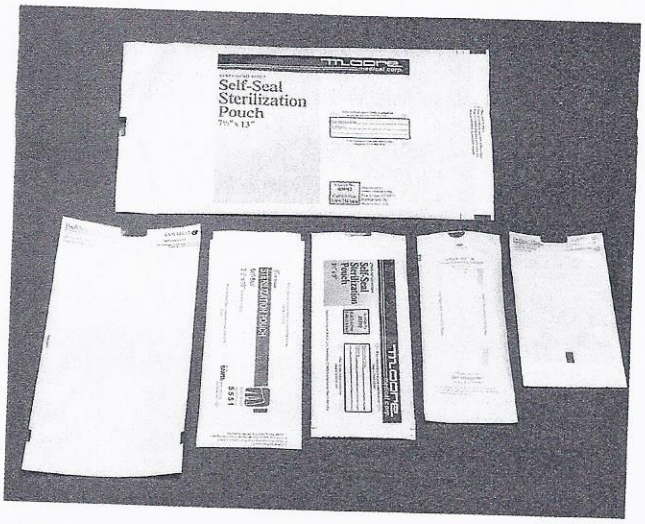

FIGURE 15-29 Special plastic or paper autoclave bags can be used to sterilize instruments.

Items that are to remain sterile must be wrapped before they are autoclaved. A wide variety of wraps are available. The wrap must be a material that will allow for the penetration of steam during the autoclaving process. Samples of wraps include muslin, autoclave paper, special plastic or paper bags, and autoclave containers (Figure 15-29).

Autoclave indicators are used to ensure that articles have been sterilized (Figure 15-30). Examples of indicators include autoclave tape, sensitivity marks on bags or wraps, and indicator capsules. The indicator is usually placed on or near the article when the article is put into the autoclave. Indicators can also be placed in the center of a package such as a tray of instruments, to show that sterilization of the entire package has occurred. The indicator will change appearance during the autoclaving process because of the length of time and the temperature, which lead to sterilization. Learn how to recognize that an article is sterile by reading the directions provided with indicators.

The autoclave must be loaded correctly for all parts of an article to be sterilized. Steam builds at the top of the chamber and moves downward. As it moves down, it pushes cool, dry air out of the bottom of the chamber. Therefore, materials must be placed so the steam can penetrate along the natural planes between the packages of articles in the autoclave. Place the articles in such a way that there is space between all pieces. Packages should be placed on the sides, not flat. Jars, basins, and cans should be placed on their sides, not flat, so that steam can enter and air can flow out. No articles should come in contact with the sides, top, or door of the autoclave.

The length of time and amount of pressure required to sterilize different items varies (Figure 15-31). *It is important to check the directions that come with the autoclave.* Because different types of articles require different times and pressures, it is important to separate loads so that all articles sterilized at one time require the same time and pressure. For example, rubber tubings usually require a relatively short period of time and can be damaged by long exposure. Certain instruments and needles require a longer period of time to ensure sterilization; therefore, items of this type should not be sterilized in the same load as are rubber tubings.

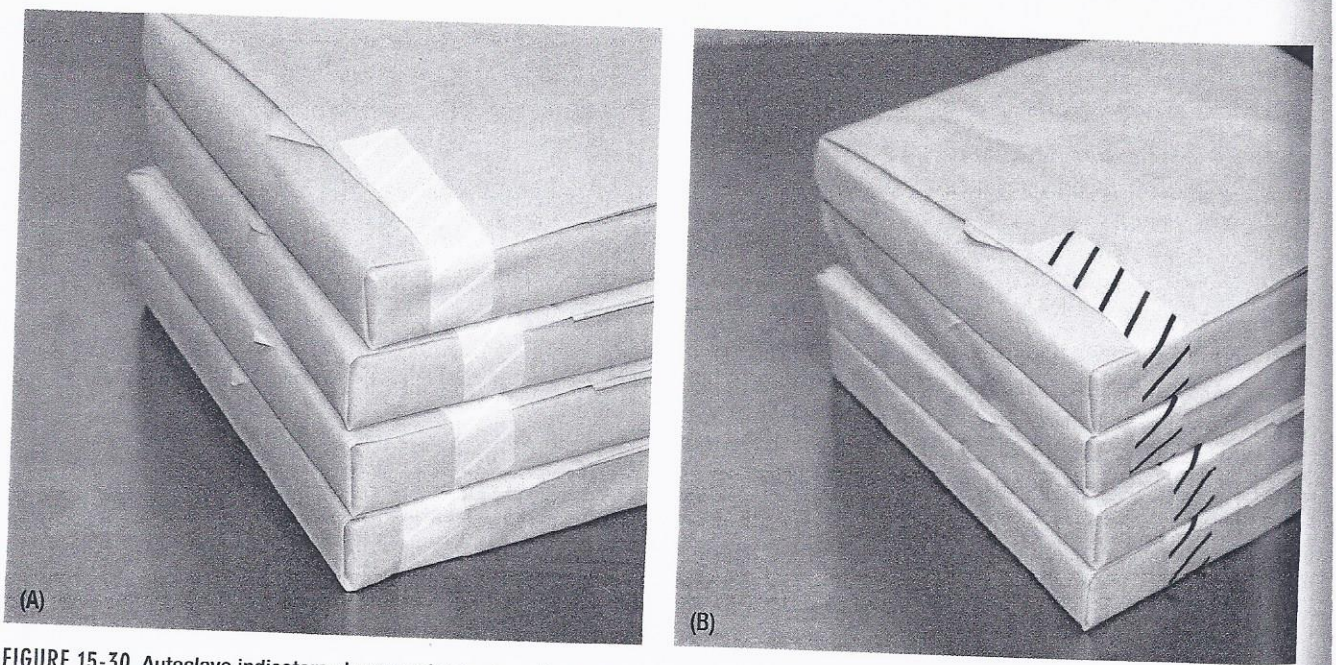

FIGURE 15-30 Autoclave indicators change color to show that sterilization has occurred: (A) before sterilization and (B) after sterilization.
Courtesy, SPSmedical Supply Corp.