Chapter 21

Safety and Infection Control

Learning Objectives

At the conclusion of this chapter, you will be able to

- Recognize potential hazards in health care settings, such as those caused by fire, obstructions, and spills, and suggest appropriate responses
- List four complications that may arise from improper patient positioning and state the correct position for each situation
- Demonstrate safe techniques for helping patients to stand, sit, lie down, and walk using the principles of good body mechanics
- Demonstrate methods for immobilizing and restraining adult patients and list precautions to be taken when these methods are used
- List and explain the four factors involved in the cycle of infection and state the most direct way to intervene in this cycle
- Describe the disease processes involved in human immunodeficiency virus infection, hepatitis, and tuberculosis and explain how to limit the transmission of these diseases
- Define *medical asepsis, disinfection*, and *sterilization* and give examples of the correct application of each
- List examples of personal hygiene practices that help to prevent the spread of infection
- Demonstrate the technique for effective handwashing
- Demonstrate the correct principles of medical asepsis in linen handling, disposal of contaminated items, and disinfection of radiographic tables and equipment
- Demonstrate the correct techniques for establishing a sterile field, donning sterile gloves, removing contaminated gloves, and changing dressings

Key Terms

airborne contamination
antibodies
asepsis
autoclave
biohazard symbol
carriers
disinfection
droplet contamination
dyspnea
emesis
endospores
fomite
health care–associated infections (HAIs)
iatrogenic
immunocompromised patients
microbes
microbial dilution
microorganisms
normal flora
nosocomial infections
opportunistic infections
orthopnea
orthostatic hypotension
PASS
pathogen
sharps container
spontaneous combustion
Standard Precautions
sterilization
vector
vehicle

Whether your job description involves only radiography or includes other back-office clinic functions, patient care skills will be essential to your work. In this chapter, you will learn some basic principles of patient care and ways in which to ensure the safety of your patients while also preventing injury to yourself and others.

Gathering places for the sick are often focal points for the transmission of disease. Anyone with a health problem is more susceptible to infection; therefore infection control is of critical importance in patient care. It is your professional duty to follow established infection-control procedures. This will promote the safety of your patients, yourself, and your coworkers.

Health care facilities that are affiliated with hospitals or government agencies are required to have policy and procedure manuals that provide protocols for many procedures discussed in this chapter. Small, private facilities may have less formal policies but should also have written protocols. It is your duty to be familiar with these protocols and to know where to find answers to questions about procedures.

As stated in Chapter 1, this text assumes that most limited operators will not be employed in hospitals and will not perform procedures involving radiographic contrast media. If your work involves hospital care or contrast procedures, a comprehensive text on patient care is recommended.

HAZARD CONTROL

Fire Prevention

The first consideration in fire safety is fire prevention, because preventing fires is obviously preferable to coping with one. An awareness of potential hazards is the first step toward prevention.

Three components must be present for a fire to burn: a flammable substance (fuel), oxygen, and heat (Fig. 21.1). Fire can be prevented by ensuring that these three elements are never in the same place at the same time. Conversely, a fire can be stopped if one of the elements can be removed from the situation. We use this principle when we fight a fire by adding water (lowering the temperature) or by smothering (removing oxygen, as when we wrap a blanket around a person whose clothing has ignited). Most accidental fires are traceable to one of four causes: (1) spontaneous combustion, (2) open flames, (3) smoking, and (4) electricity.

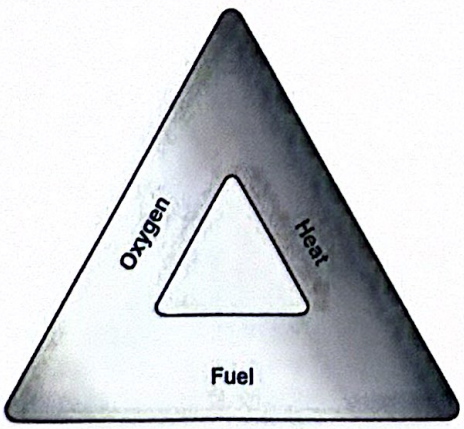

Fig. 21.1 Chemistry of fire.

Spontaneous combustion occurs when a chemical reaction in or near a flammable material causes sufficient heat to generate a fire. This is a relatively infrequent cause of fire in health care facilities because local safety regulations control the types of chemicals and cleaning products in general use. Spontaneous combustion can occur when paint products, solvents, or oily cleaning rags are stored in a closed environment or too near a heat source. Oily or paint-soaked waste should be placed in tightly covered containers outside the building. Storage areas for dangerous products must meet the safety standards of the local health department.

Open flames that burn out of control are a common source of fires in homes but are less likely to cause problems in health care facilities. Take appropriate precautions in kitchens and laboratories where open burners are used. Precautions include keeping flammable substances a safe distance from the burner, using strict standards of cleanliness in kitchen areas, and never leaving open burners untended when they are in use. Do not burn candles.

Health care providers promote positive health habits by prohibiting smoking; therefore most hospitals, clinics, and physicians' offices are designated as nonsmoking facilities. Although this prohibition has reduced the incidence of smoking-based fires, some smokers may be tempted to smoke covertly. Smoking is especially dangerous in facilities that are not equipped to accommodate smoking. Be alert for the smell of smoke. Direct smokers to the designated smoking area, which will usually be outside the building.

Limited operators use a wide variety of complex electric equipment. Do not let familiarity with electric items lull you into a false sense of security. Electric fires are potential sources of fire hazard and are of special concern in radiology departments, where there is much electric equipment. Box 21.1 lists precautions for avoiding electric hazards. Adherence to these rules greatly reduces the risk of both electric fire and electric shock. These principles apply in any area where electric equipment is used. When the building is not occupied, x-ray machines and all equipment that does not require constant power should be turned off or unplugged.

Short circuits in older x-ray control panels can generate enough heat to cause a fire. This is usually preceded by smoldering wire insulation, which causes smoke and an unpleasant odor that are readily detectable before an actual fire. If a short circuit occurs, turn off the electricity at the main power source, call for qualified assistance, and stand by with the proper fire extinguisher.

Oxygen by itself does not burn but it does support combustion. Because the presence of oxygen greatly increases the fire hazard, it is important to exercise extreme care when oxygen is being used. There should be no smoking,

Box 21.1
Electric Safety Rules

- All electric equipment and appliances must be approved for their intended use and used as intended.
- Follow equipment manufacturers' instructions.
- Equipment used on or near patients or near water must have grounded plugs.
- Inspect equipment regularly, paying attention to cords and plugs. Arrange for repairs as necessary.
- Do not overload circuits by connecting too many devices to a single outlet or outlet group.
- Unplug or turn off electric equipment before exposing internal parts.
- Do not attempt to repair equipment unless you are trained to do so.
- Do not use extension cords. If necessary, use an approved power strip that is equipped with a circuit breaker.
- In case of electric fire, use a class C or carbon dioxide fire extinguisher.

no open flames, and no ungrounded appliances near areas the area where oxygen is in use.

Preparedness

Limited operators must be familiar with the fire plan for the facility. Be sure you know the evacuation route from your area and at least one alternate route. In addition, have a general knowledge of your facility's floor plan. It is your duty to know the locations of fire extinguishers and fire alarms. Knowledge of the procedure for reporting a fire is also essential.

In the event of a fire, large facilities use a coded communication to notify the staff without alarming the patients. This is usually a code number or code name announced over the paging system: "Attention all staff, there is a code 100 in the west wing." The same code is commonly used to signal fire drills. Take advantage of fire drills and in-service classes on fire safety to gain confidence in evacuation procedures and the use of fire extinguishers. If you are ever involved in an actual fire, your preparation and self-confidence will allow you to function effectively and will reassure those around you.

In small offices or clinics there may not be a formal fire plan or fire drills. Although the potential for fire within the facility may be small, there can be risk of fire from adjacent offices or buildings. Some sort of plan is essential. Local fire departments provide safety inspections and instruction in fire safety.

According to professional fire marshals, the most frequent infractions of fire safety rules include the following:

- Blocked fire exits
- Doors blocked open
- Equipment stored in corridors
- Improper storage of flammable items
- Improper use of extension cords

Doors should never be blocked open. Closed doors help to prevent the rapid spread of fire. Wheelchairs, carts, and other equipment must be placed so as to avoid obstructing passages and doorways. Pay particular attention to passages and doors that are not often used. They may be the only safe exits in case of fire. Corridors should not be used to store equipment. If some items must be placed there temporarily, keep them all on the same side with room to pass easily. Ask yourself, "If we had to evacuate this area, would this equipment be a problem in this location?"

In Case of Fire

If you discover a fire, your primary responsibility is to evacuate everyone from the immediate area to a safe location. Second, report the fire and location, using the prescribed procedure. A small wastebasket blaze may be extinguished with a nearby pitcher of water or smothered with a pillow, but do not waste precious minutes in futile attempts. Your responsibility is the safety of patients and yourself.

An aid to help you recall the correct response in the event of a fire is the acronym RACE, which stands for rescue, alarm, contain, and extinguish/evacuate. Box 21.2 lists the steps to follow in case of fire using the RACE concept.

Box 21.2
In Case of Fire

Remain calm and remember the acronym RACE.

R—Rescue

- Remove patients from danger by moving them to a safe area. In large buildings, move patients past at least two fire doors within the facility.
- For larger fires, follow the instructions of coordinating personnel.

A—Alarm

- Activate the alarm system directly or use the established code for fire.
- Make sure that all personnel in the area are aware of the fire, being careful not to alarm patients.

C—Contain

- Close any open doors to limit the oxygen supply to the fire and to prevent the spread of smoke and heat.
- Check to make sure oxygen valves and electric circuit breakers are turned off.
- In inpatient facilities, close the doors to patient rooms. If a patient is still in a room, place the room's trash can in front of the door.

E—Extinguish/Evacuate

- For small fires, use the available fire extinguisher to put out the fire or smother the fire with a blanket.
- For larger fires, evacuate the area of all personnel and wait for fire personnel.

During *any* emergency, it is important to remain calm and use a low voice. During a fire evacuation, try to avoid using the word *fire*. Instead, you might say, "Mrs. Jensen, there is a little smoke in one of the rooms, and we are going to move you outside until we can see how serious it is."

Fire Extinguishers

Fire extinguishers are marked to indicate the class or classes of fire for which they are appropriately used. Three of the five fire classes have potential use in the health care environment.

- Class A fires involve combustibles, such as paper or wood.
- Class B fires involve flammable liquids or gases.
- Class C fires involve electric equipment or wiring.

A multipurpose dry chemical extinguisher is suitable for all three classes of fires and is the type most often found in public buildings.

Fig. 21.2 shows a close-up view of a typical fire extinguisher mechanism. To use the fire extinguisher correctly, remember the acronym **PASS:**

Pull the pin.
Aim the nozzle.
Squeeze the handle.
Sweep. Use a sweeping motion from side to side.

Do not aim the fire extinguisher steadily at the flame; a sweeping motion is more effective and covers a wider area. This decreases the likelihood that the fire will spread. Fire extinguishers have considerable force and are effective at a safe distance from the fire. Stand back so as not to endanger yourself (Fig. 21.3).

Fire extinguishers must be inspected regularly and recharged periodically. A tag attached to the unit should indicate the date of the last inspection and the last recharge. The last inspection should have been no longer than 1 year earlier. When an extinguisher has been used, it must be recharged or replaced immediately with a fresh unit.

Electric Shock

Electric shock may pose a serious hazard to both patients and personnel if safety precautions are not observed. This is especially true with x-ray equipment, which carries an electric potential in excess of 100,000 V. The hazard of lesser circuits should not be underestimated, however,

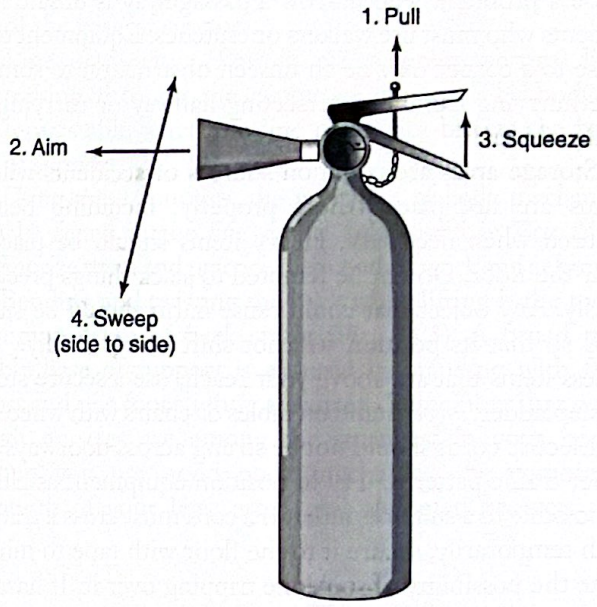

Fig. 21.2 Fire extinguisher mechanism.

Fig. 21.3 Use a fire extinguisher from a safe distance with a sweeping motion.

because shocks from standard 120-V outlets can prove fatal under certain circumstances. Basic rules of electric safety are listed in Box 21.1. Caution is especially important when one is using electricity around water. *Never stand on a wet floor or use wet hands to perform tasks involving the use of electricity.*

Falls and Collision Accidents

Reducing the risk of falls and collisions is an important safety concern. Caution is needed for the safety of both patients and personnel. Be especially conscious of hazards when wheelchairs and other mobile equipment is being used and do not store or park equipment where it might cause a problem. Too narrow a passageway is unsafe for patients who must use walkers or crutches. Equipment too close to a corner may be an unseen obstruction to someone hurrying from an intersecting hallway or carrying a bulky object.

Storage areas are common sources of accidents when items are not placed there properly, including being secured when necessary. Heavy items should be placed near the floor. Do not be tempted to stack things precariously. Any object that could cause harm should be situated so that its position will not shift unexpectedly. To access items that are above your reach, use a secure stool or stepladder. *Never* stand on tables or chairs with wheels.

Electric cords should not be strung across doorways or other traffic patterns. Try to position equipment as close as possible to a suitable outlet. If a cord must cross a traffic path temporarily, secure it to the floor with tape to minimize the possibility of someone tripping over it. If hazardous, makeshift electric connections are a common problem, discuss this with your supervisor or employer and suggest a safe, permanent remedy.

Spills

Spills deserve special attention. Depending on the nature of the substance, spills may pose a chemical hazard in addition to a risk of injury from falls. Familiar substances such as household bleach can cause eye damage or skin injury.

Hazardous liquids should be converted into solid waste and placed in plastic bags for removal. An absorbent material in the form of clay pellets (cat litter) or an absorbent mat is used to soak up the liquid before it is placed in a suitable plastic container. Your work area should have a spill kit that includes absorbent material and heavy plastic bags. If pellets are used, a broom and dustpan should be included. You can assemble your own spill kit or choose a suitable kit from the many that are commercially available. You will also need personal protective equipment. Nitrile gloves are special gloves that are impervious to most chemicals and are recommended for contact with many types of hazardous chemicals, including concentrated processing chemicals. Protective aprons and eye protection in the form of splash-proof goggles or face shields should be available.

The Occupational Safety and Health Administration (OSHA), a federal agency governing safety in the workplace, requires that all chemicals be properly labeled and that material safety data sheets (MSDSs) for all hazardous materials be on file and easily accessible to personnel. The MSDS for any chemical will spell out the required equipment and procedure for safe handling in the event of a spill. The developer and fixer solutions used to process radiographs are classified by OSHA as hazardous materials. OSHA requires that personnel wear protective aprons, splash-proof goggles, and nitrile gloves when pouring or cleaning up film processing solutions.

Appropriate cleaning measures are needed to avoid potentially serious problems whenever a spill involves a hazardous material.

The following steps will help to ensure safety when a spill occurs:

- Limit access to the area.
- Evaluate the risks involved.
- Obtain both the information and the equipment to clean up the spill safely.
- Clean up the spill.
- If you lack the necessary skill or equipment, call your supervisor.

WORKPLACE SAFETY

Ergonomics

Ergonomics is the study of the human body in relation to the working environment. Ergonomic awareness and education in the workplace have reduced job injuries in recent years, but there is still cause for concern. The US Bureau of Labor Statistics reports that workplace injury rates for health care workers are similar to those for industrial workers. The most common injuries reported by health care workers are musculoskeletal disorders (MSDs). Subcategories of MSDs as classified by OSHA include repetitive motion injuries, repetitive strain injuries, and cumulative trauma disorders (CTDs). Repetitive motion injuries and repetitive strain injuries, as their names suggest, are the result of performing repeated motions or applying pressure extensively. Stress caused by performing repetitive motion, overreaching, or maintaining the same positions for long periods causes microtrauma to muscle tissue. This microtrauma is the basis of CTDs, which may produce chronic discomfort and lead to more significant musculoskeletal injury. The symptoms of CTDs include pain, numbness, tingling sensations, clumsiness, swelling (especially in the hand and wrist), weakness, loss of function, and overdevelopment of muscle groups.

Each year thousands of health care workers suffer occupational illness or injury, causing them to miss work. All health care workers are at risk for MSDs caused by back strain from lifting and moving patients and equipment.

In addition, radiographers often experience neck and shoulder strains and rotator cuff tears from reaching overhead to move the x-ray tube. Workers who use computers extensively are more likely to experience spinal stress from sitting at a console for long periods and repetitive strain injury from intensive keyboard work. Keyboard stress can affect the hands and wrists with CTDs such as tendinitis, ganglion cyst, and carpal tunnel syndrome. Those whose work involves extended periods of viewing cathode ray tube monitors are also subject to vision problems.

Work injury is minimized when proper equipment is available and used correctly and when workers help one another. Frequent break periods and changes in position help to minimize both positional and repetitive stress. Studies indicate that ongoing education programs and appropriate responses by employers to the ergonomic concerns of their workers are effective strategies.

Body Mechanics

The principles of proper body alignment, movement, and balance are referred to as *body mechanics*. The application of these principles minimizes the energy required to sit, stand, and walk. Your effective strength is increased when you use these principles to perform tasks that require stooping, lifting, pushing, pulling, and carrying.

Applied body mechanics also prevent muscle and back strain. Such strains are a common problem among health care workers, causing much discomfort and reduced efficiency. When you injure yourself on the job, you place a greater burden on your coworkers. If you injure yourself while you are assisting a patient, you may injure the patient as well.

The three following concepts are essential to understanding the principles of body mechanics (Fig. 21.4):

1. Base of support—This is the portion of the body that is in contact with the floor or other horizontal surface. A broad base of support provides stability for body position and movement.
2. Center of gravity, or center of body weight—This is the point around which body weight is balanced. It is usually located in the midportion of the pelvis or lower abdomen, but the location may vary somewhat depending on body build. The body is most stable when the center of gravity is nearest the center of the base of support.
3. Line of gravity—This is an imaginary vertical line passing through the center of gravity. The body is most stable when the line of gravity bisects the base of support.

Using these concepts, the principles of body mechanics can be stated in the five simple rules listed in Box 21.3. Memorize them and practice them both at work and at home.

Bending and twisting the back while lifting is the most common cause of back strain (Fig. 21.5). A broad and stable base of support is ensured by standing with feet apart and one foot slightly advanced. Remember that your thigh muscles are among the strongest in your body. When you use good body mechanics, the combined strength of your legs, arms, and abdomen protects the

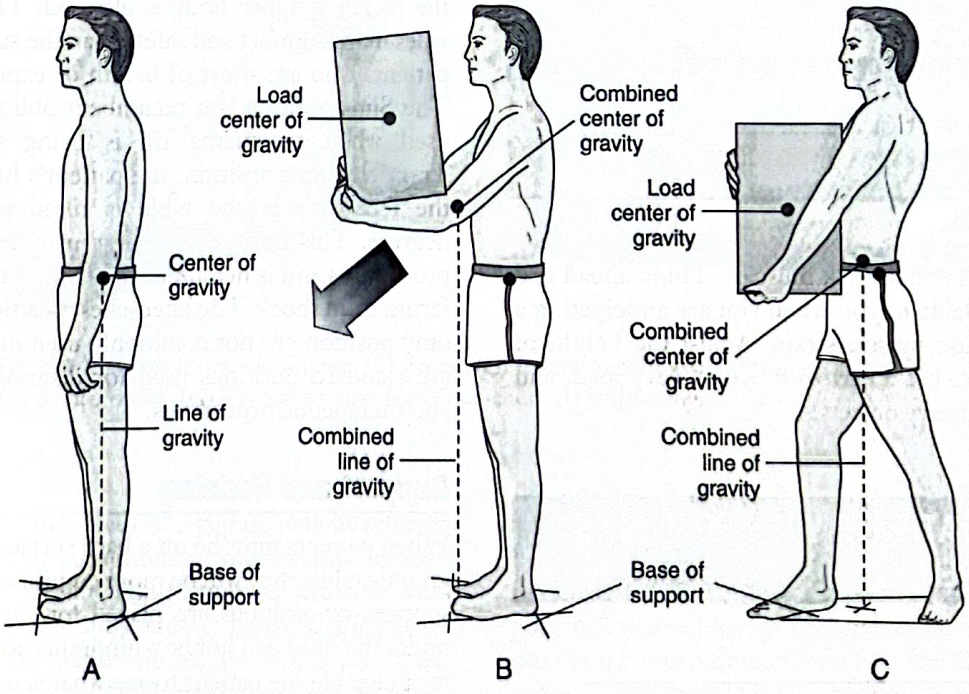

Fig. 21.4 Body mechanics. (A) With good posture, the line of gravity bisects the base of support. (B) When the load is held away from the body, the line of gravity does not bisect the base of support. (C) A wide stance with the load held close to the body allows the combined line of gravity to bisect the base of support.

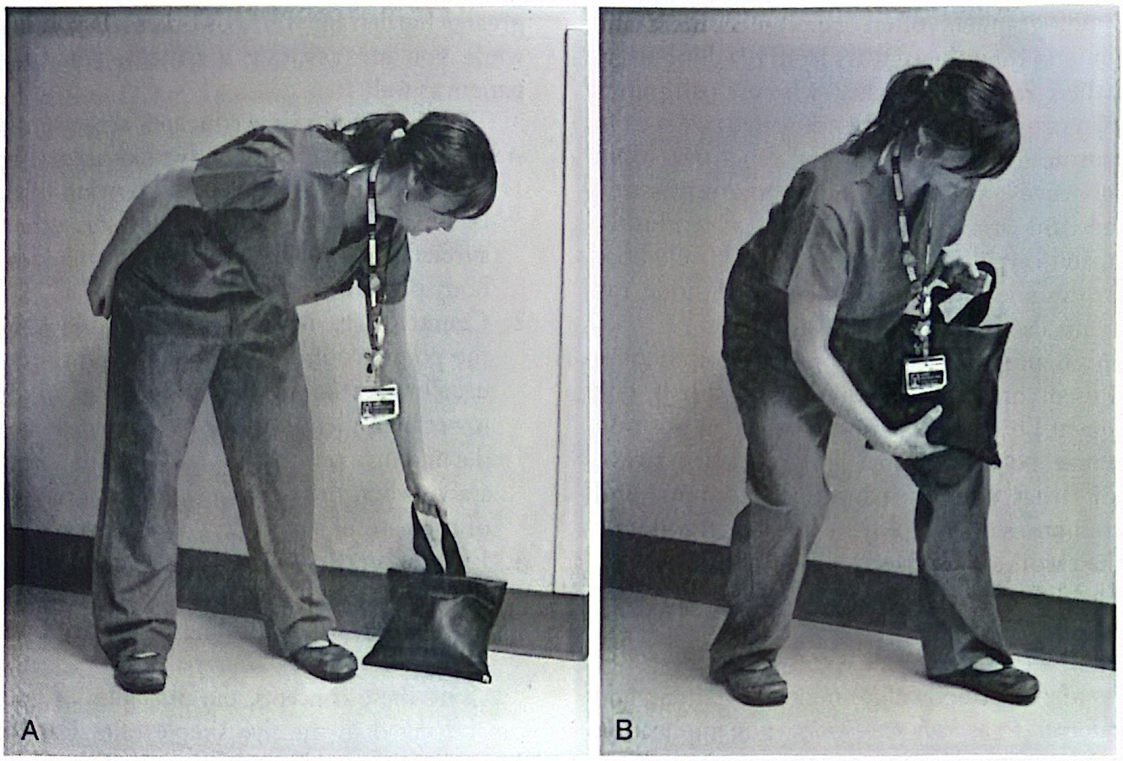

Fig. 21.5 Good body mechanics helps avoid fatigue and prevent back strain. (A) Wrong; back is bent and twisted. (B) Right; knees are flexed and back is straight.

Box 21.3

Rules of Body Mechanics

1. Provide a broad base of support.
2. Work at a comfortable height.
3. When you are lifting, bend your knees and keep your back straight.
4. Keep your load well balanced and close to your body.
5. Roll or push a heavy object. Avoid pulling or lifting.

shorter, more vulnerable back muscles. Think ahead and use the tools available to you when you are anticipating a task that may cause muscle strain. Adjust the height of your work surface, use a cart to move a heavy load, and obtain help to lift heavy objects.

ASSISTING PATIENTS WITH POSITIONS AND MOVEMENTS

Body Positions

Common body positions have names, and it is easier to communicate and follow physicians' orders if you understand these terms. You are already familiar with the terms for body positions used in radiographic positioning, such as *recumbent*, *supine*, and *prone* (see Chapter 12). In addition, certain specific positions are most commonly associated with patient care situations (Fig. 21.6). The Fowler position is a modification of the supine position in which the patient's upper body is elevated. This position provides more comfort and safety than the supine position for patients who are short of breath or experiencing nausea. The Sims position is a recumbent oblique position. It is used when an enema tip is being inserted. In the Trendelenburg position, the patient's head is lower than the feet; usually the table is tilted approximately 15 degrees. This position is used during some fluoroscopic procedures and is helpful in the treatment of patients suffering from shock. The knee-chest position and the lithotomy position are not commonly used in radiography but are standard positions used for diagnostic examinations and therapeutic procedures.

Support and Padding

When patients must lie on a hard surface, such as a radiographic table, they will be more comfortable if radiolucent sponges or cushions are placed for support. If a pillow under the head will not be a hindrance to the examination, it can enable the patient to see what is occurring and thus help to relieve apprehension. Elevation of the patient's head also relieves neck strain, allows easier breathing, and helps avoid the uncomfortable sensation that the head is lower than the feet.

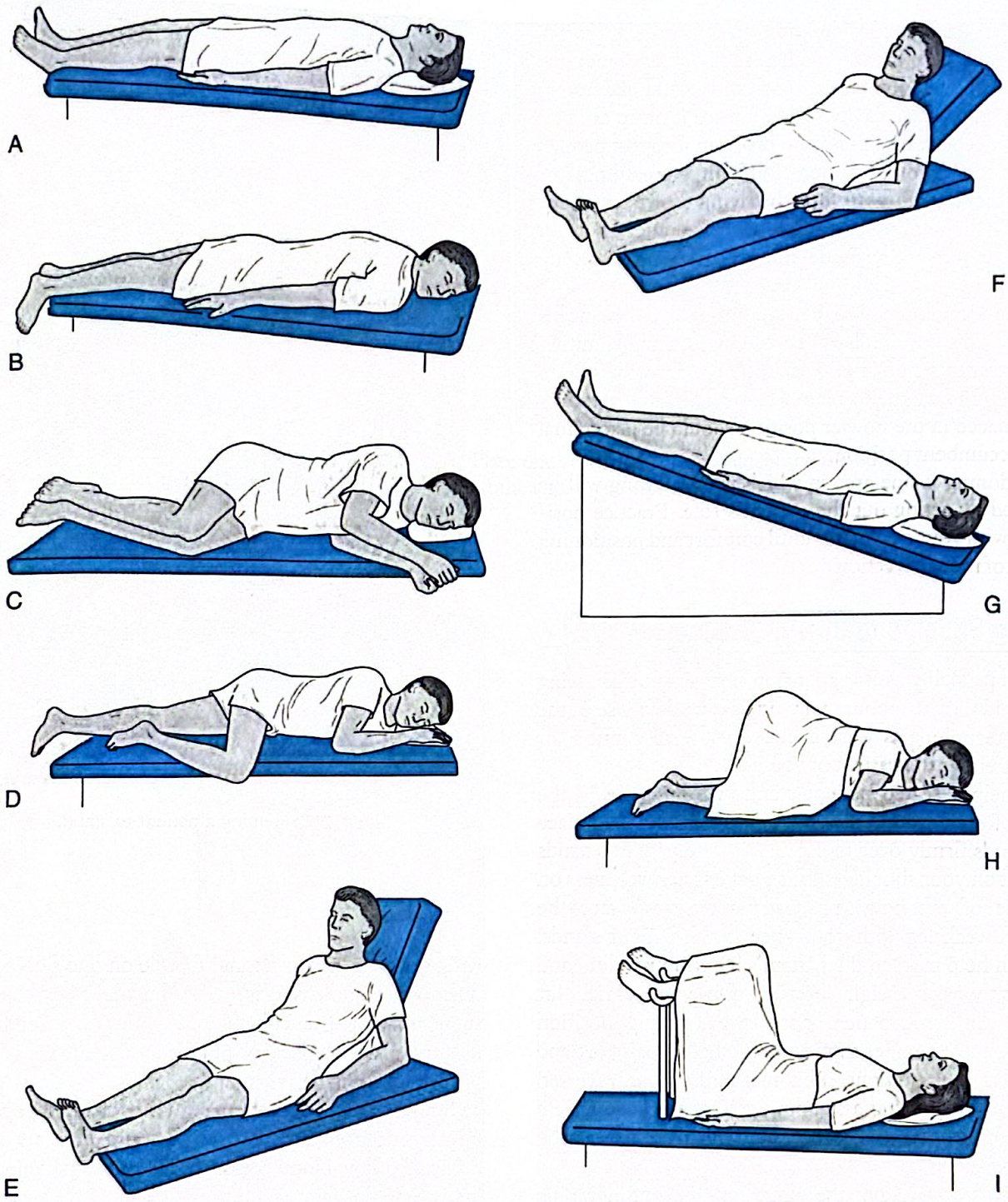

Fig. 21.6 Body positions. (A) Supine. (B) Prone. (C) Lateral recumbent. (D) Sims. (E) Fowler. (F) Semi-Fowler. (G) Trendelenburg. (H) Knee-chest. (I) Lithotomy.

A support under the knees of a supine patient relieves lumbosacral stress by straightening the lordotic lumbar curve. This is especially comforting to arthritic and kyphotic patients and to most elderly persons. It is essential for patients with spine injuries and those who have recently undergone spinal or abdominal surgery. Patients with abdominal pain must have the head elevated and a support under the knees to relieve strain on the abdomen.

Placement of padding under bony prominences—such as the sacrum, heels, and midthoracic curvature—can be important for many patients. One reason is that when patients are reasonably comfortable, they are better able to remain still, even on a hard surface, and to maintain the positions needed for an effective examination. The measures used to promote comfort are frequently the same as those that prevent complications. For example, as explained in Chapter 18, older or debilitated patients may develop pressure (decubitus) ulcers over prominent bony structures when pressure is exerted for even a short period of time.

Another safety consideration in positioning is the patient's ability to breathe. When the body is supine, the weight of the abdominal contents pushes the diaphragm up into the thoracic cavity, which makes it more difficult to take a deep breath. This is no problem for most people, but patients with **dyspnea** (difficulty breathing) or **orthopnea** (inability to breathe lying down) may be unable to lie supine. A patient who becomes short of breath when placed supine must be helped to sit up immediately.

Patients who are nauseated must also have their heads elevated. This position helps control nausea and vomiting and decreases the possibility that the patient will aspirate **emesis** (vomit). Patients who become nauseated and cannot be placed in the Fowler position should be placed in a lateral recumbent position.

Positioning is one area in which your learning will be enhanced by acting out the patient's role. Practice positioning with your classmates until comfort and positioning are part of the same action.

Helping Patients to Change Position

You will probably assist patients in sitting, standing, lying down, and moving about many times each day. Use of the correct technique is least likely to cause discomfort or injury to either the patient or yourself.

To help a seated patient stand up, stand facing the patient. Reach around the patient's upper body and place your hands firmly over the scapulae. The patient's hands may rest on your shoulders. If the patient has weakness on one side of the body, position yourself to brace the patient's weak leg with your knee as the patient stands. This will help to keep the patient's leg from bending and giving way with weight bearing. On your signal, lift upward while the patient rises to a standing position (Fig. 21.7). Remember to use a broad base of support and keep your back straight. This method may be reversed when you are helping a standing patient to sit down. Be certain that the seat is secure and will not move as the patient sits.

Patients seated on the edge of the radiographic table often find it easier to lie down with some help. Place one arm under the knees and the other around the patient's shoulders. Lift the legs as you pivot the patient and rest the legs on the table (Fig. 21.8). At the same time, ease the shoulders down so that the patient is supine. This method is reversed when a supine patient is being helped to sit up. It is much easier to sit up when the legs have been lowered somewhat than when they are extended on the table.

Patients suffering from recent back injuries and those recovering from spinal surgery will find it difficult to lie down and sit up. Moving from a supine position to a sitting position or from sitting to supine places considerable stress on the spine. It is preferable for these patients to sit from the lateral recumbent position. When the patient is lying down, he or she should first lie on one side and then turn to the supine position with the knees flexed. Provide support and assistance while the patient is extending the legs and place a bolster or pillow under the knees for support when the patient is supine.

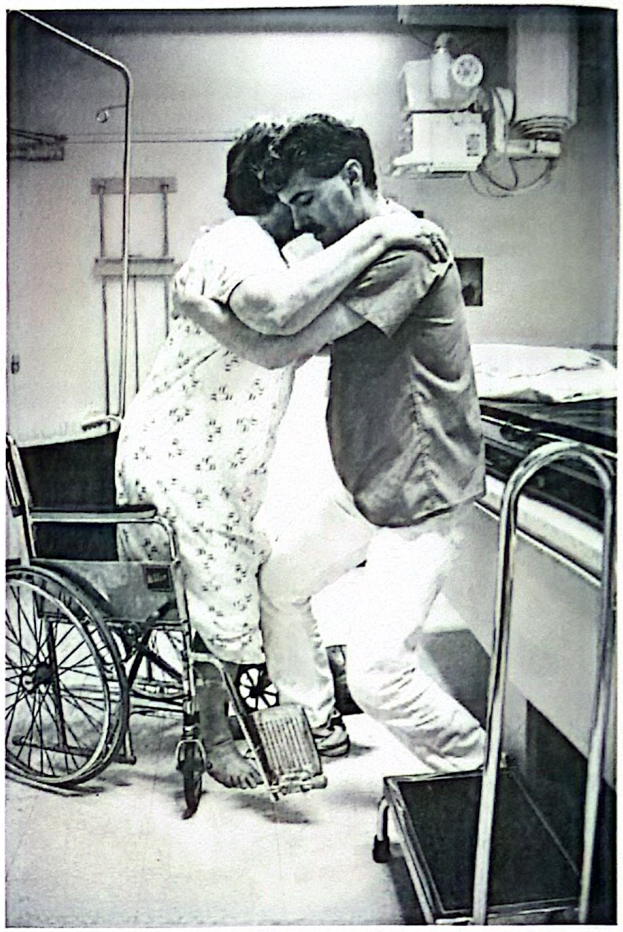

Fig. 21.7 Helping a patient to stand.

Some patients experience **orthostatic hypotension** upon rising from a recumbent position. This is a temporary state of low blood pressure that causes patients to feel lightheaded or faint when they first sit up. A pause before helping such patients to stand will give them an opportunity to regain their sense of balance.

Helping Patients to Move About

Some patients who are weak or cannot bear their full weight easily on both legs may use a cane or a walker for support to move about. A walker is a lightweight metal frame with four legs and bars at the front and sides on which the patient may lean for support (Fig. 21.9). The patient moves the walker ahead before taking each step. Patients with ample strength who cannot bear weight on one leg will usually walk with crutches (Fig. 21.10). Patients who are accustomed to using crutches or a walker do not need other assistance to walk. Your responsibility is

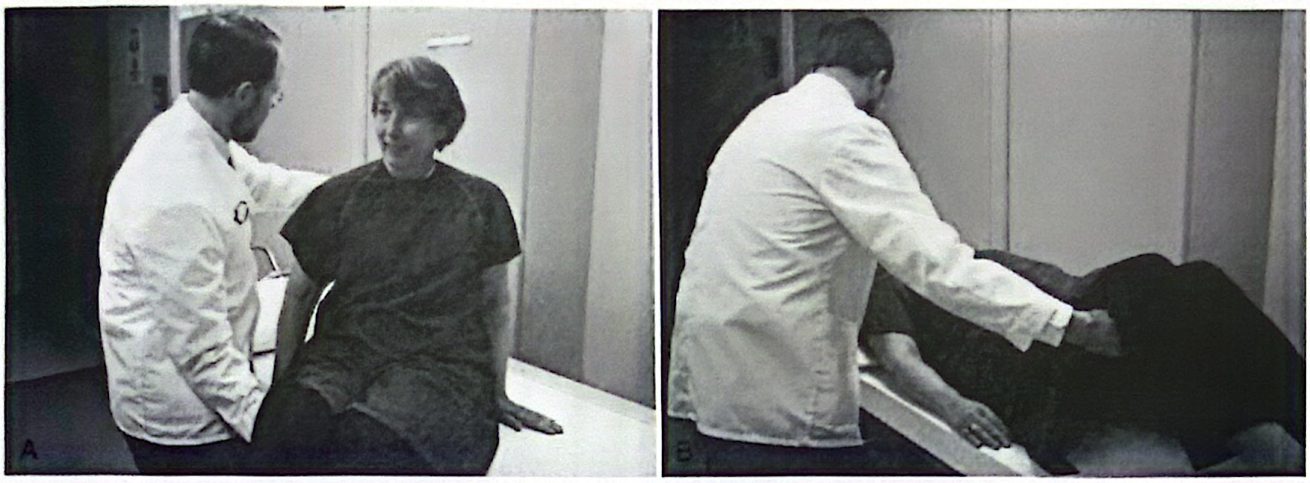

Fig. 21.8 Helping a patient to lie down. (A) Place one arm around the shoulders and the other under the knees. (B) Pivot the patient and lift the legs as you ease the upper body to a supine position.

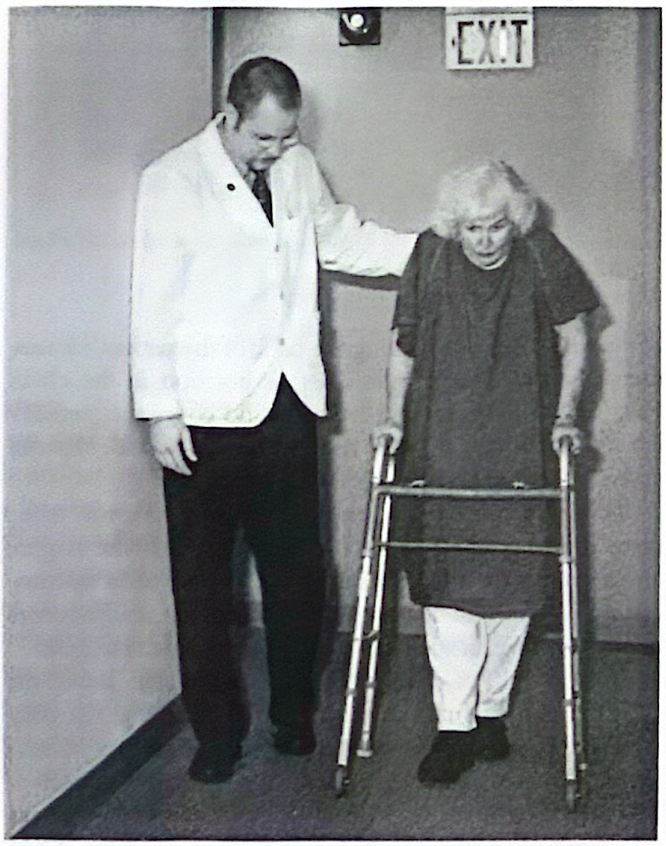

Fig. 21.9 Patient using a walker.

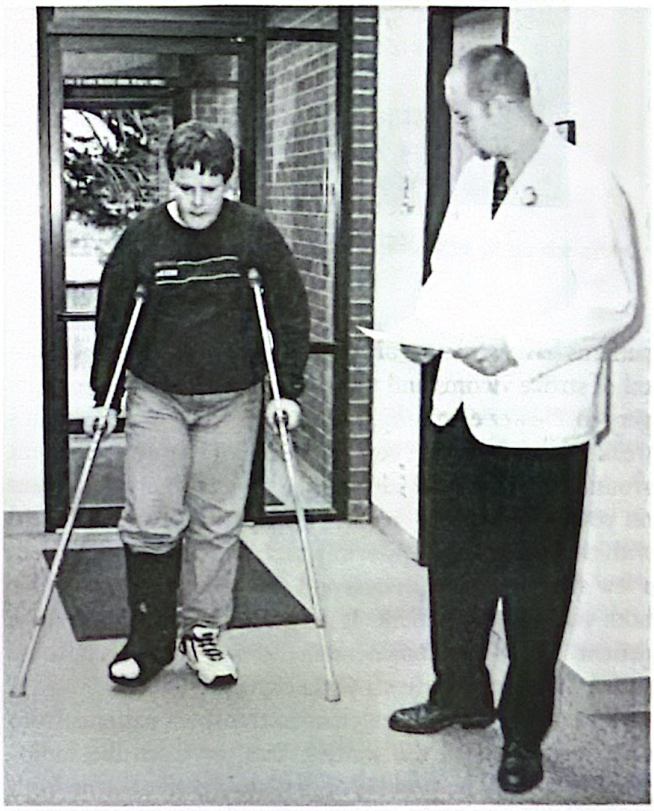

Fig. 21.10 Patients competent with crutches do not require assistance to walk.

to show them the way and to make sure that there are no obstacles in the path.

A gait belt, also called a *transfer or walking belt*, should be used when patients who are weak or unsteady are being helped. They should not be used for patients who cannot bear any weight on their legs. These belts are heavy fabric straps with strong buckles. When placed snugly around the patient's waist, the belt provides a secure handhold for you to use in helping the patient to stand and walk.

Patients who cannot walk alone and who do not use a walker or crutches will need physical support to walk. Some

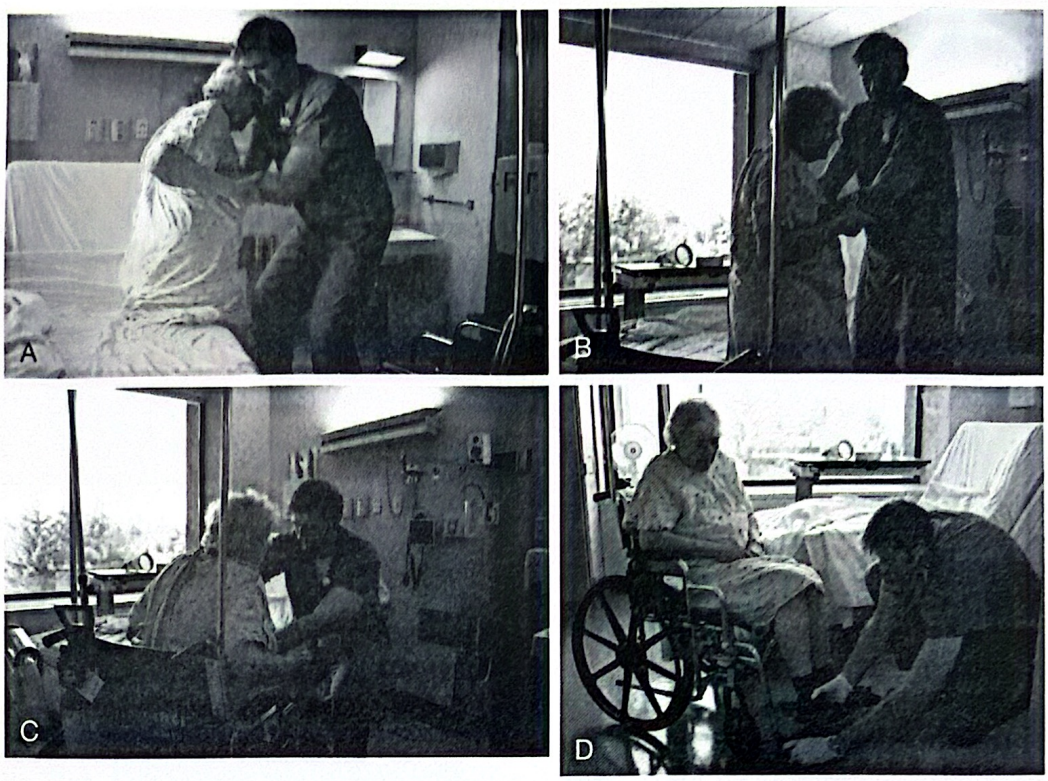

Fig. 21.11 Helping a patient into a wheelchair. Lock the wheels and move leg rests and footrests out of the way. (A) Use the face-to-face assist to help raise a weak patient to a standing position. (B) Help the patient to pivot with his or her back to the wheelchair. (C) Ease the patient to a sitting position. (D) Adjust the leg rests and footrests and cover the patient's lap and legs.

patients have weakness of one side of the body. This is typical of stroke victims and those who have had injury or surgery to a lower extremity. Determine which is the patient's weak side and position yourself next to it. Grasp the patient around the waist or by the gait belt while the patient leans on your shoulder for support. Instruct the patient to lead with the strong leg. Supporting such patients for more than a few steps is a slow process and will be uncomfortable for both you and the patient. It may also be hazardous to the patient. When any considerable distance is involved, these patients should be moved by wheelchair.

You may use the wheelchair to transport patients from cars, from seats in the waiting area, or from the radiographic table. The process of helping a patient to or from a wheelchair may seem elementary, but it is a common cause of falls and accidents. The correct technique makes this procedure safer and easier. This procedure is illustrated in Fig. 21.11. Start with the patient seated. Position the wheelchair beside the patient with wheels locked and footrests out of the way. At this point, competent patients are able to stand and move to the wheelchair with little assistance, although a steadying hand at the patient's elbow is a good practice. Weak patients may need assistance to stand, as described earlier.

With the patient standing next to the wheelchair, instruct and assist the patient to pivot a quarter turn so that the edge of the wheelchair is touching the back of the patient's knees; then ease the patient into a sitting position in the chair. Position the footrests and leg rests and cover the patient's lap and legs with a sheet or bath blanket to provide warmth and comfort and protect the patient's modesty.

To move the patient from wheelchair to x-ray table, place the wheelchair parallel to the table, lock the brakes, and move the footrests out of the way. At this point the procedure will vary depending on whether you are fortunate enough to have an x-ray table that is adjustable in height.

If the height of the x-ray table is adjustable, lower the table to chair height. In this instance the transfer to the x-ray table is the same as the transfer into the wheelchair. Using the face-to-face assistance explained in the previous section Helping Patients to Change Positions, help the patient to stand and pivot with the patient's back to the table. Then ease the patient into a sitting position on the edge of the table.

If the table height is stationary, position a step stool with a tall handle nearby. Have the patient place one hand on the stool handle, put one arm on your shoulder, and step up onto the stool, pivoting with his or her back to the table. Now ease the patient to a sitting position. This procedure is illustrated in Fig. 21.12.

Once the patient has been seated on the table, place one arm around the patient's shoulders and one under the

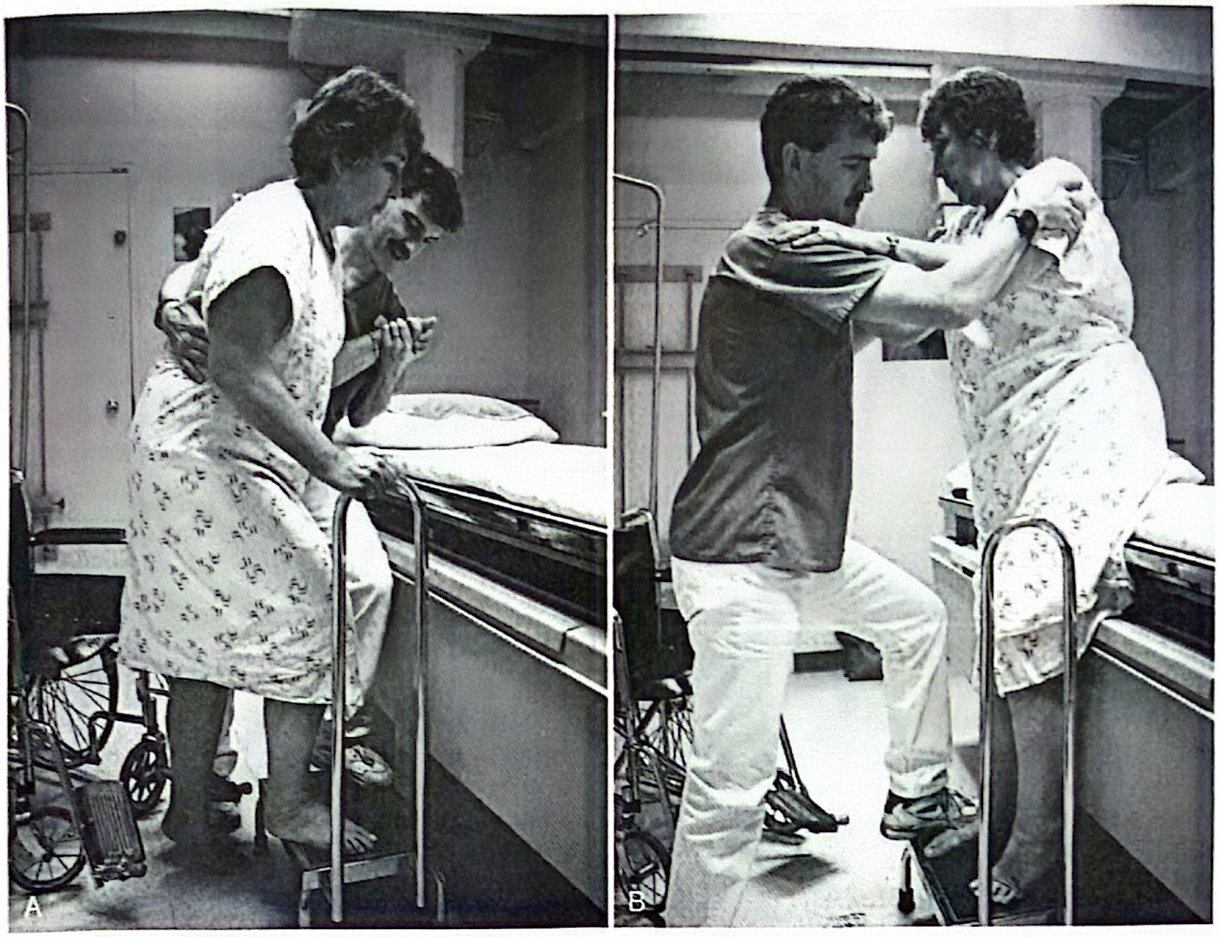

Fig. 21.12 Helping a patient onto an x-ray table. (A) Provide a step stool, if necessary. (B) Assist patient to pivot and sit on the table.

knees. With a single smooth motion, place the patient's legs on the table while lowering the head and shoulders into the supine position (see Fig. 21.8). Patients with back pain may want to lie down on one side before moving into the supine position.

The most common type of fall associated with wheelchair transfer occurs when the patient backs into the wheelchair to sit down. The patient may miss the edge of the seat or tip the chair by sitting too near the edge. To avoid such an accident, be sure to lock the wheels of the chair and help the patient until he or she is seated securely.

If the patient is paralyzed or unable to stand for any reason, a two- or three-person lift from the wheelchair is required unless a hydraulic lift is available. Never hesitate to ask for assistance when you are not sure that you will be able to handle the patient safely. Do not attempt to use a hydraulic lift unless you have been trained to use it safely.

Lifting Patients from Wheelchairs

Patients who are unable to stand may sometimes arrive in wheelchairs. Depending on the design of the chair and the requirements of the procedure, extremity and chest radiography may be performed with the patient seated in the wheelchair. However, many procedures will require that the patient sit or lie on the radiographic table. A hydraulic lift, if available, is definitely the best method to use (Fig. 21.13), but do not attempt to use it until you have been properly instructed. There may be a trained team that may be called in for assistance with the hydraulic lift. When a patient must be lifted from a wheelchair and no mechanical lift is available, a two- or three-person lift is used.

If the patient is not too heavy, two people can lift the patient from the wheelchair to the table (Fig. 21.14). The stronger of the two is the primary lifter and the second person assists. First, place the wheelchair parallel to the table and lock the wheels. Remove the chair arm that is nearest the table if possible. Instruct the patient to cross both arms over the chest. The primary lifter then stands behind the chair and reaches around the patient, extending his or her arms through the patient's axillae and grasping the patient's forearms from the top. The assistant kneels on one knee near the patient's feet and cradles the patient's thighs in one arm and lower legs in the other. On signal, both lift together and place the patient gently on the table.

Fig. 21.13 Hydraulic lift. (A) Seat portion of lift is fastened around patient and patient is lifted from the wheelchair. (B) Lift arm raises patient, rotates to position patient over table, and is lowered again to ease patient into position on the table.

The three-person lift is similar to the two-person lift and is safer if the patient's weight is beyond the ability of two people to lift easily (Fig. 21.15). In this case, remove both arms of the wheelchair and position the first two lifters as for the two-person lift. The third person kneels on one knee at the side of the chair that is farthest from the table. The third lifter places one arm around the patient's waist and the other under the buttocks. All lift together on signal. The role of the third lifter is primarily to assist in raising the patient from the chair. The wheelchair will block any forward motion of the third lifter, so the first two lifters will complete the transfer.

IMMOBILIZATION

Several methods can be used to aid in the immobilization of adults who have difficulty holding still in the desired position. When tremors such as those associated with Parkinson disease complicate the procedure, it is useful to

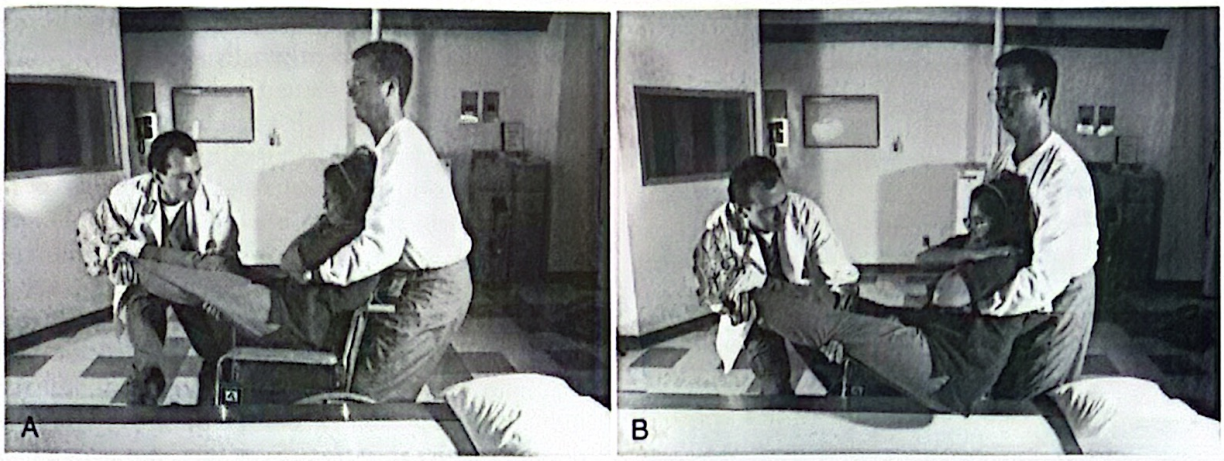

Fig. 21.14 Two-person lift. (A) Primary lifter stands behind the chair and reaches around the patient, extending his or her arms through the patient's axillae and grasping his or her arms from the top. The assistant kneels on one knee, cradling the patient's thighs and legs. (B) On signal, both lift together and place the patient gently on the table.

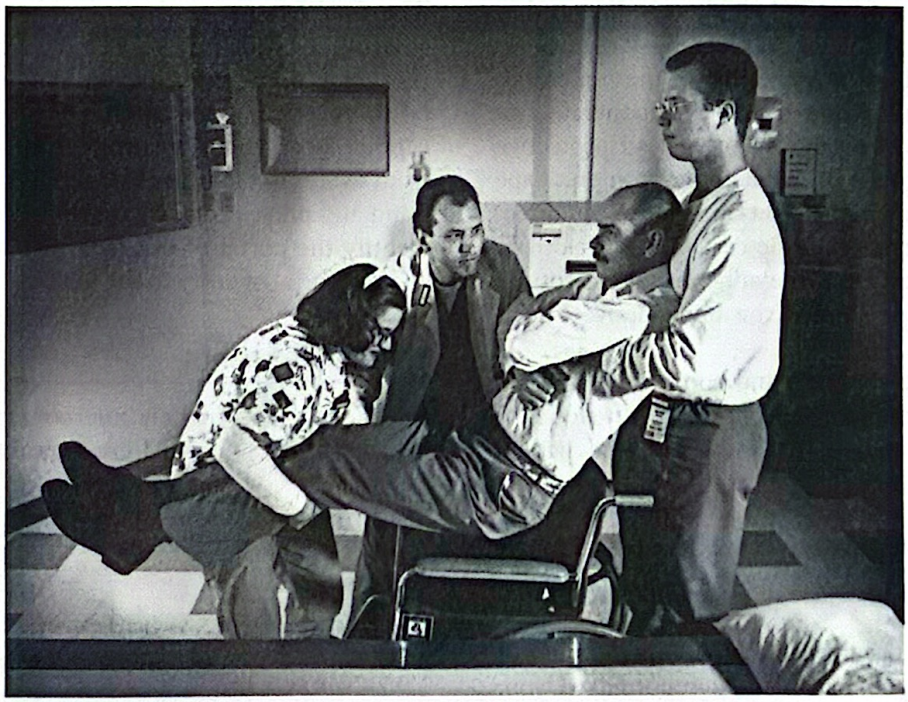

Fig. 21.15 The three-person lift is much like the two-person lift, with the third person helping to raise the patient's hips until they are clear of the chair.

support the patient as comfortably as possible. A sandbag placed across an extremity proximal to the area of interest will stabilize the part during radiography. The use of sandbags to immobilize trembling extremities can help to minimize motion even when the area of interest does not involve the extremity.

Safety straps or compression bands may be used on the x-ray table for stabilization during radiography or during waiting periods as a precaution against falling (Fig. 21.16). Patients whose motion is restricted by safety devices must be monitored carefully. *A patient who is unable to change position should never be left unattended.* Difficulty breathing or the need to cough or vomit may require an immediate positional change. The patient's inability to respond to this need may pose a serious hazard. If you must leave the room, another qualified person must be assigned to attend the patient.

The application of physical restraints to the arms, legs, or chest of an adult patient without the patient's consent

Fig. 21.16 Table restraint provides stabilization and security during radiography.

requires a physician's order. Liability for a charge of false imprisonment may result from the unauthorized use of restraints.

Immobilization of infants and children is discussed in Chapter 18. Immobilization for radiography does not constitute restraint in a legal sense. Some of these methods may be applied to adults who are unable to cooperate. For example, the weight of a sandbag or of lead protective devices can be used to aid in maintaining position. Tape can also be used to maintain a position if it is not in direct contact with the patient's skin. Be certain that a cloth or tissue protects the skin from the adhesive surface of the tape, or twist the tape so that the nonadhesive side is against the skin.

When patients are coherent and cooperative and are neither sedated nor in distress, they may be left alone for brief periods. If delays occur, check with the patient frequently.

ACCIDENTS AND INCIDENT REPORTS

Any fall, accident, or occurrence that results in injury or potential harm must be immediately reported to your supervisor and/or your employer. As soon as the victim has been properly attended to, an incident report, sometimes called an *unusual occurrence form*, must be completed. The reporting of incidents is essential, whether the victim is a patient, a visitor, or a member of the staff. Do not hesitate to report incidents in which you are injured even though the injury may seem minor at the time.

Incident reports are crucial to risk management. They aid in establishing or limiting liability for any injury and in documenting the need for changes that may improve safety practices in the future. Occasionally a very minor incident may result in no harm and may not seem to require the formal procedure of an incident report. It is always a good idea to keep a record of *any* unusual occurrence in case it should later turn out to be of greater consequence than was originally apparent. Making a note of such events in the patient's chart or on the requisition form provides a record that can be important if questions or consequences develop regarding the event.

The decision as to whether a particular occurrence merits an incident report is a judgment call. For example, a simple sneeze should not prompt an incident report, but a severe asthmatic attack is a reportable occurrence. A very mild asthmatic episode that is successfully self-treated by an outpatient with the patient's own medication is an example of a situation in which judgment will vary with individuals. The ability to make these kinds of judgments develops with experience. Seek the counsel of a supervisor when such questions arise; when in doubt, err on the side of caution by filing a report.

INFECTION CONTROL

Cycle of Infection

The four factors involved in the spread of disease are sometimes collectively called the *cycle of infection* (Fig. 21.17). For infections to be transmitted, there must be an infectious organism, a reservoir of infection, a susceptible host, and a means of transporting the organism from the reservoir to the susceptible individual. To understand and prevent disease transmission, it is useful also to identify the portal of exit from the reservoir of infection and the portal of entry to the host.

Infectious Agents

Infectious agents include microorganisms and infectious proteins called prions. **Microorganisms** or **microbes** are

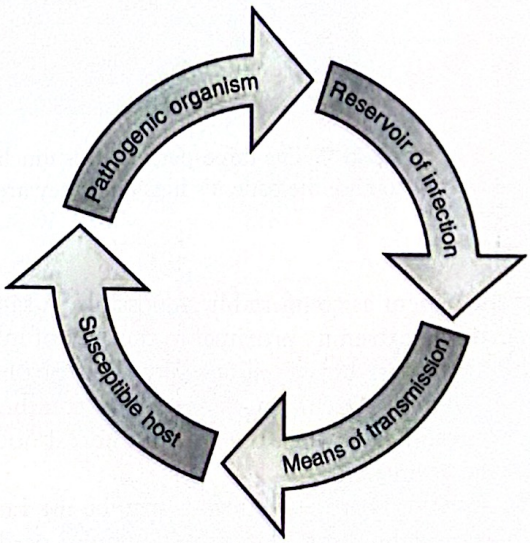

Fig. 21.17 Cycle of infection.

Fig. 21.18 Photomicrograph of a bacterium. Note the absence of a nuclear membrane.

referred to in lay terms as *germs*. They are living organisms too small to be seen with the naked eye and include bacteria, viruses, protozoa, and fungi. Most microorganisms do not cause disease, and many are essential to our continued well-being. Some microorganisms live on or within the body without causing disease and are referred to as **normal flora**. They aid in skin preservation and digestion and protect us from infection. Microorganisms that cause disease are called **pathogens**. Normal flora may also be pathogenic when they are not confined to their usual environment. For example, *Candida albicans* may be found in the throats or gastrointestinal tracts of most healthy individuals, but they can cause urinary tract or vaginal infections in females and sometimes cause respiratory disease in infants or in adults with compromised immune systems. Prions are infectious protein particles that are not living organisms; they are similar to microorganisms in that they can cause disease and can replicate within the human body.

Bacteria

Bacteria are very small single-cell organisms with a cell wall and an atypical nucleus that lacks a membrane (Fig. 21.18). Bacteria grow independently and do not need a host cell to reproduce. They are classified according to shape. Most bacteria have one of three distinct shapes: spherical bacteria are called *cocci;* rod-shaped bacteria are called *bacilli;* and spiral-shaped bacteria are called either *spirilla* or *spirochetes* (Fig. 21.19).

Bacteria are able to adapt to new conditions and also to mutate, which allows them to resist antimicrobial drugs and survive in their presence. Some types of bacteria have

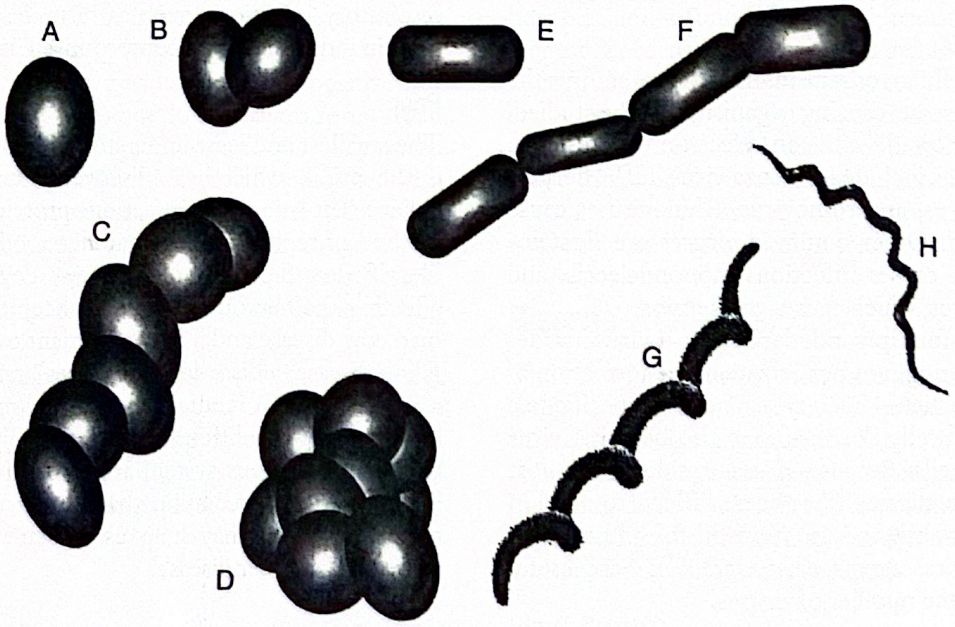

Fig. 21.19 Bacterial forms. Cocci: (A) Single coccus. (B) Diplococcus. (C) Chain formation *(Streptococcus)*. (D) Cluster *(Staphylococcus)*. Bacilli: (E) Single bacillus. (F) Chain. Spiral bacteria: (G) Spirillum. (H) Spirochete.

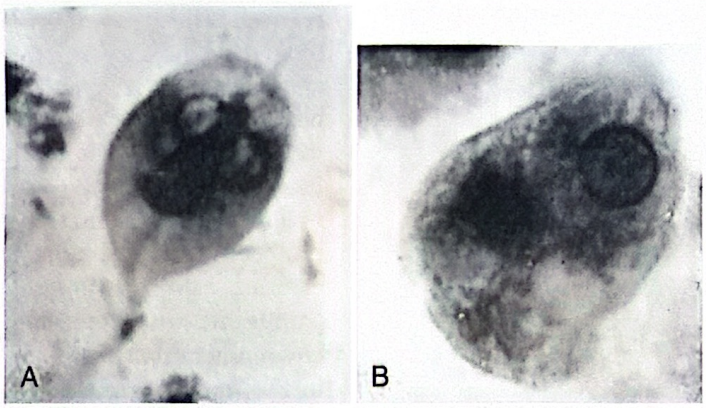

Fig. 21.20 Photomicrographs of protozoa. (A) *Giardia lamblia*, a flagellate. (B) *Entamoeba histolytica*, an ameba.

the ability to generate **endospores**, which are formed within the cell when environmental conditions are unfavorable. This bacterial form is resistant to heat, cold, and drying and can live without nourishment. Most endospore-forming bacteria live in the soil, but they can reside almost anywhere. When conditions are favorable, endospores germinate, revitalizing the bacteria. Endospore-forming organisms are responsible for tetanus, anthrax, and gas gangrene. These diseases are serious but also relatively uncommon. However, one of these organisms, *Clostridium difficile*, or "*C. diff*," is becoming more prevalent as a cause of a nosocomial infection that results in severe, difficult-to-treat diarrhea.

Significant diseases caused by bacteria include tuberculosis (TB) and streptococcal pharyngitis (strep throat) as well as infectious diarrhea and a kidney disease caused by a particular strain of *Escherichia coli* (*E. coli* 0157:H7).

Viruses

Viruses are subcellular organisms. They are among the smallest known disease-causing organisms. To be studied, they must be viewed with an electron microscope. Examples of viruses include influenza virus, HIV, herpesvirus, hepatitis virus, and rhinovirus. Rhinoviruses cause the common cold. Other common viruses are Epstein-Barr virus, which causes infectious mononucleosis, and varicella zoster virus, which causes chickenpox.

Viruses cannot multiply independently. A virus invades a host cell, stimulating it to participate in the formation of additional virus particles. Each type of virus is specific to a particular type of cell. For example, the hepatitis virus attaches to liver cells. Because viruses reside in the host cell and use it to replicate, it has been difficult to develop antiviral drugs that are not also harmful to the host cell. Only a few antiviral agents exist, and these are useful against only a limited number of viruses.

Protozoa

Protozoa are complex single-cell animals that generally exist as free-living organisms (Fig. 21.20). A few, however, are parasitic and live within the human body. Most parasitic protozoa produce some type of resistant form, such as a cyst, to survive in the environment outside the host. Other protozoa have complicated life cycles involving alternate existence in the human body and in insects. This is true of the protozoan that causes malaria. Protozoa can infect the gastrointestinal, genitourinary, respiratory, and circulatory systems.

Fungi

Fungi (singular, *fungus*) occur as single-celled yeasts or as filament-like structures called *molds* that are composed of many cells (Fig. 21.21). There are more than 100,000 diverse species of fungi, and many are useful. They aid in the production of alcoholic beverages, are responsible for the flavors of cheeses, give bread its lightness, and produce the antibiotic penicillin. In humans, fungi can cause skin infections such as athlete's foot and ringworm; respiratory infections, such as histoplasmosis; and infections in individuals with compromised immune systems.

Prions

The smallest and least understood of all infectious agents is the prion, which was discovered in 1983. Scientists believe that prions are infectious protein particles. Their method of replication is not understood. They were first identified as the cause of scrapie, a degenerative disease affecting the nervous systems of sheep. Prions also cause mad cow disease and a human variant called Creutzfeldt-Jakob disease, a disorder that causes brain damage with a rapid decrease of mental function and movement. It may be that other conditions characterized by slow deterioration of the nervous system are caused by prions as well. There is early speculation that further research into the nature of prions may help us to better understand the cause of Alzheimer disease.

Reservoir of Infection

The reservoir, or source, of infection may be any place where pathogens can thrive in sufficient numbers to pose

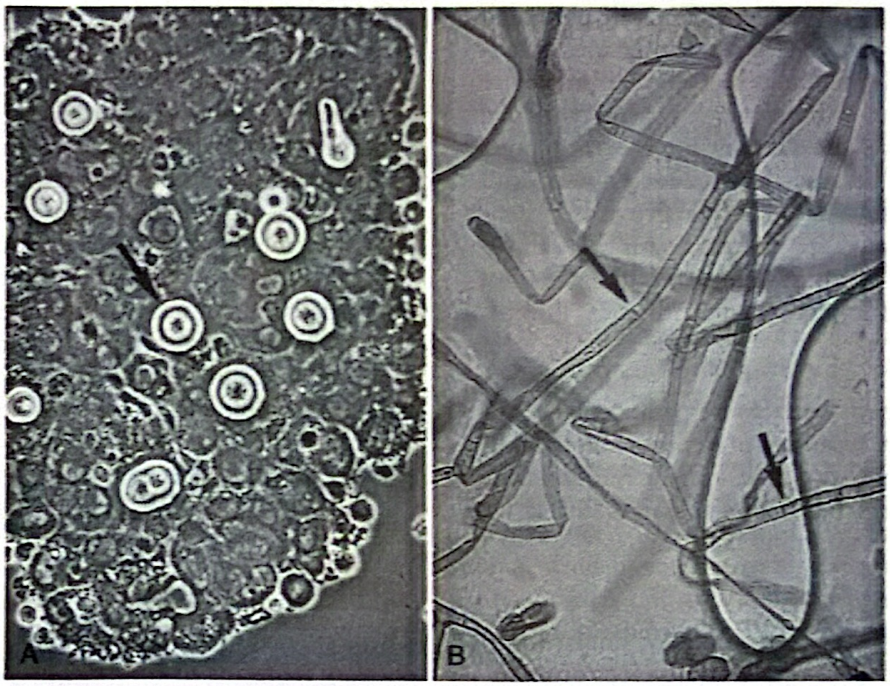

Fig. 21.21 Fungi: (A) Single-cell yeast *(arrow)*, (B) Mold *(arrows)*, a multicellular fungus.

a threat. Such an environment must provide moisture, nutrients, and a suitable temperature, all of which are found in the human body. A source of infection might be the patient with hepatitis, a health care worker with an upper respiratory tract infection, or a visitor with staphylococcal boils.

Because some pathogens live in the bodies of healthy individuals without causing apparent disease, a person may be the reservoir for an infectious organism without realizing it. These persons are called **carriers.** Many people have throat culture results that are positive for *Staphylococcus aureus* (staph) but do not have a sore throat. A susceptible patient with an open wound could contract a life-threatening infection if sufficiently contaminated with this organism. A common example of a carrier of infection is the individual infected with HIV who has no symptoms and who spreads the disease through sexual intercourse or by sharing contaminated needles with intravenous drug users.

Although the human body is the most common reservoir of infection, any environment that will support the growth of microorganisms has the potential to be a secondary source. Such sources include contaminated food or water or any damp, warm place that is not cleaned regularly.

Susceptible Host

Healthy individuals have a high level of natural resistance to infection. Fatigue, stress, malnutrition, illness, and injury tend to tax and weaken the immune response, reducing natural resistance. In a health care setting, susceptible hosts are frequently patients whose natural resistance to infection is diminished. In addition to the primary problems that caused them to seek care, they may develop **iatrogenic** (health care–related) infections.

Infections also pose a threat to health care workers because their work results in exposure to many pathogens. In a single day, you may care for patients with pneumonia, hepatitis, and wound infections. Hepatitis B and C are the biggest concerns. Both are spread by blood and blood products and are most often transmitted to health care workers by accidental needle sticks. Those who must work when resistance is low because of fatigue, stress, or a low-grade infection have increased susceptibility to infection. Maintain your resistance to infectious illness by keeping your body healthy and well rested.

Disease Transmission

The most direct way to intervene in the cycle of infection is to prevent transmission of the infectious organism from the reservoir to the susceptible host. To accomplish this, you must understand the six main routes of transmission, including direct and indirect routes. Indirect routes may involve transport of organisms by fomite, vectors, vehicles, and airborne particles or droplets.

Direct Contact

The first route is by means of direct contact. In this transmission mode the host is touched by an infected person in such a manner that the organisms are placed in direct

contact with susceptible tissue. For example, syphilis and HIV infections may be contracted when infectious organisms from the mucous membranes of one individual are placed in direct contact with the mucous membranes of a susceptible host. Also, skin infections often occur among health care workers because of frequent contact with patients who have bacterial diseases. The five other principal routes of transmission are indirect and involve transport of organisms by means of fomites, vectors, vehicles, airborne particles, and droplet contamination.

Fomites

An object that has been in contact with pathogenic organisms is called a **fomite.** Examples of fomites in the radiology department are the x-ray table, upright Bucky, image receptors, calipers, and positioning sponges that have been contaminated with infectious body fluids.

Vectors

A **vector** is an arthropod (insect, spider, or similar form) in whose body an infectious organism develops or multiplies before becoming infective to a new host. Some examples of vectors are mosquitoes that transmit malaria and dengue fever, fleas that carry bubonic plague, and ticks that spread Lyme disease and Rocky Mountain spotted fever. In these examples, the bites of infected insects transmit diseases to humans.

Vehicles

A **vehicle** is any medium that transports microorganisms. Examples include contaminated food, water, drugs, and blood.

Airborne Contamination

Airborne contamination is spread by dust containing either endospores or droplet nuclei (tiny infectious particles from evaporated droplets that contain microorganisms). Contaminated dust may remain suspended in the air for long periods. These particles may be dispersed by air currents and can be inhaled by a susceptible host. Special ventilation and airflow control are required to prevent airborne transmission of these infective particles. TB, rubeola (measles), and varicella (chickenpox) are examples of infections spread by airborne particles.

Droplet Contamination

Droplet contamination often occurs when an infectious individual coughs, sneezes, speaks, or sings in the vicinity of a susceptible host. Droplet transmission involves contact of the mucous membranes of the eyes, nose, or mouth of a susceptible person with droplets containing microorganisms. These particles are relatively large and do not remain suspended in the air. They travel only short distances, usually 3 feet or less. Influenza, meningitis, diphtheria, pertussis (whooping cough), and streptococcal pneumonia are examples of illnesses spread by droplet contamination.

Although most microorganisms are fragile—requiring continuous warmth, moisture, and nutrients to exist—some are resistant to destruction and can remain viable for long periods of time. Bacteria that are capable of forming endospores may live in this form for many years. They are often carried in invisible dust particles in the atmosphere. Research has shown that some viruses can resist drying, remaining infectious for weeks. This is true of the viruses that cause herpes, both oral and genital. These examples indicate that some microorganisms can float through the air and lurk in dusty corners, waiting for the opportunity to invade a susceptible host. This should emphasize to you the need for cleanliness as a defense against infection.

INFECTIOUS DISEASES

Disease Information

There are many new diseases in the world, and some old ones are returning in epidemic proportions after years of low-level incidence. The wide and inappropriate use of broad-spectrum antibiotics has led to the development of drug-resistant infections in hospitals and in the community. Some of these infections are untreatable because the causative organisms are resistant to the available drugs. Development of a new drug takes time, is costly, and does not seem to be a lasting solution to this complex problem. As a worker in the health care field, you may be on the front line of exposure to infectious diseases. The Centers for Disease Control and Prevention (CDC) monitors and studies the types of infections occurring in the nation, compiles statistical data about these infections, and publishes this information in both a weekly report and an annual surveillance summary report. The CDC also provides information about prevention and treatment of specific infections. When questions arise regarding current information on disease prevention and infection control, the best source of answers is the CDC.[a]

Human Immunodeficiency Virus Infection and Acquired Immunodeficiency Syndrome

According to the CDC,[b] more than 1 million people in the United States are living with HIV infection, and approximately 25% of these infections are undiagnosed and/or untreated. The global annual mortality rate is 3 million, and the worldwide cumulative death toll could reach 100 million by 2020.

Although the incidence of acquired immunodeficiency syndrome (AIDS) has dropped significantly since 1990, the total number of HIV patients continues to rise. This is

[a] www.CDC.gov.

[b] http://www.cdc.gov/hiv/library/reports/surveillance/2013/surveillance_Report_vol_25.html.

not only because of new cases but also because of the increasing number of HIV-infected individuals who have avoided converting to AIDS by the use of new, more effective drugs.

In the early 1980s, HIV was identified as the cause of AIDS. Two major types of HIV have been found to infect humans: HIV type 1 (HIV-1), the predominant type throughout the world, and HIV type 2 (HIV-2), found primarily in heterosexual populations in West Africa.

An HIV-infected individual can transmit the virus to others a few days after infection, even though antibodies to the virus may not be detected in the blood for 3 to 6 months. Without therapy, this individual will pass through several phases of infection over a span of months to years before exhibiting the immunosuppression of full-blown AIDS.

In the early stages of the infection, there is usually a brief period of flulike symptoms, often followed by years without symptoms. During the asymptomatic phase, the virus is silently replicating in the body and decreasing the number of CD4 lymphocytes. At the end of the asymptomatic period, before the full development of AIDS, the individual will experience night sweats, oral infections, weight loss, persistently enlarged lymph nodes, and low-grade fever. The appearance of AIDS is characterized by the occurrence of multiple **opportunistic infections** and malignant diseases. Opportunistic infections are caused by pathogens that do not cause disease in individuals with healthy immune systems. Some of the opportunistic infections observed are *Pneumocystis jirovecii* pneumonia (formerly termed *Pneumocystis carinii*), mucocutaneous *Candida*, disseminated herpes, and cytomegalovirus infection. There is also increased risk of contracting TB and developing active disease. Kaposi sarcoma, a malignancy of pigmented skin cells, is the most common form of cancer affecting AIDS patients.

Although drugs have been developed that prolong the time required for HIV infection to progress to AIDS, at this time no known cure exists. The primary problem in producing a successful vaccine has been the high mutation rate of this virus, but there is continued hope that a vaccine will be developed.

Fortunately the AIDS virus is not acquired by casual contact. Touching or shaking hands, eating food prepared by an infected person, and contact with drinking fountains, telephones, toilets, or other surfaces do not result in transmission of HIV. The routes of transmission are sexual contact, contaminated blood or needles, fluids containing blood, or from mother to fetus via the placenta. Infection can also be transmitted to infants through breast milk. Men who have sex with other men still account for the largest number of cases of AIDS in the United States, followed by intravenous drug users and persons engaging in high-risk heterosexual contact (unprotected contact with a person known to have or be at high risk for HIV). AIDS is increasing at a faster rate in the same groups in which HIV infection is increasing: non-Hispanic blacks, Hispanics, and women. The higher rate of AIDS in these groups has been attributed to poor access to health care, which has improved in the last few years, and/or failure to follow prescribed drug regimens. This means that a continued decline in AIDS diagnoses and deaths in the future will depend on better access to health care, simpler drug regimens, and the development of more effective antiretroviral drugs.

As a health care worker in today's world, you must expect to encounter unidentified or undiagnosed cases of AIDS and other blood-borne diseases. Controversy currently surrounds the patient's right to confidentiality regarding the AIDS diagnosis within the clinical setting, preventing you from being informed about diagnosed cases. Diagnosed patients are only the tip of the iceberg, however, because many undiagnosed cases exist for every known case. Anxiety about HIV infection is typical and understandable among health care workers, but the occupational risk is not great. The vast majority of health care workers infected with HIV were exposed as a result of activities unrelated to their work. The most common occupational exposure is the needle stick, but according to the CDC, the probability of infection following a needle stick injury exposing the injured person to blood containing HIV is only 3 out of 1000 exposures, or 0.3%. Thousands of needle sticks have been reported over the years, but as of December 2001, only 57 health care workers with no other identified risk factors had been diagnosed as HIV positive. Of these 57 cases, 26 had developed AIDS. Recent statistics for health care workers are not available, but it is projected that the percentages would be similar. The implications here are obvious. Although prevention at work is essential, self-care in terms of safe sexual practice and avoiding intravenous drug use is equally crucial.

Hepatitis

The five common types of hepatitis are classified A through E. Hepatitis A and E are transmitted through food and water contaminated with feces. Hepatitis B, C, and D are blood-borne. Hepatitis E is uncommon in the United States, and hepatitis D appears only as a coinfection with hepatitis B. Hepatitis B virus can be spread through contact with blood or blood products; contact with body fluids such as saliva, semen, and vaginal secretions; and maternal-fetal contact. Hepatitis C is primarily spread by contact with blood or blood products. The risk for contracting this virus is greatest for persons with large or repeated percutaneous exposures to blood, such as intravenous drug users, whose risk is 60%. The risk is lowest for those who are subject to sporadic percutaneous exposures such as health care workers, whose risk following a needle stick is 1% to 2%. The risk is 15% to 20% for sexual transmission and 5% to 6% for maternal-fetal transmission.

The manifestations of all forms of hepatitis are similar: jaundice, fatigue, abdominal pain, loss of appetite, nausea,

vomiting, and diarrhea. Hepatitis C is a more silent infection and may not cause symptoms or awareness of the infection until there is liver damage. Both hepatitis B and hepatitis C have the potential to develop into chronic infections and cirrhosis, although the risk is greater with hepatitis C. After infection with hepatitis C virus, about 85% of individuals develop chronic infection, approximately 70% develop liver disease, 10% to 20% develop cirrhosis, and 1% to 5% develop liver cancer. These sequelae take place over a 10- to 20-year period.

The number of new cases of hepatitis B and C has decreased because of immunizations for hepatitis B, decreased needle sharing among intravenous drug users, and blood donor screening for both B and C viruses. However, the incidence of hepatitis A has shown periodic increases. Large nationwide outbreaks of type A usually occur once each decade, with the last major outbreak occurring in Pittsburgh in 2003. Small outbreaks were reported in Colorado and New York in 2010. The nationwide incidence has decreased dramatically since the turn of the 21st century.

Health care workers can protect themselves against hepatitis B by taking a vaccine, which usually provides immunity for 7 to 10 years. There is also a vaccine for hepatitis A, but it is indicated only in certain situations, namely for individuals with medical, behavioral, occupational, or other indications, such as travelers to Third World countries. Protection from hepatitis A and C can be achieved by following the established infection-control practices in your institution. Hepatitis A remains the most common form of the disease and is best controlled by practicing good personal hygiene, especially hand hygiene.

Managing Occupational Exposures to Bloodborne Pathogens

If an accidental needle stick occurs or the skin is broken by a contaminated object, allow the wound to bleed under cold water and wash with soap. If the mucous membranes of your eyes, nose, or mouth are splashed with body fluids, rinse the affected area immediately with water. An incident report must be filed, even though the injury or incident might seem insignificant. In addition to completion of an incident report, most hospitals now ask that a baseline blood sample be drawn to help rule out infection acquired before the occupational exposure. You will also be advised by the medical provider about postexposure prophylactic (PEP) therapy following a puncture with a contaminated needle. If treatment is recommended, it should be administered within 2 hours of the blood exposure. Currently, for most HIV exposures that warrant PEP, a 4-week two-drug regimen is recommended, and several drug options are available. At the time that you are being tested for HIV, you will also be tested for hepatitis B and C. If you have not had the hepatitis B vaccine series, it will be initiated along with hepatitis B immune globulin for immediate immunity. There is no effective prophylactic therapy for hepatitis C at this time, so if testing reveals you were exposed to a hepatitis C virus–positive source, follow-up hepatitis C virus testing will be necessary to see if infection develops. Because HIV infection may not be apparent in the blood for approximately 3 months, another sample is tested for HIV at 6 months.

Tuberculosis

TB is a disease of the lungs caused by the acid-fast bacillus *Mycobacterium tuberculosis*, also referred to as *tubercle bacillus*. Historically, this disease was called *consumption*, because of the victim's tendency to "waste away." In the past, the incidence of TB in the United States was spread across all economic levels of society, but today the highest rate of active cases is seen among the homeless, recent immigrants, and immunosuppressed individuals. Although the incidence of cases in this country is much lower now than it was in the years before 1950, recent outbreaks of TB have raised grave concern because of the appearance of drug-resistant strains of the bacteria.

Pulmonary TB is spread through airborne droplet nuclei that are generated when an infected person coughs or speaks. These particles are easily transmitted because they are extremely tiny (1 to 5 μm in size) and air currents keep them airborne. The probability that a susceptible person will be infected depends on the concentration of the infectious droplet nuclei in the air.

Most people who become infected with tubercle bacilli do not develop a clinical disease or become infectious to others. In the vast majority of cases, the body's immune system walls off the infection within 2 to 10 weeks, preventing its multiplication and spread. The walled-off disease is inactive or dormant, but the infection can be reactivated at any time. Reactivation may occur with lowered resistance because of immunodeficiency, malnutrition, other illness, or old age.

In a weakened or immunosuppressed state, such as with HIV infection, patients progress rapidly to active disease. Symptoms of active disease include productive or prolonged cough, fever, chills, loss of appetite, weight loss, fatigue, and night sweats. As the bacilli multiply, they cause tissue necrosis that results in cavities in the lung. These spaces are major reservoirs of the infectious organisms, which can then be spread by coughing. Severe cases can be fatal. Examples of radiographs showing various stages of TB are presented in Chapter 16, Fig. 16.46. Extrapulmonary TB, infecting bone or organs other than the lung, accounts for a small percentage of TB infections. Patients with extrapulmonary infection and no active pulmonary disease do not transmit the disease through airborne contamination.

The simplest and most common method of testing for TB infection is the tuberculin skin test, also called a *Mantoux test* or *PPD test* (*PPD* stands for purified protein

derivative, obtained from killed tubercle bacilli). This test involves an intradermal injection on the anterior forearm. The injection produces a raised area on the skin, similar to an insect bite, called a *wheal*. The wheal is inspected 48 to 72 hours after injection to determine whether the individual has been infected with TB. A negative test result indicates that the person has never been infected. A positive result indicates that a person has at one time been infected and has developed **antibodies** (resisting proteins) to the organism. Because few people who become infected ever develop clinical symptoms or become infectious to others, many people have a positive skin test result without having active disease. This test is administered when a person is known to have been exposed to TB and has not already tested positive for it.

If the skin test result is positive or if symptoms are present, a chest radiograph is ordered to rule out active disease. When there are symptoms and/or positive radiographic findings, sputum smears and cultures are tested for acid-fast bacilli. Positive results are definitive proof of active disease and are an indication to begin treatment.

For example, schoolteachers, corrections officers, and health care workers are often required to have preemployment tuberculin skin tests. TB screening is often required for those who work in contact with vulnerable or high-risk populations.

The CDC reports that the current number of reported TB cases is the lowest since national reporting began in 1953.[c] Although TB rates have declined in both American-born and immigrant populations, the decline has been substantially less among immigrant and foreign-born populations. The continued decline in the number of reported cases since 1992 reflects improvements in TB prevention and control programs by state and local health departments but falls short of the national goal the CDC has set to eventually eliminate this disease from the population.

Early identification, isolation, and treatment are required to minimize transmission of TB. Health care workers are at risk of contracting this disease only when a patient is exhibiting symptoms of active TB. According to OSHA's standard on TB, infection-control experts within the health care facility are to assess the actual risk for transmission of TB in inpatient and outpatient settings. If the findings reveal risk, they are to develop TB infection-control interventions. These include free TB skin tests, the provision of personal respirator equipment, the operation of one or more isolation rooms with negative air pressure and special ventilation or circulation, annual employee training about the disease, and implementation of effective work practices. OSHA estimates that the average lifetime occupational risk of TB infection may be as high as 386 infections per 1000 workers exposed to TB on the job.

Health Care–Associated Infections

Approximately 2 million patients each year acquire infections within the health care setting. These have been historically known as **nosocomial infections.** More recent terms include **health care–associated infections or hospital-acquired infections (HAIs).** Although many of these infections are not life threatening, the CDC estimates that 90,000 patients die each year of complications associated with HAIs and that most of these are preventable. Although the clinic or office setting provides substantially less risk, the same problems exist wherever health care is provided, and you should be aware of these types of infections and of the ways in which they are transmitted.

Medical settings provide an ideal environment for the development and transmission of HAIs. Typical sources of these infections include the contaminated hands of health care providers and contaminated instruments and urinary catheters, which can allow microbes to gain easy entrance into the body. Invasive procedures permit pathogens to enter the bloodstream and overcome the defense mechanisms of **immunocompromised patients** (those with deficient immune systems, such as those with HIV infection and those taking antirejection drugs following organ transplants).

There are several HAIs that greatly concern health care providers and their patients because they are multidrug resistant. This means that they are resistant to more than one antibiotic. Methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant enterococci (VRE) both contribute to surgical wound, urinary tract, and bloodstream infections. MRSA can also cause respiratory infections. Penicillin-resistant *Streptococcus* and *Pseudomonas aeruginosa* cause respiratory infections. The overuse of antimicrobial agents and poor infection-control practices have been implicated in the emergence and spread of these multidrug-resistant organisms. These pathogens are very difficult to treat, and intensive infection control is required to limit their spread.

MRSA has been recognized as a problem in the health care setting for the last 20 years. More recently, MRSA has also become a problem in the community and is referred to as *community-associated* or *CA-MRSA*. According to the CDC, infection with this variant has been associated with recent antibiotic use, sharing of contaminated personal items, living in crowded settings, and poor hygiene. This form of MRSA is associated with skin and soft tissue infections that are treatable with alternate antibiotics. The following groups have been affected: injection drug users, men who have sex with men, inmates, military recruits, children in child care facilities, and athletes. Even as we write, other organisms are adapting to the drugs used to treat them and will soon emerge to

[c] www.cdc.gov/tb/statistics/default.htm.

Box 21.4
Standard Precautions for All Patient Care

- Wash hands often and well and use alcohol-based hand rubs between washings.

- Wear protective gloves when likely to touch body substances, mucous membranes, or nonintact skin.

- Wear a plastic apron or a protective gown when clothing is likely to be soiled.

- Wear mask and eye protection when likely to be splashed.

- Place intact needle-syringe units and sharps in designated disposal containers. Do not break, bend, or recap needles.

present new infection-control threats in health care facilities and possibly communities, so this problem will be with us for some time.

Another type of HAI that is very common in the hospital environment is *C. difficile* colitis, a gastrointestinal infection that causes diarrhea. *C. difficile* is especially difficult to control because it is a spore-forming bacterium that is not eliminated by the usual routine methods of asepsis. Patients receiving antibiotic therapy are particularly susceptible to developing this infection because antibiotics tend to upset the normal balance of intestinal flora. About 20% of hospital patients receiving antibiotics develop *C. difficile* infections. Treatment is usually quite successful, but about 20% of treated patients relapse, sometimes developing a chronically recurring disease.

PREVENTING DISEASE TRANSMISSION

Until about 30 years ago, infection transmission was minimized by keeping infected persons separated from others. In acknowledgment that many patients with blood-borne infections are not recognized, the CDC introduced a system in 1985 known as *Universal Precautions (UP)*. In this system, all patients are treated as potential reservoirs of infection. It is based on the use of barriers for all contacts with blood and certain body fluids known to carry blood-borne pathogens. The need to use barriers, such as gloves and masks, depends on the nature of the interaction with the patient rather than on the specific diagnosis.

Because UP placed emphasis on blood-borne infections and did not include precautions for contamination by feces, nasal secretions, sputum, urine, and vomitus (unless contaminated with visible blood), a new system was introduced in 1987 called *Body Substance Precautions (BSP)*, also called *Body Substance Isolation (BSI)*. This system focused on the use of barriers to prevent contact with all moist and potentially infectious body substances from all patients. The system was developed to protect health care workers from acquiring and transmitting infections from all pathogens. As of 1996, however, the CDC has recommended a system that synthesizes the features of UP and BSP. This most recent system is called **Standard Precautions** and incorporates guidelines for isolation in hospitals. As applied in an outpatient setting, Standard Precautions are essentially the same as BSP.

Standard Precautions

Standard Precautions involve the use of barriers whenever contact is anticipated with any of the following:

- Blood
- Any body fluid or wound drainage
- Secretions and excretions (except sweat), regardless of whether they contain visible blood
- Nonintact skin
- Mucous membranes

Standard Precautions, as applied in an outpatient setting, are summarized in Box 21.4. They are designed to reduce the risk of transmission from unrecognized sources of pathogens in health care facilities, whether blood-borne or not. If unanticipated contact with any body substance occurs, thoroughly wash the contact area as soon as possible. Use gloves to wipe up after all blood spills and disinfect using 1 part bleach to 10 parts water or the disinfectant specifically recommended for potential blood-borne pathogen contamination in your facility.

Standard Precautions require that each individual use judgment in determining when barriers are necessary.

Each individual must establish his or her own standards for consistent use of barriers. These personal standards should be based on the individual's skills and the anticipated interactions involving the patient's body substances, nonintact skin, and mucous membranes. You will be making frequent decisions about when to take the extra time to protect both yourself and your patients. In the beginning, your level of precautions should be very high. Although you may observe more experienced workers taking fewer precautions, do not think you must follow their example. At this stage it is far better to take too many precautions than to take too few.

Be aware of the specific infection-control policies in place at your facility. The key to effective protection is a consistent approach to *all contact* with *all body substances* of *all patients* at *all times*.

Medical Asepsis

Medical **asepsis** is the process of reducing the *probability* of infectious organisms being transmitted to a susceptible individual. The healthy human body has the ability to overcome a limited number of infectious organisms. This resistance can be overwhelmed by a massive exposure. On the other hand, a reduced resistance caused by disease, cancer chemotherapy, immunosuppressants, or extremes in age may result in infection after only minimal exposure. The fewer the organisms to which an individual is exposed, the more likely that he or she will resist infection. The process of reducing the total number of organisms is called **microbial dilution** and can be accomplished at several levels.

Simple cleanliness measures prevent the transmission of organisms when proper cleaning, linen handling, and hand-washing techniques are used. The second level is **disinfection** and involves the destruction of pathogens by chemical agents. The third stage is surgical asepsis, or **sterilization**. This involves treating items with heat, gas, or chemicals to make them germ free. They are then stored in a manner that prevents contamination.

You can easily find examples of poor aseptic technique in most clinical settings. Unfortunately, the results of carelessness are seldom traced to the culprit. It is the patient acquiring an infection who suffers. Armed with the knowledge of disease transmission, how can you fight the spread of infection?

- Stay home when you are ill, if possible. Definitely avoid contact with immunocompromised patients.
- Cover your mouth with a tissue when you sneeze or cough or cover your face with your arm so that you cough into your elbow rather than your hand.
- Wear a clean uniform daily and remove it immediately when you go home.
- Follow hand hygiene recommendations.
- Use established precautions when handling patients, linens, or items contaminated with body substances.
- Practice good housekeeping techniques in your work area.
- When in doubt about the cleanliness of any object, do not use it.
- Immediately dispose of linens, instruments, or other items that touch the floor because the floor is always considered contaminated.
- When patients are coughing or sneezing, provide tissues and ask them to cover their mouth and nose.

Hand Hygiene

The first three principles listed earlier are simple and self-explanatory. Hand hygiene also may seem obvious, but this is the rule most consistently ignored in many health care settings. Hand hygiene refers to decontamination of the hands using soap and water, an antiseptic hand wash, or an alcohol-based hand rub. *Frequent hand hygiene is the single best protection against disease transmission.* It should be followed explicitly before and after work, before meals, and often during the day.

The use of alcohol-based hand rubs takes less time and is often more convenient than handwashing. Some individuals find hand rubs less irritating to the skin. The CDC believes that the use of hand rubs has greatly improved hand hygiene compliance in the health care setting and recommends that this method of hand hygiene be used before and after patient contact, before donning gloves, after removing gloves, and after contact with equipment or objects that may have been in contact with a patient. Alcohol rubs are very effective against most microorganisms, including multidrug-resistant organisms. Alcohol-based rubs will not destroy endospores, however. Handwashing with soap and water is still recommended to physically remove spores from the surfaces of contaminated hands. Use of alcohol-based hand rubs should not replace handwashing with soap and water when hands are visibly soiled or contaminated with blood or body secretions or excretions. Aseptic hand-washing technique is both simple and effective. The technique is illustrated in Fig. 21.22.

Gloves should always be worn to prevent contact with the patient's blood or other body fluids. Always perform hand hygiene following the removal of gloves.

Studies reveal that health care workers who wear artificial nails are more likely to harbor bacteria at the fingertips below the nails, both before and after handwashing, than those who have natural nails. For this reason, many health care facilities do not permit health care workers to wear artificial nails. According to the CDC, artificial fingernails or extenders should not be worn by health care workers who have direct contact with patients at high risk. The tips of natural nails should be kept smooth and short, less than 0.25 inch in length.

Housekeeping

Good housekeeping in the workplace reduces the incidence of airborne infections and the transfer of pathogens

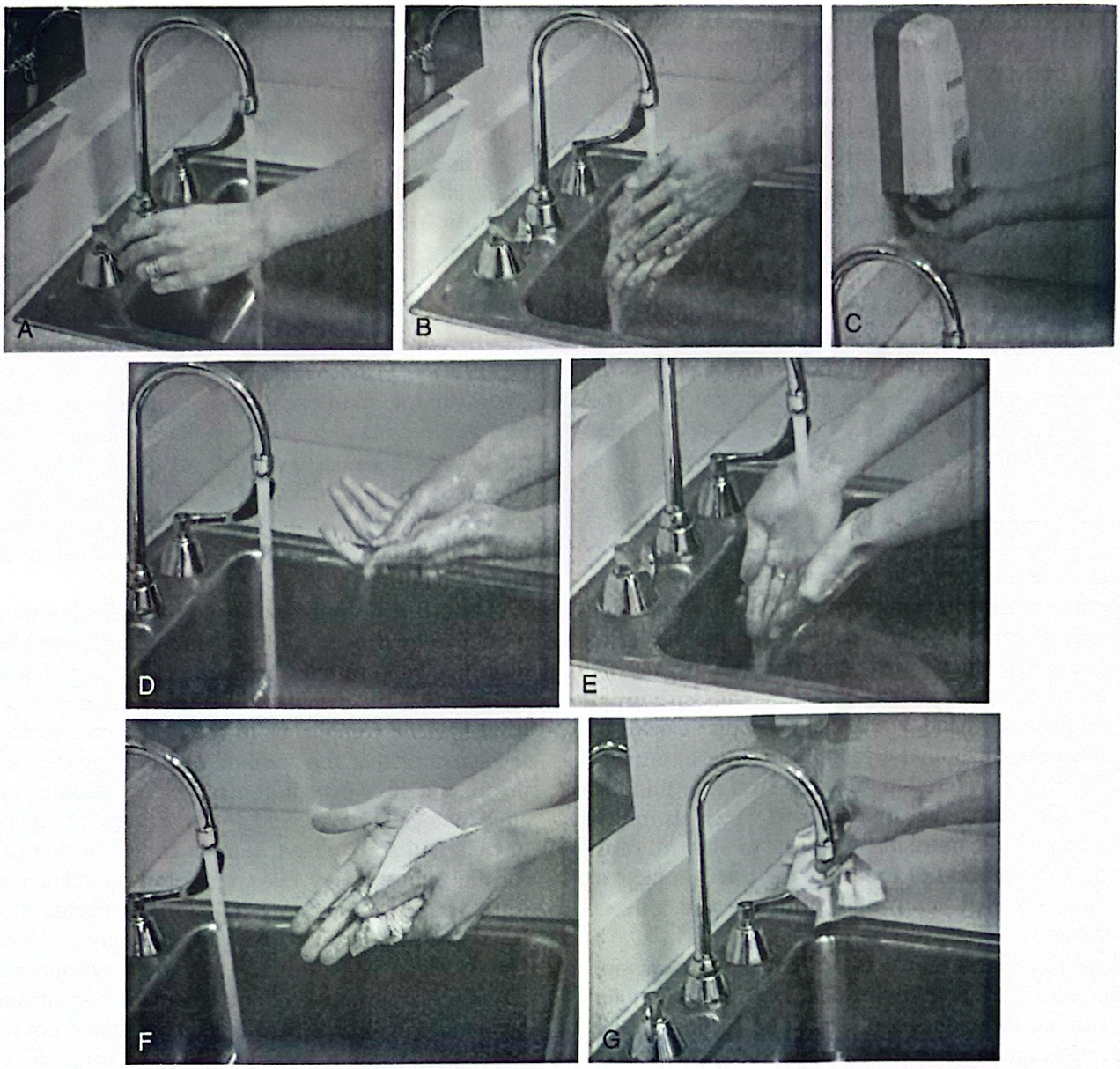

Fig. 21.22 Handwashing. (A) Turn on water and adjust temperature. (B) Wet hands thoroughly. Keep hands lower than elbows so water will drain from clean area (forearms) to most contaminated area (fingers). (C) Apply antimicrobial soap. (D) Lather well. Rub hands and fingers together with firm rotary motion for 20 seconds. *Friction is more effective than soap in removing microorganisms from skin.* Rub palms, backs of hands, and areas between fingers. (E) Rinse, allowing water to run down over hands. Repeat steps to cleanse wrists and forearms. (F) Use paper towel to dry thoroughly from fingertips to wrist. (G) Turn off water with paper towel to avoid contaminating hands.

by fomites. A clean, dry environment discourages the growth of all microorganisms. A custodian or cleaning service may do much of the cleaning in the office or clinic at night, but you are responsible for inspecting the work area regularly and maintaining high standards of medical asepsis.

Several general principles apply whenever cleaning is required:

- Always clean from the least contaminated area toward the more contaminated area and from the top down.
- Avoid raising dust.
- Do not contaminate yourself or clean areas.
- Clean all equipment that comes in contact with patients after each use using a cloth moistened with disinfectant. Allow disinfectant to remain wet for the recommended amount of time listed on the packaging in order to effectively kill germs.

For a cleaning agent for decontaminating environmental surfaces, the CDC recommends either a diluted solution of sodium hypochlorite bleach (e.g., Clorox) or a

disinfectant registered by the Environmental Protection Agency (EPA) as effective against HIV, hepatitis B virus, and the TB bacterium. Dilute the bleach by mixing 1 part bleach with 10 parts water. Mix fresh bleach daily because its effectiveness declines rapidly when diluted. EPA-registered disinfectants are available as liquids, spray foams, and disposable wipes. Your facility may have written procedures with detailed instructions concerning preferred cleansing agents and the extent of responsibility for disinfecting rooms. Consult the policy and procedure manual.

Handling Linens

Objects or linens soiled with body secretions or excretions are considered contaminated and may serve as fomites even though stains may not be apparent. For this reason, many clinics use disposable gowns and linens. Any linens used by patients should be handled as little as possible. To prevent airborne contamination, fold the edges to the middle without shaking or flapping and immediately place loosely balled linens in a hamper or a lined trash container. *Never use any linen for more than one patient.*

Handling and Disposal of Contaminated Items and Waste

A modern health care facility uses many disposable items, from simple objects (e.g., paper cups and tissues) to more complex items (e.g., trays for minor surgical procedures). Disposable items are designed to be used only once and then discarded. The only exception to this rule involves the immediate reuse of an unsterile item, such as an emesis basin, by the same patient.

Your facility will have a protocol for the discard of disposable items. Some place glass, plastic, and paper into separate covered containers. Others place everything together. Regulations demand that objects contaminated with blood or body fluids be discarded in a suitable container and marked with the **biohazard symbol** (Fig. 21.23). Used bandages and dressings are assumed to be contaminated. They are handled with gloves and placed directly into waterproof bags, which are then sealed and discarded. Do not remove anything from a hazardous waste container once it has been placed inside, and do not place any object in a plastic biohazard bag that could puncture the bag. Specific regulations vary by state with respect to what constitutes biohazardous waste and how these wastes must be handled.

Needles, syringes, and contaminated items capable of puncturing the skin are disposed of in a **sharps container.** Sharps containers are made of tough material that cannot be punctured by needles or glass and are designed to receive syringes and attached needles without recapping. They are discussed further and illustrated in Chapter 24. *Never recap a used needle.* This is how most finger punctures occur.

Before specimens are sent to the laboratory, they should be placed in clean containers with secure caps and slipped inside a plastic bag labeled with a biohazard symbol (Fig. 21.24).

Always wear gloves when assisting patients with bedpans or urinals. Collect any specimen needed and empty the bedpan or urinal immediately. Rinse it well over the toilet; discard it if disposable, or put it in the proper place to be sterilized.

Fig. 21.23 Biohazard symbol.

Fig. 21.24 Laboratory specimens are placed in a plastic bag labeled with a biohazard symbol.

SURGICAL ASEPSIS

Earlier in this chapter, we defined *medical asepsis* as a method of reducing the number of pathogenic microorganisms in the environment and intervening in the process by which they are spread. *Surgical asepsis*, on the other hand, is the complete removal of all organisms and their spores from equipment used to perform specific procedures. The linens, gloves, and instruments used in surgery may be the first examples brought to mind, but many other procedures, such as injections and the drawing of blood samples, also require sterile equipment, and some procedures demand an assortment of sterile equipment and supplies arrayed in a sterile field. In addition, some procedures require special skin preparation to prevent pathogens from entering the body.

Sterile items used in clinics and physicians' offices, such as syringes and needles, are usually disposable items. They are sterile when purchased and are protected by a paper or plastic wrap. Reusable items such as instruments and glass syringes are wrapped, sterilized, and stored in a clean, dry location.

Sterilization

Although you are unlikely to be directly involved in the process of sterilization, it is helpful to understand the methods that may be used. Chemical, gas, and steam sterilization are most common.

Chemical sterilization involves the immersion and soaking of clean objects in a bath of germicidal solution. Sterilization depends on solution strength and temperature and the immersion time, all of which are difficult to control accurately. Contamination of the solution or the object being sterilized may occur and is not easily detectable. For these reasons, chemical sterilization is not the most satisfactory method for providing surgical asepsis and is not recommended. If chemical sterilization must be used, be certain to follow the chemical manufacturer's instructions completely.

Items that would be damaged by moist heat are sterilized by means of conventional gas sterilization or by gas plasma technology. The conventional method uses a mixture of gases (Freon and ethylene oxide) heated to 135°F (57°C). Gas sterilization is too expensive and time consuming for general use and is used primarily for electric, plastic, and rubber items and for optical ware. Telephones, stethoscopes, blood pressure cuffs, and other equipment may be sterilized in this manner. This treatment sterilizes very effectively but has one drawback: because the gases used are poisonous, they must be dissipated by means of aeration in a controlled environment. Aeration is a slow process, so it is important to send items for conventional gas sterilization well in advance of the time they will be needed.

A safer method of sterilizing items that are sensitive to heat or moisture is the use of gas plasma technology. Items are cleaned, wrapped, and placed in a compact mobile unit where low-temperature hydrogen peroxide gas plasma diffuses through the wrappings and effectively kills both microorganisms and spores. Because the gas plasma system uses very low heat and moisture, it can effectively sterilize endoscopes, fiberoptic devices, microsurgical instruments, and powered instruments.

Another advantage is greater safety for supply department workers because there are no toxic fumes, byproducts, or residues and no handling of hazardous chemicals. Gas plasma technology has significantly reduced the use of ethylene oxide, but it cannot completely replace this method because it is not effective for instruments that have long, narrow lumens and cannot be used for powders, liquids, or any cellulose materials, such as paper, cotton, linen, or muslin.

Hospitals usually have equipment for both gas and gas plasma sterilization, but these methods are not usually available in outpatient facilities. Items of value that have become contaminated may have to be sent out for gas sterilization.

An **autoclave** is an electric steam chamber that seals tightly to achieve high temperatures under pressure. Autoclaving, or steam sterilization, is the quickest and most convenient means of sterilization for items that can withstand heat. Higher temperatures can be achieved under pressure, which makes this an extremely effective method. Clinics that need to sterilize reusable equipment will have a small autoclave for this purpose.

An advantage of both steam and gas sterilization is that indicators can be used to identify that a pack has been sterilized. Indicators are placed inside the pack and outside to show that the gas or steam has penetrated to all surfaces. Indicators change color when the required conditions have been met. You are responsible for correctly recognizing the sterilization indicators used in your clinical facility.

Suppliers of commercial packs use ionizing radiation to destroy microorganisms and spores. Commercial packs also contain expiration dates and indicators to confirm their sterility.

Sterile Fields

If your job description includes assisting the physician with sterile procedures, you will need to know how to prepare a sterile field. A sterile field is a germ-free area prepared for the use of sterile supplies and equipment. The principles of surgical asepsis used in establishing and working with a sterile field are stated in Box 21.5. The first step in preparing a sterile field is to confirm the sterility of packaged supplies and equipment. Packages are considered sterile if they meet the following criteria:

- They are clean, dry, and unopened.
- Their expiration date has not been exceeded.
- Their sterility indicators have changed to a predetermined color, confirming sterilization.

Proper preparation is essential to any procedure that requires sterile technique. You may be responsible for

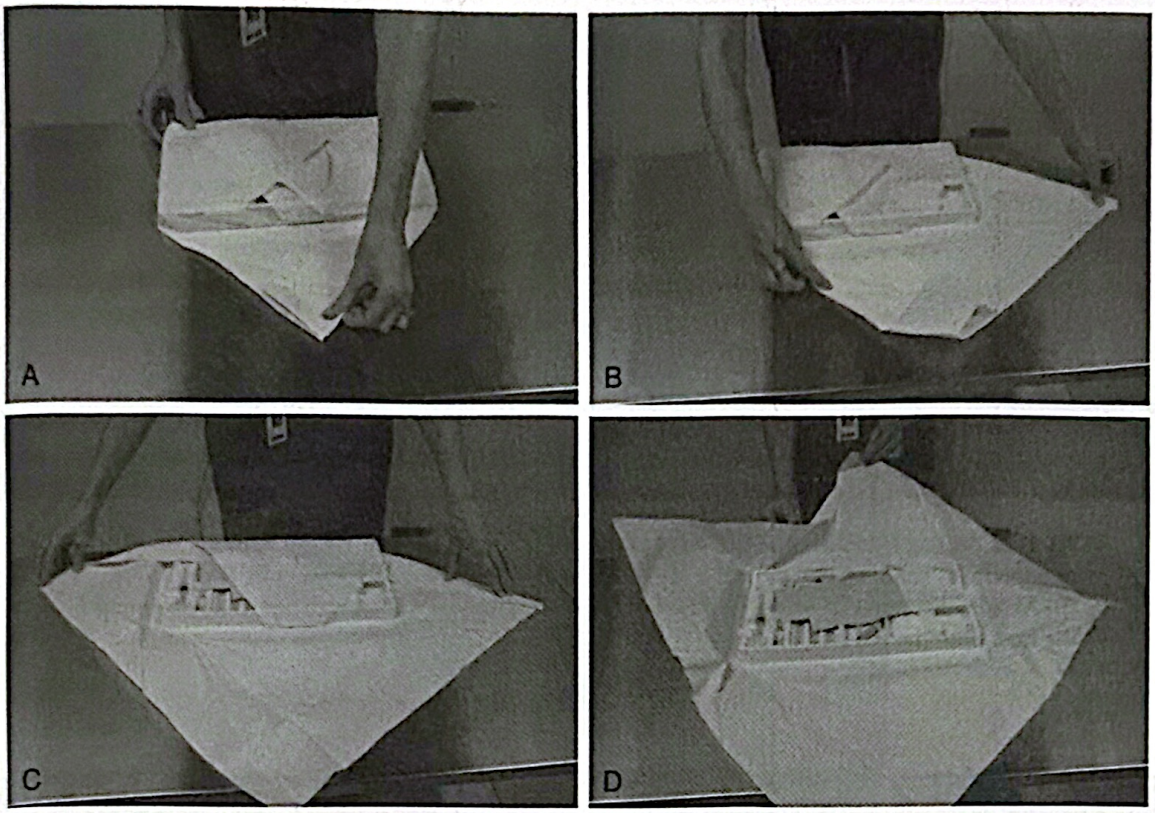

Fig. 21.25 Sterile field. (A) After checking the sterilization indicator and expiration date on the pack, open the first corner away from you. (B) Open one side by grasping its corner tip. (C) Open second side in the same manner. (D) Pull remaining corner toward you. If there is an inner wrap, open it in the same manner. A sterile field is now established.

Box 21.5
Standard Principles of Surgical Asepsis

- Any sterile object or field touched by an unsterile object or person becomes contaminated.
- Never reach across a sterile field. Organisms may fall from your arm into the field. Also, reaching increases the chance of brushing the area with your uniform.
- If you suspect that an item is contaminated, discard it. This includes items that are damp (moisture permits the transfer of bacteria from the outside to the inside of a wrapped set) and items that have had the seal broken or on which the indicator tape has not assumed the correct color.
- Do not pass between the physician and the sterile field.
- Never leave a sterile area unattended. If the field is accidentally contaminated, for example, by a fly or a patient reaching for her glasses, no one would know.
- A 1-inch border at the perimeter of the sterile field is considered to be a "buffer zone" and is treated as if it were contaminated.

assembling the necessary equipment. Most procedures today use disposable equipment that is wrapped in paper or plastic. Directions on the packages are usually clear and precise. Taking time to read them well in advance increases self-confidence when assisting the physician. Nondisposable equipment that has been sterilized is double-wrapped in cloth or heavy paper and sealed with indicator tape. All packs are wrapped in a standardized manner and are always opened using the following method (Fig. 21.25):

- Check the pack to be certain it is the correct item and that all sterility indicators are positive as listed in the previous paragraph.
- Place the pack on a clean surface within reach of the physician.
- Just before the procedure begins, break the seal and open the pack.
- Unfold the first corner away from you, and then unfold the two sides.
- Pull the front fold down toward you and drop it. Do not touch the inner surface.
- The inner wrap, if there is one, is opened in the same manner.
- You have now established a sterile field.

Nondisposable sterile items wrapped separately may now be added to the sterile field. Standing back from the table, grasp the object through the wrapper with one hand. With the other hand, unseal the wrapper, allowing it to fall down over your wrist. Hold the edges of the

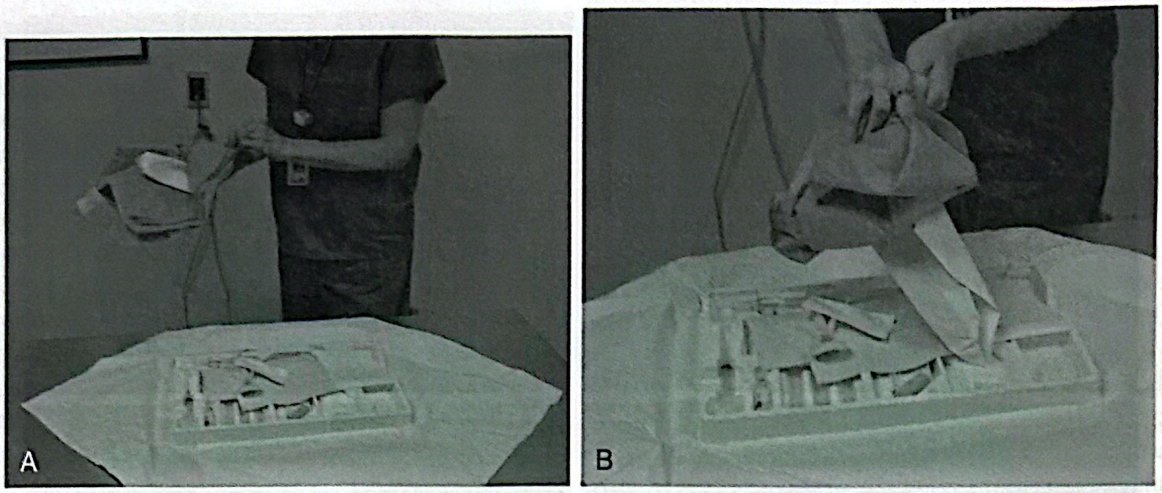

Fig. 21.26 Adding a double-wrapped item to the sterile field. (A) Holding the item in the nondominant hand, open the outer wrap, opening the first fold away from your body. (B) Avoid contamination of the field by holding the corners of the outer wrap while dropping the item onto the tray.

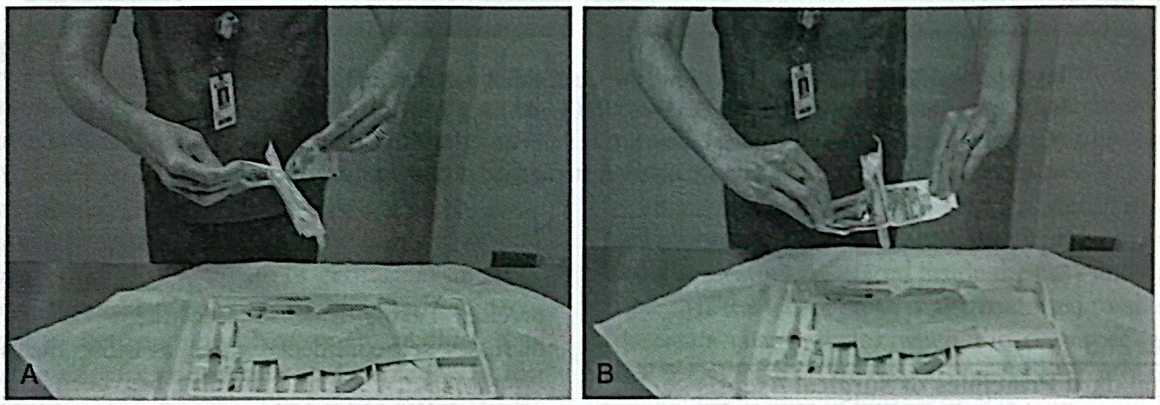

Fig. 21.27 Adding a disposable item to a sterile field from a "peel-down" wrap. (A) Separate the wrap according to package instructions. (B) Invert the package, allowing the item to drop onto the field.

wrapper with your free hand, and drop the object onto the sterile field without releasing the wrapper (Fig. 21.26).

Disposable sponges, gloves, and other small items are supplied in "peel down" paper wraps and may be added to the sterile field. Following the instructions, separate the paper layers, invert the package, and allow the object to fall onto the sterile field without contaminating the object or the sterile field (Fig. 21.27).

It may be necessary to add a liquid medium, such as povidone-iodine (Betadine, a skin disinfectant), to a sterile tray. After double-checking the label, position the label toward your hand, open the spout, and squirt the first few drops into the wastebasket or sink. Then pour the required amount into the sterile receptacle on the tray, show the physician the label, and close the spout. By discarding the first small amount poured, you rinse the container's lip with the liquid and avoid the possibility of contaminating the tray (Fig. 21.28).

When a limited operator must manipulate items in a sterile field without wearing sterile gloves, a sterile transfer forceps is used. Unwrap the forceps, grasping the handles firmly without touching the remainder of the instrument. Keep the forceps above your waist and in your sight at all times. After use, place the tips in a sterile field with the handles protruding so you can use them again. Do not reach across the sterile field.

If a procedure must be postponed, do not open the tray. If it is already open, cover it immediately with a sterile drape or discard it, because airborne contamination is just as serious as a break in sterile technique.

When the sterile procedure is completed, don protective gloves and thoroughly clean all reusable items to be

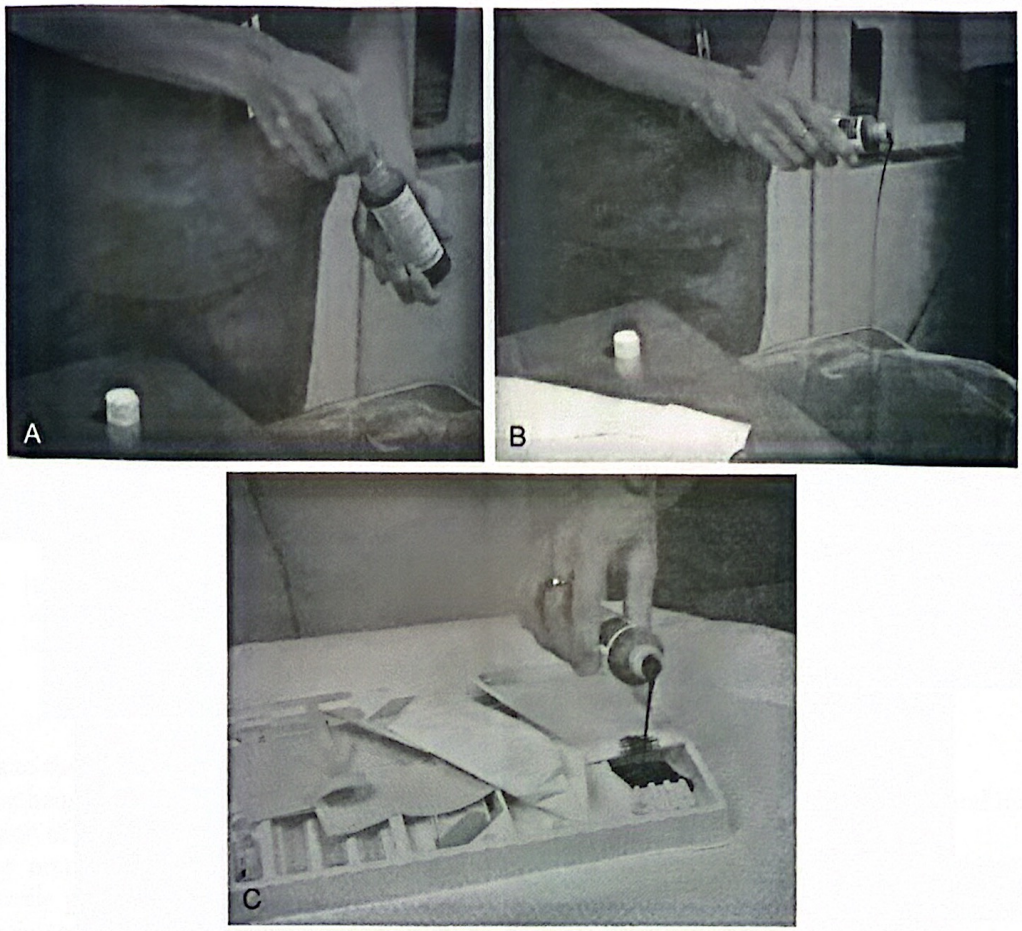

Fig. 21.28 Adding liquid to a sterile field. (A) Check the label and open bottle. (B) Cleanse the lip of the container by squirting a small amount into a waste container. (C) Pour the required amount into a receptacle on the tray, taking care not to contaminate the field.

sterilized. Items must be free of all residue so that the sterilizing agent can penetrate to all surfaces. Thorough cleaning is very important and is most easily accomplished when done promptly. Discard disposable items; place needles in the sharps container and put bloody sponges and other biohazardous waste in a biohazard bag. Remove your gloves and perform hand hygiene.

Anyone whose work involves sterile fields must have a "sterile conscience." This refers to an awareness of sterile technique and the responsibility for telling the person in charge whenever you contaminate a field or observe its contamination by someone else. You may feel reluctant to speak out about apparent breaks in technique because of the inconvenience of reestablishing a sterile field. Physicians and co-workers may not seem to appreciate your challenge at the moment, but your professionalism and concern for the patient's welfare will be reflected in the confidence they place in your aseptic technique.

Gloving

It is unlikely that you will be required to don sterile gloves. This skill may be important, however, if you are needed to assist with certain sterile procedures or to apply a sterile dressing. The technique is illustrated in Fig. 21.29.

The technique for removing contaminated gloves is shown in Fig. 21.30. This method avoids contamination of your arms or sleeves and also of your ungloved hand.

Always perform hand hygiene before gloving and after removing gloves.

Removing and Applying Dressings

In many health care facilities today, limited operators and medical assistants are called upon to perform tasks that were once performed solely by nurses. For example, you may be directed by a physician to remove a patient's dressing. It may also be your duty to apply a fresh dressing when the examination has been completed.

When a dressing is to be removed, perform hand hygiene, don protective gloves, and inform the patient of what you are about to do. Use care in removing the dressing to prevent cross-contaminating the wound and yourself. Remove the dressing gently to avoid hurting the patient. Place the soiled dressing in a plastic bag and seal it

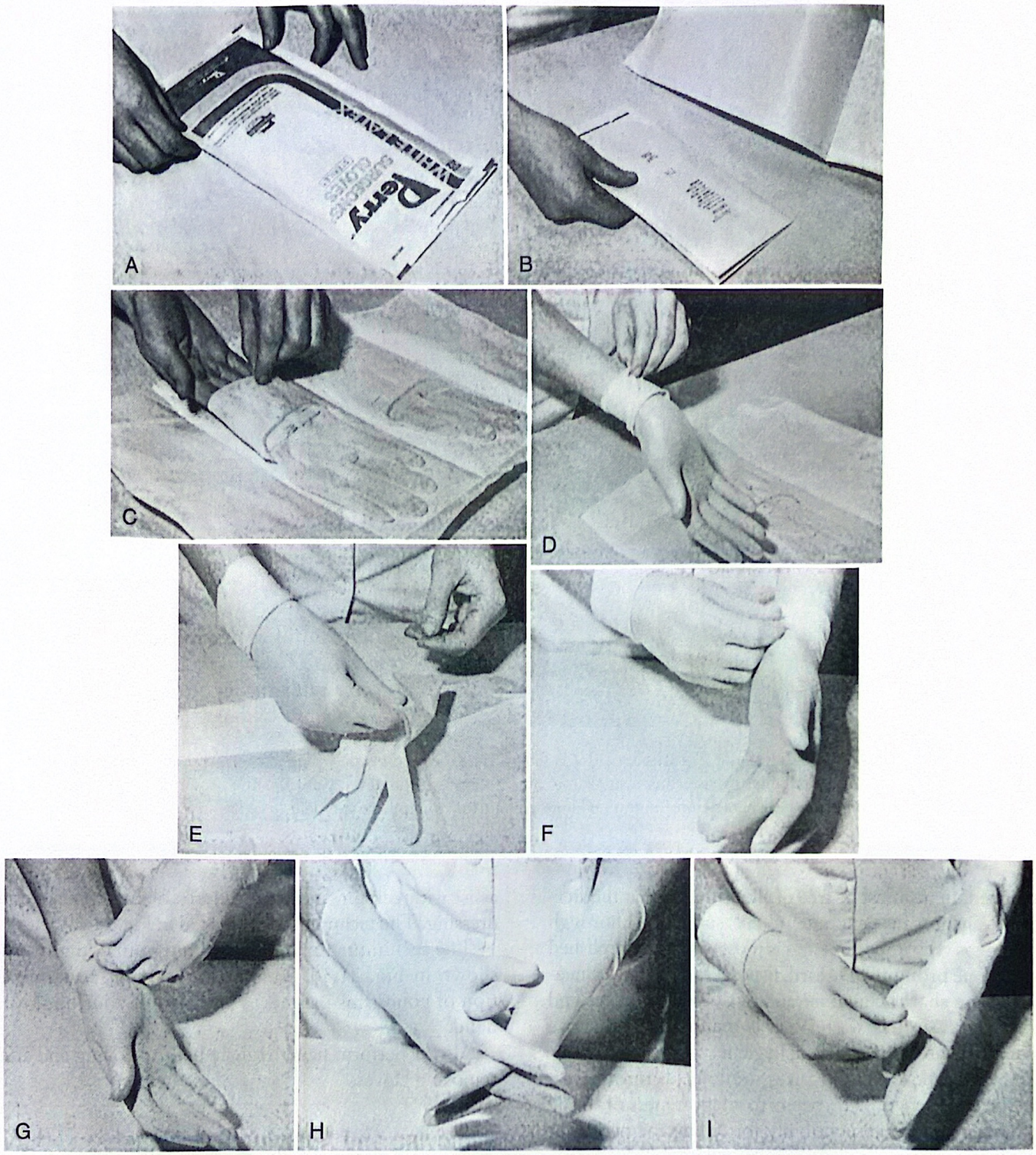

Fig. 21.29 Donning sterile gloves. (A) *Perform hand hygiene.* Check the glove package to be certain that the size is correct and open the package. (B) Open the outer wrap to expose the folded inner wrap. (C) Open the inner wrap, touching only the outer surface. Expose the gloves with the open ends facing you. (D) Put on the first glove, touching only the inner surface of the folded cuff. (E) Using the gloved hand, grasp the second glove *under* the cuff. (F) Put on the second glove and unfold the cuff. (G) Insert the fingers under the cuff on the first glove and unfold the cuff. (H) Gloving is complete. Keep your hands in front of your body at a safe distance from your uniform to prevent contamination. (I) Remove the gloves by inverting them as you pull them off. Perform hand hygiene.

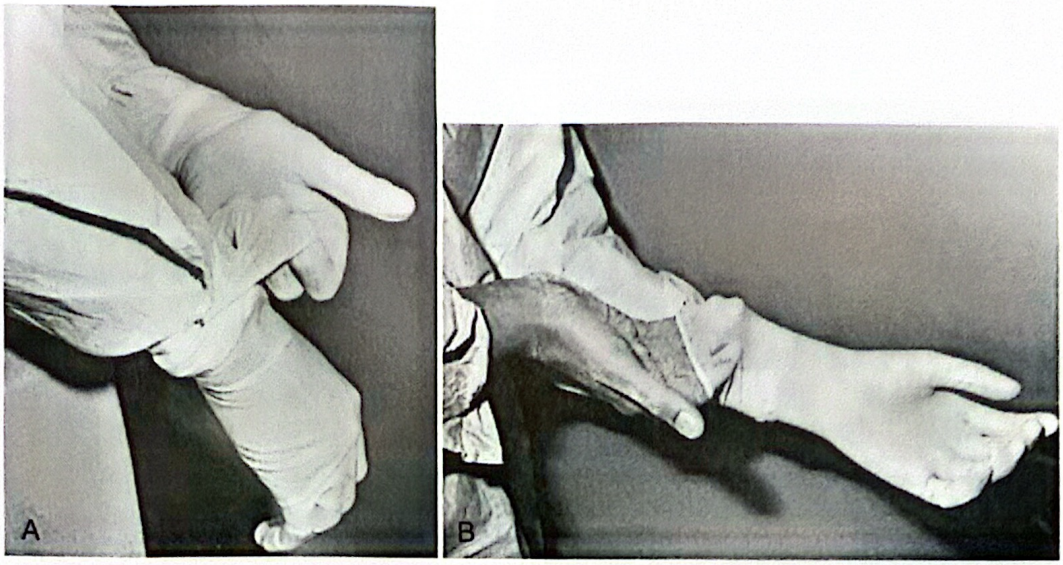

Fig. 21.30 Removing contaminated gloves. (A) Grasp the first glove from the outside and pull it off. (B) Insert your clean fingers inside the cuff of the second glove and remove it. Perform hand hygiene.

before adding it to the biohazard container. Remove your gloves and repeat hand hygiene.

The application of a new dressing requires sterile technique. Begin by preparing your supplies: sterile gloves, sterile drape, sterile gauze, and tape. You may also need some normal saline solution to clean the area around the wound. When everything you will need has been assembled, proceed as follows:

- Tell the patient what you plan to do.
- Perform hand hygiene.
- Tear several strips of tape to a convenient length.
- Open the sterile drape pack, placing the drape near the patient.
- Partially open the drape by pulling from the corners. This creates a small sterile field for your other sterile items.
- Open the dressing package and add the sterile dressing to the sterile field.
- If you will need to cleanse around the wound, drop sterile gauze sponges into your field for this purpose.
- To moisten the gauze sponges, open a small vial of sterile normal saline solution. Recheck the label and pour a small amount of the saline over the sponges. Do not allow liquid to soak through to the sterile towel. Check the label for the third time before discarding the vial.
- Don sterile gloves using the method described for sterile gloving.
- Use the moist sponges to clean gently around the wound.
- Allow the area to dry completely.
- Apply the dressing over the wound and secure it in place with tape.
- Cover the patient.
- Dispose of any waste.
- Remove your gloves and repeat hand hygiene.

SUMMARY

The principle underlying everything discussed in the first part of this chapter is safety. You must be alert to potential hazards from fire, falls, spills, and electric shock and be prepared to respond appropriately when these hazards pose a threat. Safety is ensured when you use correct techniques for positioning patients and for assisting their movements. The objective is to protect patients when they are unable to protect themselves and to do so without personal injury.

Despite the "miracle drugs" developed over the past 60 years, infectious diseases are still a significant public health problem, and some are growing alarmingly worse. There are still no medications to treat most viral infections. Other organisms are changing rapidly and becoming immune to medications that were once highly effective. Asymptomatic carriers of HIV and hepatitis B virus pose a significant threat to members of the community, including health care workers, who may be exposed to infectious blood or body fluids without being aware that the infection is present.

For all of these reasons, the safety of patients and health care workers requires conscientious infection-control practices. Standard Precautions protect health care workers from infectious body fluids, both known and unsuspected. Aseptic techniques begin with a commitment to proper practices and are implemented through the conscientious application of knowledge and skill.