

# Infection Control and Prevention

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Contact hours: 5

Course price: \$29

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## **Course Summary**

Infection control training for healthcare professionals, including responsibility for adhering to accepted principles and monitoring the performance of all for whom one is responsible. Reviews the mechanisms of transmission along with strategies of prevention and control. Coverage of controls, PPE, and practices to protect both workers and healthcare settings.

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## **Criteria for Successful Completions**

80% or higher on the post test, a completed evaluation form, and payment where required. No partial credit will be awarded.

# Course Objectives

When you finish this course you will be able to:

1. Summarize the most prevalent risk factors for healthcare-associated infections (HAIs) and their related sites of infection.
2. Identify and explain six essential elements of infection control.
3. Recall and explain each of the six links in the Chain of Infection.
4. Describe prevention strategies in terms of Standard and Universal Precautions, Transmission-Based Precautions, Contact Precautions, Droplet Precautions, and Airborne Precautions.
5. Explain the importance and proper practice of hand hygiene for preventing HAIs.
6. Discuss safe injection practices and sharps disposal as they relate to patient and worker health.
7. Outline the use of engineering and work practice controls to reduce the opportunity for exposure to potentially infectious material (PIM).
8. Demonstrate the selection and use of personal protective equipment (PPE).
9. Define the principles and practices for cleaning, disinfection, and sterilization.
10. Spell out guidelines for post exposure prophylaxis.

## Healthcare-Associated Infections (HAIs)

Healthcare-associated infections (HAIs) are among the most common adverse events in healthcare. In addition to the personal consequences for patients, families, and professionals, HAIs add to the skyrocketing costs of the nation's healthcare system. A recent CDC report estimated the annual medical costs of HAIs in U.S. hospitals to be between \$28 and \$45 billion (Scott, 2009).

**Healthcare-associated infections** are infections that people acquire in a healthcare setting while they are receiving treatment for another condition. HAIs can be acquired anywhere healthcare is delivered, including inpatient acute care hospitals, outpatient settings such as ambulatory surgical centers and end-stage renal disease centers, as well as long-term care facilities such as nursing homes and rehabilitation centers. HAIs may be caused by any infectious agent, including bacteria, fungi, and viruses, as well as other less common types of pathogens (HHS, 2011).

HAIs are associated with a variety of risk factors, including:

- The use of indwelling medical devices such as bloodstream, endotracheal, and urinary catheters
- Surgical procedures
- Injections
- Contamination of the healthcare environment
- Transmission of communicable diseases between patients and healthcare workers
- Overuse or improper use of antibiotics (HHS, 2011).

HAIs are a significant cause of morbidity and mortality. At any given time, 1 in 20 hospital patients have an HAI. More than a quarter of all hospital-acquired HAIs are of the following four types:

- Urinary tract infections
- Surgical site infections
- Bloodstream infections
- Pneumonia (HHS, 2011).

In 2002 the CDC estimated that more than 1.7 million HAIs occur in U.S. hospitals each year, and they are associated with approximately 99,000 deaths (Klevens, 2007).

Using even the most conservative data, the number of HAIs far exceeds the number of cases of any currently notifiable disease. Deaths associated with HAIs in hospitals exceeded the number of deaths attributed to several of the ten leading causes of death reported in U.S. vital statistics (Klevens, 2007).

New attention to HAIs, seen as both patient safety and public health problems, has underscored the need for systematic surveillance as part of a broad-based prevention and control strategy. To address this need, the American Recovery and Reinvestment Act of 2009 provided \$50 million to support states in the prevention and reduction of HAIs. These funds have supported surveillance and research, improved quality, encouraged collaboration, and trained healthcare workers in HAI prevention and in measurement of outcomes. Data from these programs may be accessed [here](#).

Nearly 5000 hospitals, in all 50 states use CDC's NHSN (National Healthcare Safety Network) to track HAI's. As of April 2012 27 states and the District of Columbia require reporting of HAIs using NHSN. Links and information about CDC and state-based HAI prevention activities can be found on the CDC website [here](#).

The Centers for Medicare and Medicaid Services (CMS) have increased scrutiny of practices and implemented financial incentives for prevention of HAIs. In 2011 the CMS implemented a new requirement that all hospitals nationwide receiving payment from CMS provide information on specific HAIs, using standardized reporting.

In April 2011 the Obama administration launched a public/private program called *Partnership for Patients: Better Care, Lower Costs*, designed to make hospital care safer, more reliable, and less costly by:

- **Keep patients from getting injured or sicker.** By the end of 2013, preventable hospital-acquired conditions would decrease by 40% compared to 2010, which would mean approximately 1.8 million fewer injuries and 60,000 lives saved.
- **Help patients heal without complication.** By the end of 2013, preventable complications during a transition from one care setting to another would be decreased so that all hospital readmissions would be reduced by 20% compared to 2010 (HealthCare.gov, 2011).

## Six Elements of Infection Control

Since August 1992 New York State has had a legislative requirement in place that mandates training on infection control (IC) and barrier precautions for certain healthcare professionals at license renewal. While no other state currently has as stringent a licensing requirement in place, IC is a critical concern in healthcare professional practice and the six core elements outlined in the New York State Training Syllabus provide a useful structure for understanding IC and barrier precautions. The six elements, which are also reflected in CDC and OSHA standards and requirements and in many state laws and regulations, are spelled out in the following box and then explained in the sections that follow.

## **ELEMENT I**

The responsibility to adhere to scientifically accepted principles and practices of infection control and to monitor the performance of those for whom the professional is responsible.

## **ELEMENT II**

Modes and mechanisms of transmission of pathogenic organisms in the healthcare setting and strategies for prevention and control.

## **ELEMENT III**

Use of engineering and work practice controls to reduce the opportunity for patient and healthcare worker exposure to potentially infectious material in all healthcare settings.

## **ELEMENT IV**

Selection and use of barriers and/or personal protective equipment for preventing patient and healthcare worker contact with potentially infectious material.

## **ELEMENT V**

Creation and maintenance of a safe environment for patient care in all healthcare settings through application of infection control principles and practices for cleaning, disinfection, and sterilization.

## **ELEMENT VI**

Prevention and management of infectious of communicable diseases in healthcare workers.

Source: NYSDOH, 2010

# **Element 1: Scientifically Accepted Principles**

**The responsibility to adhere to scientifically accepted principles and practices of infection control and to monitor the performance of those for whom the professional is responsible.**

Scientific evidence is the primary source of guidance for infection control practice and, as the science has evolved, practices have been updated to reflect new findings. A number of factors contribute to this changing landscape; for example, germs evolve and mutate, and new diseases emerge. The recent H1N1 influenza outbreak is an example of a potentially deadly virus that emerged as a mix of human, swine, and bird viruses. Human immunodeficiency virus (HIV) is a well-known example of a disease that emerged in the late 1970s, prompting widespread and rapid changes in infection control practices.

The transition of healthcare delivery from acute care hospitals to other healthcare settings (home care, ambulatory care, free-standing specialty care sites, and long-term care) has created a need for infection control guidelines that can be applied in all settings. These guidelines must follow common principles of practice, yet be modified to reflect setting-specific needs. The emergence of new pathogens, concern for evolving pathogens, development of new therapies, and increasing concern for the threat of biological weapons attacks has led to broader guidelines for infection control and prevention.

Until recently, infections were an expected consequence of hospitalization, and reliance on scientifically accepted information for infection prevention had not penetrated all corners of the healthcare system. However, as healthcare moves rapidly toward practices and procedures based on scientifically accepted, evidence-based principles, we are seeing a cultural shift in the management of HAIs.

In the past it was accepted practice for hospitals to compare the success of their infection control activities to national averages called **benchmarks**—if the hospital's infection rates were comparable to these benchmarks their performance was acceptable. **Zero tolerance** has now emerged as a guiding concept in the management of HAIs. The goal for all healthcare organizations—from hospitals to home care—is to reduce the number of HAIs to zero.

The CDC's National Healthcare Safety Network (NHSN) is a useful tool for monitoring HAI rates and evaluating the effectiveness of prevention strategies, and it supports state-based collaborative efforts to reduce HAIs. Hospitals have continuous access to their own data and can compare their rates to national levels and monitor trends over time. HAIs monitored include central-line associated infections, catheter-associated urinary tract infections, surgical site infections, ventilator-associated pneumonia, blood transfusion infections and more. In March 2012 the CDC released information on successful collaborative efforts to reduce *Clostridium difficile* (*C. difficile*) infection rates in three states: Illinois, Massachusetts, and New York (CDC, 2011; 2012a; 2012b).

# Laws, Regulations, and Infection Prevention

Both regulations and science impact infection control practice. Whichever is stricter must be followed. Regulation is often more specific than science.

**Law** is a broad term that refers to legally binding rules of conduct adopted by a legislative or other government body at the international, federal, state, or local level. The most common laws are statutes enacted by a legislature. A **regulation** is an official policy issued by an agency of the executive branch in response to statutory authority. Regulations have binding legal force and are intended to implement the administrative policies of an agency. Regulations govern professional conduct and establish acceptable conduct for those regulated by the agency (Pain & Policy Studies Group, 2008).

Legal issues first began to impact IC practices at the beginning of the AIDS epidemic in the early 1980s. The need to protect healthcare workers from bloodborne exposures resulted in the publication of the Bloodborne Pathogens Standard by the Occupational Safety and Health Administration (OSHA) in 1991. The OSHA Standard requires employers whose employees have exposure to blood to provide safe work practices, education, and barriers to exposure. The standards were later amended to cover the safe use of sharps.

Part of the OSHA Bloodborne Pathogens Standard is the requirement that every healthcare worker who may have contact with body fluids on the job must receive specific annual education. This education includes instruction in the basics of infection control and prevention, bloodborne pathogens training, and instruction in modes of transmission, needlestick precautions, and contact precautions.

Since 1991 other laws and regulations have been enacted, some at the federal and some at the state level. The Conditions of Participation, published by the CMS is an important source of legal guidance for the infection control community. The Conditions of Participation must be met for a hospital to receive Medicare funding, which is typically about half their income for most facilities. Inspection for compliance with the Conditions of Participation is generally carried out by survey teams from either the Joint Commission or the American Osteopathic Association (AOA). Validation surveys may also be made by state health department staff.

In most jurisdictions healthcare facilities are responsible for establishing and maintaining written infection control policies and procedures and implementing them according to published guidelines. They must ensure that these policies and procedures are reviewed and updated regularly and that staff members are familiar with them.



In many cases state laws and national and state professional associations require standards of professional conduct that specify requirements and actions for healthcare workers regarding healthcare associated infections or infectious material handling. Such laws and codes may also define professional misconduct and and punishment for incidents of misconduct. It is important to familiarize yourself with state and local laws and regulations and applicable codes of professional conduct that apply to your practice area.

New York State's listing of scientifically accepted infection prevention techniques (2011) includes:

- **Wear appropriate protective gloves at all times** when touching blood, saliva, other body fluids or secretions, mucous membranes, non-intact skin, blood-soiled items or bodily fluid-soiled items, contaminated surfaces, and sterile body areas, and during instrument cleaning and decontamination procedures
- **Discard gloves used following treatment of a patient** and change to new gloves if torn or damaged during treatment of a patient; wash hands and don new gloves prior to performing services for another patient; and wash hands and other skin surfaces immediately if contaminated with blood or other body fluids
- Wear appropriate masks, gowns, or aprons, and protective eyewear or chin-length plastic face shields whenever splashing or spattering of blood or other body fluids is likely to occur
- **Sterilize equipment and devices** that enter the patient's vascular system or other normally sterile areas of the body
- **Sterilize equipment and devices** that touch intact mucous membranes but do not penetrate the patient's body, or use high-level disinfection for equipment and devices that cannot be sterilized prior to use for a patient
- **Use appropriate agents**, including but not limited to detergents, for cleaning all equipment and devices prior a sterilization or disinfection
- **Clean, by the use of appropriate agents**, including but not limited to detergents, equipment and devices which do not touch the patient or that only touch the intact skin of the patient
- Maintain equipment and devices used for sterilization according to the manufacturer's instructions
- **Adequately monitor the performance of all personnel**, licensed or unlicensed, for whom the licensee is responsible regarding infection control techniques
- **Place disposable used syringes, needles, scalpel blades, and other sharp instruments in appropriate puncture-resistant containers for disposal;** and

place reusable needles, scalpel blades, and other sharp instruments in appropriate puncture-resistant containers until appropriately cleaned and sterilized

- **Maintain appropriate ventilation devices** to minimize the need for emergency mouth-to-mouth resuscitation
- Refrain **from all direct patient care and handling of patient care equipment when the healthcare professional has exudative lesions or weeping dermatitis** and the condition has not been medically evaluated and determined to be safe or capable of being safely protected against in providing direct patient care or in handling patient care equipment
- **Place all specimens of blood and bodily fluids in well-constructed containers with secure lids** to prevent leaking; and clean any spill of blood or other bodily fluid with an appropriate detergent and appropriate chemical germicide (NYSED, 2011)

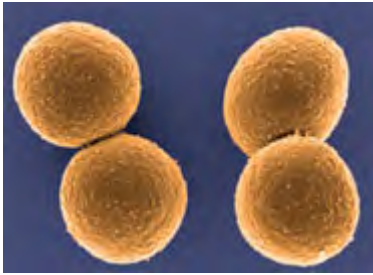
## Element II: Mechanism of Transmission

### **Modes and mechanisms of transmission of pathogenic organisms in the healthcare setting and strategies for prevention and control.**

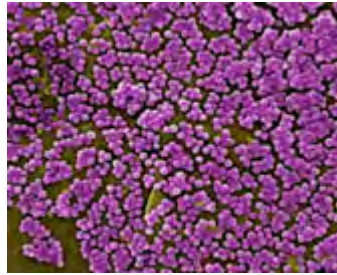
It is becoming increasingly clear that transmission of infections in healthcare settings is largely preventable through the use of evidence-based infection control guidelines. The concept of the chain of infection has provided the basis for understanding the transmission of pathogens as well as identifying practices and procedures to prevent healthcare-associated infections.

A **healthcare-associated infection (HAI)** is defined as a localized or systemic condition that (1) results from an adverse reaction to the presence of an infectious agent or its toxin, (2) occurs during a hospital admission, (3) has no evidence of the infection being present or incubating at admission, and (4) meets body site-specific criteria (Klevens, 2007a).

Antibiotic-resistant organisms have changed the infection control landscape. Methicillin-resistant *S. aureus* (MRSA), *C. difficile*, and vancomycin-resistant enterococcus (VRE), among others, have become serious problems in healthcare facilities over the past two decades. The MRSA organism alone is responsible for more than 94,000 invasive infections and almost 19,000 deaths each year in the United States (Klevens et al., 2007).



This colored electron micrograph shows isolated *S. aureus* bacteria that are resistant to many forms of antibiotics. Source: NIAID.



Scanning electron micrograph depicting numerous clumps of MRSA bacteria. Source: CDC.

## Antibiotic Resistance

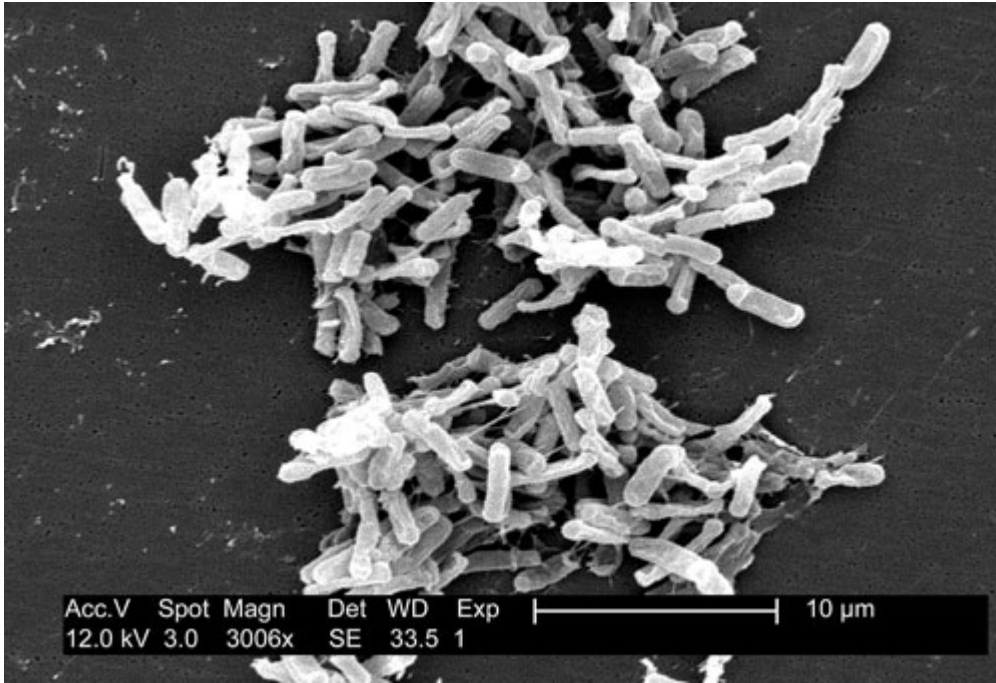
To understand how quickly disease-causing bacteria can develop resistance to antibiotics, take the example of *S. aureus*. Penicillin, introduced in the early 1940s, once kept staph bacteria at bay. By the late 1960s more than 80% of staph bacteria were penicillin-resistant. Methicillin was introduced in 1961 to combat resistant staph bacteria, but reports of methicillin-resistant *S. aureus* (MRSA) rapidly followed. In 1974, 2% of the staph bacteria found in U.S. hospitals were methicillin-resistant. By 2002 that figure had jumped to 57.1%, according to CDC data.

Source: IDSA, 2004.

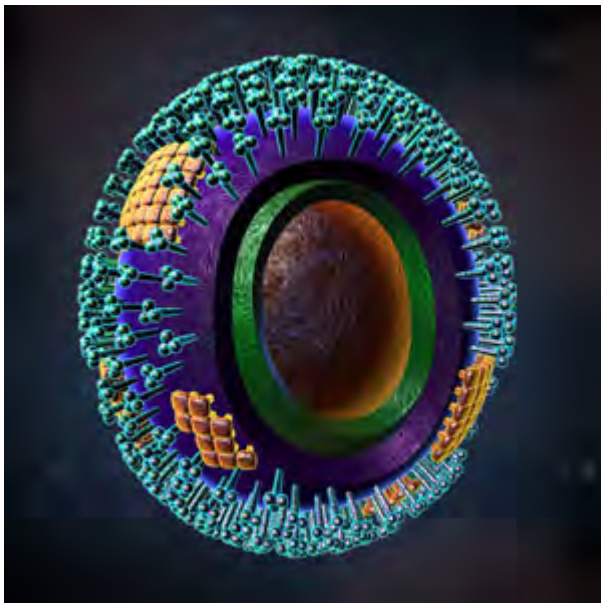
*Clostridium difficile* has also become more virulent, and hospital-associated outbreaks are causing increased deaths. In the general population, *C. difficile* is present in about 5% of the population. The need to control outbreaks of *C. difficile* has focused new attention in the area of environmental cleaning. Because *C. difficile* causes watery diarrhea it can spread easily and rapidly in the healthcare setting, passing from person to person via clothing, equipment, and dirty hands.

Vancomycin-resistant enterococcus (VRE) is another antibiotic-resistant organism that has been associated with increased mortality and length of hospital stay. Many studies have shown that VRE can be readily found on cabinets, bedrails, equipment, and bedside tables and it is easily transmitted on the hands, gloves, and clothing of healthcare workers. Vancomycin-resistant enterococcus is also easily transmitted on equipment such as blood pressure cuffs, stethoscopes, pulse oximeters, IV poles, telephones, and infusion pumps. Aggressive environmental cleaning, screening of incoming patients for VRE and MRSA, isolation, and stringent barrier precautions have led to remarkable success in controlling and eliminating these organisms in hospitals in Denmark, Finland, and the Netherlands (Muto et al., 2003).

Even before the recent H1N1 outbreak, influenza has long been an area of focus for infection prevention. Although flu pandemics have occurred periodically for centuries, causing hundreds of thousands of deaths, we now have the ability to identify an influenza epidemic as it is emerging. We also have the public health capability to take action (vaccines, surveillance, education) to minimize the impact of a flu outbreak. Addressing and controlling these emerging threats has become a priority for healthcare organizations.



Scanning electron micrograph of *Clostridium difficile* bacteria from a stool sample. Source: CDC/Lois S. Wiggs (PHIL #6260), 2004.



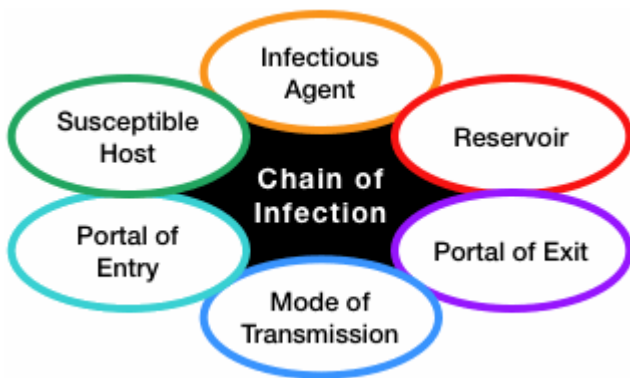
An illustration of the influenza virus micro-organism. Illustration provided by 3DScience.com.

## The Chain of Infection

We have all seen infections spread through a family, classroom, or office; this situation can be described using a concept called the **chain of infection** (see figure below). It is a process that begins when (1) an infectious agent or pathogen (2) leaves its reservoir, source, or host through (3) a portal of exit, (4) is conveyed by some mode of transmission, (5) enters the host through an appropriate portal of entry, and (6) infects a susceptible host. The now-infected susceptible host becomes a new reservoir and the whole process starts over.

The concept of a chain of infection is essential to our understanding of why we do what we do to prevent infection. If any link of the chain of infection can be broken, the spread of infection can be prevented.

### The Chain of Infection



### Infectious Agents or Pathogens

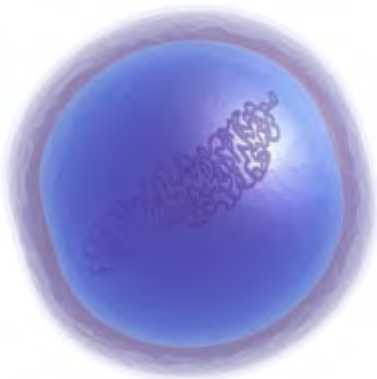
Infectious agents or pathogens are the microorganisms or “germs”—bacteria, viruses, fungi, and protozoa—that can cause disease or illness in its host. Some microorganisms are *pathogens*, a word derived from the Greek, meaning “that which produces suffering.” Although microorganisms are common in the environment, most are not harmful to people.

Pathogens vary in infectivity and virulence, and to cause disease an **infectious dose** (a sufficient number of organisms) is required. Creating an environment with no pathogens is not a realistic goal outside of highly specialized laboratories.

### Bacteria

Bacteria are single-celled organisms, the vast majority of which are harmless or even beneficial. Our bodies contain bacteria, called **normal flora**, that protect us from infection by providing competition to pathogens. Normal flora usually do not cause disease unless balance is disturbed or the bacteria get into a part of the body that cannot tolerate them. Antibiotics are effective against many bacterial infections although, as already noted, the overuse or misuse of antibiotics has produced strains of bacteria that are resistant to them.

Pathogenic bacteria contribute to a number of globally prevalent diseases, including pneumonia, tuberculosis, and bacterial meningitis. Pathogenic bacteria include group A and group B streptococcus, *Haemophilus influenzae*, *Staphylococcus aureus*, including MRSA, *Clostridium difficile*, *Neisseria meningitidis*, and *Streptococcus pneumoniae*.



A **coccus** is a bacterium with a spherical shape. Chains of cocci indicate streptococcus, while clusters indicate staphylococcus. Illustration provided by 3DScience.com.



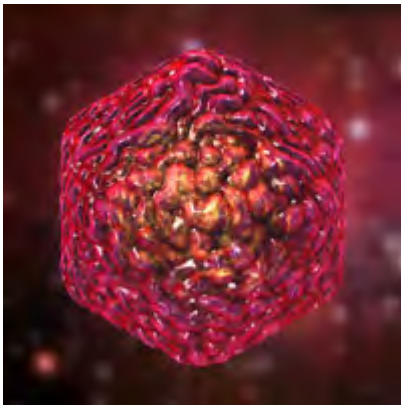
**Bacillus** can refer to any rod-shaped bacterium, or can be more specific to *Bacillus*, which is a gram-positive and rod-shaped genus. Illustration provided by 3DScience.com.

## Viruses

Viruses are true parasites in that they can only reproduce inside the host cell. More than five thousand types of viruses have been described since the first was discovered in 1899. Viruses are about a hundred times smaller than bacteria and, like bacteria, not all viruses cause disease.

Viruses spread in many different ways—by direct or indirect contact (soiled hands or articles), by droplets from coughing and sneezing, by contact with blood, sexual contact, fecal contamination, in contaminated food and water, or via certain insects. Examples of diseases caused by viruses include influenza, chickenpox, West Nile fever, and HIV.

Antibiotics are not effective against viruses. Vaccines, however, have been successful in eliminating or controlling some viral disease—including smallpox, polio, measles, mumps, and rubella—that have killed millions of people throughout the world. Anti-viral medications for some illnesses have varying degrees of effectiveness.



This image of the West Nile Virus shows the characteristic rough and furrowed surface with no protein arms projecting from it, as so many viruses have. Illustration provided by 3DScience.com.



HIV is a retrovirus, whose genetic content is stored in RNA, which is copied into the DNA of the host upon infection. Illustration provided by 3DScience.com.

## Fungi

Fungi are very common, but only a few cause diseases in humans. Some fungal infections are life-threatening in certain susceptible patients. Fungal infections can be superficial (limited to the surface of the skin and hair), cutaneous (extending into the epidermis, nails, and hair), or subcutaneous (extending into the dermis, subcutaneous tissues, muscle, and fascia). Fungal infections can also be systemic, often originating in the lungs and spreading to multiple organs. There are several classes of antifungal medications, although fungal and human cells are similar on the molecular level, so antifungal drugs can have mild to serious side effects. Athlete's foot, yeast infections, and candidemia (yeast growing in the blood) are examples of diseases caused by fungi.



An example of a fungal infection called ringworm (no worm is involved). Source: CDC.

One fungus that survives well in air, dust, and moisture in healthcare facilities is *Aspergillus spp.*, a ubiquitous, aerobic fungus that is present in soil, water, and decaying vegetation. Site renovation and construction can disturb *Aspergillus*-contaminated dust and produce bursts of airborne fungal spores, which have been associated with clusters of HAIs in immunocompromised patients. Absorbent building materials such as wallboard are an ideal growth medium for this organism if they become and remain wet. Patient-care items, devices, and equipment can become contaminated with *Aspergillus spp.* spores and serve as sources of infection (CDC, 2003).

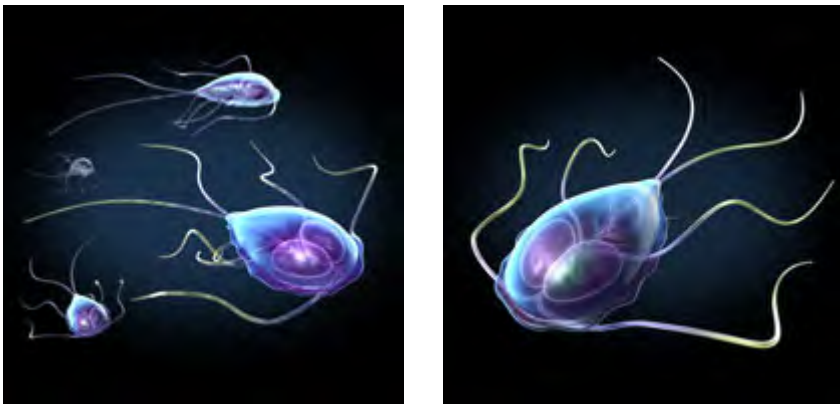
Other opportunistic fungi that are occasionally linked with HAIs are members of the order *Mucorales* and molds such as *Fusarium* and *Penicillium*. Many of these fungi can proliferate in moist environments, for example in water-damaged wood and building materials. Some fungi, such as *Fusarium* and *Pseudoallescheria*, can be airborne. As with aspergillosis, a major risk factor for disease caused by any of these pathogens is the host's severe immunosuppression from either underlying disease or immunosuppressive therapy.

## Protozoa

Protozoa are single- or multi-celled microorganisms that are larger than bacteria. They have traditionally been classified by their means of propulsion: flagella, amoeboid, sporozoan, or ciliate. They may be transmitted in soil, via water, by direct contact, or by an insect such as a mosquito.

Examples of diseases caused by protozoa include malaria and Giardia. Malaria is a protozoan which lives in the blood of the host and is transmitted when an insect bites, ingests infected blood, and then transmits it by biting a new host.

Protozoa are less common than the other types of organisms in the United States and can be treated with specific medications.



These images depict Giardia trophozoites in a variety of positions. Giardia stick closely to the lining of the small intestine in the hosts they infect and cause mild to severe diarrhea. Illustrations provided by 3Dscience.com.



## Parasites

Parasites are usually larger organisms that exploit a host by living on the skin, inside the gut, or in tissues. The life of a parasite is precarious because the host usually does everything it can to destroy the parasite. Parasites are dependent upon the host for survival and employ a number of strategies to move from host to host. They can be transmitted by direct contact, as with lice or scabies, or wait in the external environment until there is contact with the host (ticks, leeches).

Helminthes are a class of parasites that live inside the body and include roundworms, tapeworms, and flukes. They infect humans principally through ingestion of fertilized eggs or when the larvae penetrate the skin or mucous membranes.



The parasitic roundworm *Ascaris lumbricoides*. As many as one-quarter of the world's population is infected with *Ascaris*. Source: Wikipedia.



*Pediculus humanus var capitis*, also known as head louse. Source: Wikipedia.

## Reservoirs

Reservoirs are the places where the germs live and grow. A general rule: If an area stays wet, it is probably a reservoir. The most common reservoirs in healthcare facilities are people, who may be sick or healthy.

Infectious agents transmitted during healthcare derive primarily from human sources. Human reservoirs include patients, healthcare personnel, and household members and other visitors. These **source individuals** may have active infections, may be in the asymptomatic or incubation period of an infectious disease, or may be transiently or chronically colonized with pathogenic microorganisms, particularly in the respiratory and gastrointestinal tracts (Siegel, 2007).

Surprisingly, reservoirs can be complex and difficult to identify. The CDC defines a **reservoir** as “one or more epidemiologically connected populations or environments in which the pathogen can be permanently maintained and from which infection is transmitted to the defined target population” (Haydon et al., 2002).

Although many emerging diseases of human, domestic animal, and wildlife populations are assumed to be maintained in reservoir hosts, these reservoirs may not be identified. Sometimes there is agreement as to where an infectious organism resides and a specific public health action is taken. For example, approximately one million pigs were slaughtered in Malaysia in 1999 to control Nipah virus; several million chickens were slaughtered in Hong Kong in 1998 and 2001 to prevent a projected pandemic of Influenza A virus; and several million cows were slaughtered in Britain to curtail the epidemic of bovine spongiform encephalopathy.

In other instances the identity of reservoirs is less clear; for example, the reservoirs that harbor emerging deadly viruses such as Ebola and Marburg are unknown. Incomplete understanding of reservoirs has hampered control of many diseases in Africa, such as Ebola virus infection, Buruli ulcer, and rabies (Haydon et al., 2002).

In humans, the reservoir and the susceptible host can be the same person and can cause disease if the person’s normal flora gets into the wrong part of the body. For example, oral flora getting into the lungs can cause aspiration pneumonia, skin flora contaminating an IV site can cause a site or bloodstream infection, and fecal flora contaminating the urinary tract can cause a urinary tract infection (UTI). This is why care must be taken to avoid carrying germs between different body sites of the same patient. The most effective prevention technique is to change gloves and do hand hygiene when going from a contaminated area to a cleaner area.

In healthcare facilities, activities aimed at eliminating reservoirs include:

- Treating people who are ill
- Handling and disposing of body fluids carefully
- Using sterile water in respiratory equipment
- Drying equipment before storing it
- Handling food safely and cooking meat thoroughly
- Monitoring soil and contaminated water in sensitive areas of the hospital and washing hands carefully after contact with either
- Vaccinating people
- Encouraging ill workers to stay home

Infection control practices should be followed in all settings where healthcare is delivered, including home care, although the relative risk of acquiring an infection may differ. In acute care, a patient's risk for an HAI is related not only to the severity of illness and exposure to invasive interventions and devices but also to environmental risks, including exposure to other patients and inanimate reservoirs or pathogens. In home care, the rationale and strategy for use of precautions differ from those applied in hospitals. In most cases, the use of gowns, gloves, and masks in the care of homebound patients is recommended to protect the healthcare provider, not the patient.

Caregivers in the home may need to use respiratory protection only when caring for patients with pulmonary tuberculosis (CDC, 2001).

Home care patients known to have a multidrug-resistant organism should be cared for using appropriate barriers. Although these organisms may not be a risk to providers, they may be transmitted to other homecare patients through inanimate objects or hands. Reusable equipment such as stethoscopes and blood pressure cuffs should remain in the home. If practical, such patients should be seen as the last appointment of the day. If this is not possible, visits should be scheduled to avoid seeing at-risk patients—such as patients requiring wound care—after seeing a patient with multidrug-resistant organisms (CDC, 2001).

## Portals of Exit: How Pathogens Leave the Body

A pathogen leaves its reservoir or host through a portal of exit. The portal of exit usually corresponds to the site where the pathogen is located. For example, influenza viruses and *M. tuberculosis* exit from the respiratory tract, cholera exits its host in feces, and *Sarcoptes scabiei* in scabies skin lesions. Some bloodborne pathogens can exit by crossing the placenta from mother to fetus (rubella, syphilis, and toxoplasmosis), while others exit through cuts in the skin or needles (hepatitis B) or blood-sucking insects (malaria) (DHHS, n.d.).

The portal of exit is the link of the chain over which we have the *least* control. Any break in the skin—such as natural anatomical openings or draining lesions—may be a portal of exit from a host. Any body fluid may carry infectious agents out of the body. Some bacteria (such as MRSA) live on the patient's skin, so even dry skin contact may serve as the portal of exit.

Activities aimed at eliminating portals of exit in healthcare facilities include:

- Covering coughs and sneezes with a tissue
- Handling body fluids with gloves—followed by hand hygiene

- Keeping draining wounds covered with a dressing
- Staying home from work when you have wet lesions or weeping dermatitis

## Means of Transmission

Very few germs can fly—almost all have to be carried from one place to another. The means of transmission is the weakest link in the chain of infection, and it is the only link we can hope to eliminate entirely. Most infection control efforts are aimed at preventing the transport of germs from the reservoir to the susceptible host.

All types of precautions (standard, contact, droplet, and airborne) are designed to interrupt the means of transmission. These are reviewed in detail under “Prevention Strategies.” Direct and indirect contact are the most common means of transmission in the healthcare setting—from the hands of the caregivers and items that move patient to patient. Because it addresses the weakest link in the chain of transmission, **hand hygiene is still the single most important procedure for preventing the spread of infection.**

Items moving between patients should be cleaned after each use to avoid indirect contact transmission of pathogens.

Common Means of Transmission	
Type of contact	Example
Direct	Person-to-person transmission of pathogens through touching, biting, kissing, or sexual intercourse
Indirect	Involves an intermediate person or item between the portal of exit and the portal of entry to the next person. Microorganisms may be carried by unwashed hands or soiled objects, called <i>fomites</i> . Any soiled object, such as blood-pressure cuffs, pens, bed rails, used tissues, soiled laundry, or doorknobs, may be a fomite.

An agent or pathogen can be indirectly transmitted from a reservoir to a susceptible host on inanimate objects. Cleaning and disinfection are important practices to ensure that medical equipment surfaces do not serve as reservoirs for infectious pathogens. Hands of healthcare personnel may transmit pathogens after touching an infected or colonized body site on a patient or a contaminated inanimate object if hand hygiene is not performed before touching another patient (Siegel, 2007).

Patient-care devices, such as electronic thermometers, glucose monitoring devices, stethoscopes, blood-pressure cuffs, and other devices may transmit pathogens if they are contaminated with blood or bodily fluids or are shared between patients without cleaning and disinfecting. Shared toys may become a vehicle for transmitting respiratory viruses (eg, respiratory syncytial virus) or pathogenic bacteria (eg, *Pseudomonas aeruginosa*) among pediatric patients (Siegel, 2007).

Toys used by young children should be washable. A system should ensure that they are washed and dried routinely. Older children should wash hands before and after using shared toys or equipment.

Instruments (eg, endoscopes, surgical instruments) that are inadequately cleaned between patients before disinfection or sterilization or that have manufacturing defects that interfere with the effectiveness of reprocessing may transmit bacterial and viral pathogens. Clothing, uniforms, laboratory coats, or isolation gowns used as **personal protective equipment (PPE)** may become contaminated with potential pathogens after care of a patient colonized or infected with an infectious agent (Siegel, 2007).

The potential also exists for soiled garments to transfer infectious agents to successive patients. A 2007 study in a Maryland teaching hospital revealed that 27% of the white coats worn by 109 doctors and other medical professionals were colonized with *S. aureus* and 6% were colonized with MRSA. In a follow-up questionnaire, 65% of the healthcare workers reported they had last washed their white coat more than a week ago and nearly 16% had last washed their coat more than 30 days ago (Treakle, 2006).

Transmission of germs can also occur through the air via droplet or airborne routes. **Droplet transmission** is common, easily spreading infections such as colds, influenza, whooping cough (pertussis), and some forms of meningitis. Droplets are produced when the infected person coughs, sneezes, or speaks. Droplets can travel about 3 to 6 feet before drying out or falling to the ground. Droplet Precautions are designed to interrupt this means of transmission, and respiratory hygiene practices recommend that they be used when caring for any person with active respiratory symptoms.



This photograph captures a sneeze in progress, revealing the plume of salivary droplets as they are expelled in a large cone-shaped array from this man's open mouth, thereby dramatically illustrating the reason for covering your mouth when coughing or sneezing in order to protect others from germ exposure. Source: CDC, 2009.

**Airborne transmission** occurs with only a few infections—those caused by organisms that can survive the drying of respiratory droplets. When the droplets evaporate, they leave behind droplet nuclei, which are so tiny they remain suspended in the air. Diseases transmitted by the airborne route include tuberculosis, chickenpox, measles, severe acute respiratory syndrome (SARS), and smallpox. Airborne Precautions are designed to interrupt this means of transmission.

Means of transmission that are not common in hospitals include:

- Common-source vehicles such as contaminated food, water, milk, or IV fluid. In hospitals, these products are obtained only from safe and approved sources to prevent contamination.
- Vector-borne transmission by an animal carrier such as a rat or mosquito that carries the pathogen from reservoir to host. Hospitals maintain their environment so that vector-borne transmission is not likely to occur.

Activities aimed at eliminating the means of transmission in healthcare facilities include:

- Hand hygiene
- Wearing gloves to minimize contamination of hands and discarding them after each patient
- Maintaining Standard, Contact, Droplet and Airborne Precautions as indicated
- Cleaning, disinfection, or sterilization of equipment used by more than one patient

- Cleaning of the environment, especially high-touch surfaces
- Maintaining directional air flow

## Portals of Entry: How Pathogens Are Introduced

The portal of entry refers to the location through which a pathogen enters a susceptible host. The portal of entry must provide access to tissues in which the pathogen can multiply or a toxin can act. Often, the infectious agent uses the same portal to enter the new host that it used to exit the source host. For example, influenza virus exits the respiratory tract of the source host and enters the respiratory tract of the new host.

Other pathogens follow a so-called fecal-oral route because they exit the source host in feces, are carried on inadequately washed hands to a vehicle such as food, water, or utensils, and enter a new host through the mouth. Other portals of entry include skin, mucous membranes, and blood.

Pathogens cannot cause illness until they gain entry into the body, and, in general, they cannot enter through intact skin. They may gain entry through an anatomical opening, a skin break caused by illness or accident, or an opening created during a medical procedure, such as a surgical wound or an IV site. Preventing or eliminating portals of entry, where possible, and protecting portals that cannot be eliminated is a must for both patients and healthcare personnel.

Examples of portals of entry include:

- Mouth, nose, eyes, and other anatomic openings
- Rash or dermatitis
- Insect bites
- Injuries, from microscopic to major
- Surgical wounds
- Intravenous sites
- Any location, whether anatomic or created, with a tube in place
- Needle-puncture injuries

Activities aimed at protecting or eliminating portals of entry in healthcare facilities include:

- Use of aseptic surgical technique
- Application of dressings on surgical wounds
- Use of IV site dressings and proper care

- Elimination of tubes as soon as possible
- Use of masks, goggles, and face shields
- Protecting your skin to prevent holes (such as dermatitis)
- Keeping unwashed hands and objects away from the mouth
- Use of actions and devices to prevent needlesticks

## **Susceptible Host**

The final link in the chain of infection is the susceptible host. Most of the factors that influence infection and the occurrence and severity of disease are related to the host, although agent and environmental factors also play a role (table below). However, characteristics of the host-agent interaction—such as pathogenicity, virulence, and antigenicity—are also important. The infectious dose, mechanism of disease production, and route of exposure are also factors.



## Factors that Influence the Outcome of an Exposure

- |                       |  |
|-----------------------|--|
| Host factors          | <ul style="list-style-type: none"><li>▪ Extremes of age</li><li>▪ Underlying disease</li><li>▪ HIV/AIDS</li><li>▪ Malignancy</li><li>▪ Transplants</li><li>▪ Medications that alter normal flora, such as antimicrobial agents, gastric acid suppressants, corticosteroids, anti-rejection drugs, antineoplastic agents, and immunosuppressive drugs</li><li>▪ Surgical procedures</li><li>▪ Radiation therapy</li><li>▪ Indwelling devices such as urinary catheters, endotracheal tubes, central venous and arterial catheters, and synthetic implants</li></ul> |
| Agent factors         | <ul style="list-style-type: none"><li>▪ Infectivity</li><li>▪ Pathogenicity</li><li>▪ Virulence</li><li>▪ Size of inoculum</li><li>▪ Route of exposure</li><li>▪ Duration of exposure</li><li>▪ The ability of a pathogen to maintain infectivity over that distance</li></ul>   |
| Environmental factors | <ul style="list-style-type: none"><li>▪ Contamination of environment and equipment</li><li>▪ Availability of means of transmission</li><li>▪ Temperature and humidity</li></ul>  |

Some people exposed to pathogenic microorganisms never develop symptomatic disease while others become severely ill and even die. Those who are extremely old or young, are already ill, have holes in their skin, have invasive devices in place, or are immunocompromised are more susceptible. Still others progress from colonization to symptomatic disease either immediately following exposure or after a period of asymptomatic colonization.

Susceptibility can be reduced in several ways. For some diseases there are effective vaccines and some diseases produce lasting immunity after illness. We have better resistance to disease when we are well rested, well fed, and relatively stress-free. People with healthy immune systems are often able to resist infection even when bacteria do invade.

The healthy body has numerous protective structures and systems that support resistance to infection. These include intact skin, blood circulation bringing white blood cells and nutrients to the tissues, antibodies to previously encountered infectious agents, the inflammatory response, stomach acid, and a robust community of normal flora, which provides competition to invading pathogens. A person with these defense mechanisms intact is said to be **immunocompetent**.

Immune compromise varies in severity and can be temporary or long term. A person who is sick in bed for a few days may be mildly compromised, while a person with a chronic illness such as diabetes is probably moderately and chronically compromised. Someone receiving chemotherapy or a transplant patient may be severely immunocompromised.

Extra care should be taken to protect a person who is immunocompromised. Nutritional status should be closely monitored to support immune competence. The care should be tailored to the specific needs and situation of the patient. Both the very young and very old need extra protection from infection. Any indwelling device (eg, IV catheters, urinary catheters) increases susceptibility. To reduce the risk of infections associated with these devices, the device should be discontinued as soon as the patient no longer needs it.

Infections are sometimes more related to host factors than to the infectious agent. For example, a person who is well rested may resist the virus that makes the over-tired person sick. Some organisms are widely found but only cause disease in a **susceptible host**—such as the person recently treated with antibiotics who then develops a yeast infection. Examples of susceptible hosts include people who:

- Are already ill
- Have invasive devices or tubes in place
- Are malnourished
- Are very old or very young
- Are tired or under high stress
- Have skin breaks such as surgical wounds or IV sites
- Are undergoing steroid therapy or treatment for cancer
- Have HIV infection

- Are well and healthy! (No one is immune to all disease.)

Activities aimed at protecting or eliminating susceptible hosts in healthcare facilities include:

- Preventing exposure of both patients and staff to communicable disease
- Removal of invasive devices as soon as they are no longer needed
- Maintaining good nutrition
- Maintaining good skin condition
- Covering skin breaks
- Vaccinating people against illnesses to which they may be exposed
- Encouraging rest and balance in our lives

## Prevention Strategies

Both science and regulation address prevention of healthcare-associated infections (HAIs). The Centers for Disease Prevention and Control (CDC) provide the chief authority for science. Regulations may be federal, state, or local.

Since 1991, when OSHA first issued its Bloodborne Pathogens Standard to protect healthcare personnel from blood exposure, the focus of regulatory and legislative activity has been on implementing a hierarchy of prevention and control measures. A central tenet is to **consider all patients to be potentially infected with a bloodborne pathogen.**

The federal OSHA Bloodborne Pathogens Standard requires that each employer having employees with occupational exposure to blood or other potentially infectious material shall establish a written exposure control plan designed to eliminate or minimize employee exposure. Among other things, this plan must address:

- Standard/Universal Precautions, including hand hygiene (Element II)
- Engineering and work practice controls (See Element III.)
- Personal protective equipment (PPE) (See Element IV.)
- Housekeeping, Laundry, regulated waste (See Element V.)
- Contaminated sharps and equipment (See Element III.)
- Hepatitis B vaccination and exposure follow-up (See element VI.)
- Employee communication and education (See Element VI.)
- Recordkeeping

The Exposure Control Plan must be available to employees. Many of the educational requirements are addressed in this course, but it does not take the place of an employer-specific Exposure Control Plan.

The complete **federal** Bloodborne Pathogens Standard is available at [www.osha.gov](http://www.osha.gov).

## Standard and Universal Precautions

**Universal Precautions** were originally developed by OSHA to protect healthcare workers from bloodborne pathogens, such as HIV, Hepatitis B (HBV), and hepatitis C (HCV). Universal Precautions were developed for use with ALL patients because those with bloodborne infections may be asymptomatic or unaware of their infectious status. Universal Precautions continue to be required by the OSHA Bloodborne Pathogens Standard.

Universal Precautions requires avoidance of contact with blood or other potentially infectious materials (OPIM). OSHA defines "other potentially infectious materials" as (1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; (2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and (3) HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Because the focus of Universal Precautions was narrow (protect healthcare workers from bloodborne pathogens), the CDC was led to develop Standard Precautions, which include all of Universal Precautions and more.

Standard Precautions protect patients and healthcare workers from many bacterial and viral infections, including bloodborne pathogens. When we use Standard Precautions, we are in full compliance with Universal Precautions.

Standard Precautions tell us to avoid contact with:

- Blood and all body fluids from all patients. Any body fluid may carry microorganisms.
- Mucous membranes
- Non-intact skin (abrasions, dermatitis, rash)

Standard Precautions, as described by the CDC, requires all of the following:

- Assume that every person is potentially infected or colonized.

- Perform hand hygiene correctly and routinely.
- Use personal protective equipment (PPE)—see Element IV. Note that mask, eye protection and gown may be required for care of a patient on Standard Precautions. Supplies must be readily available.
- Use safe injection practices to protect patients and workers—Elements II and III.
- Clean patient-care equipment and the environment as described in Element V.
- Implement Respiratory Hygiene in all areas where people with respiratory symptoms may be seen.

Respiratory Hygiene was incorporated into Standard Precautions by the CDC in 2007, to:

- Educate healthcare personnel on the importance of source control measures to prevent droplet and fomite transmission of respiratory infection. Cover the portal of exit!
- Put these measures in place beginning at the point of initial encounter in the healthcare setting.
- Apply them to both patients and accompanying individuals.
- Post signs at entrances and other key locations asking people with respiratory symptoms to cover their mouths and noses when coughing or sneezing, to dispose of tissues and do hand hygiene. Signs in several languages are available from the CDC.
- Provide tissues, waste receptacles, and hand hygiene materials.
- Offer a simple mask to coughing patients.
- Encourage coughing patients to stay at least 3 feet away from others.

## Correct Use of Standard Precautions

- Always
- Use good hand hygiene.
  - Use gloves for contact with blood, body fluids, non-intact skin (including rash), mucous membranes, used equipment, linen, and trash.
  - Use a gown any time your clothing may become soiled and if a patient has uncontained body substances.
  - Use a mask and eye protection if you may be splashed. OSHA-compliant eye protection must have solid side shields.
  - Change gloves if they become heavily soiled or if you must go from a dirtier area to a cleaner one.
- Never
- Wear artificial fingernails—check your facility’s policy for details.
  - Touch a second patient with the same pair of gloves.
  - Re-use gowns, even for repeated contacts with the same patient.
  - Contaminate the environment with dirty gloves.
  - Wear gloves in the hall unless you can say why you are wearing them.

## Transmission-Based Precautions

The CDC also recommends, for patients with certain infections, use of transmission-based precautions, **in** addition to Standard Precautions. Standard Precautions are used with all patients and do not require a sign on the door. Patients being cared for using Contact, Droplet, or Airborne Precautions will have a sign on the door in most facilities. Note that the sign on the door may not specify the patient’s diagnosis for reasons of privacy.

Precautions may vary between facilities. Refer to your facility’s policies for details. Details for all types of precautions may be found in the CDC Guideline for Isolation Precautions, 2007. The list of diseases requiring transmission-based precautions and the duration of those precautions may be found in Appendix A of that guideline.

Facilities should have policies for transport of the patient outside the room, addressing each type of transmission-based precautions.

## Contact Precautions

The following are CDC recommendations for acute-care facilities. Other types of facilities should develop policies based on the Guideline.

- Hand hygiene is critical in the care of these patients.

- Visitors must perform hand hygiene on leaving the room.
- Use a single-patient room as possible. Consult with Infection Control staff if not possible.
- Wear gloves to enter the room. Change gloves as specified by Standard Precautions.
- Wear a gown to enter the room.
- Use single-patient equipment, left in the room, as possible.
- Disinfect any equipment that must leave the room.
- Clean and disinfect these rooms at least daily.

Supplies needed include:

- Gloves
- Gowns
- Disinfectant for removed equipment
- Trash container for discarded PEP
- Single-patient use equipment

Contact Precautions are often used to care for patients with Methicillin-resistant *Staph aureus*, *C. difficile*, wounds with uncontained drainage, and a number of other infections.

## Droplet Precautions

The following are CDC recommendations for acute-care facilities. Other types of facilities should develop policies based on the Guideline.

- Use a single-patient room as possible. Consult with Infection Control staff if not possible.
- Maintain at least 3 feet separation between the patient and others.
- If two patients must share a room, draw the privacy curtain between them.
- Hand hygiene must be done as specified for Standard Precautions.
- Staff should wear a simple mask to enter the room.
- Supplies needed (beyond Standard Precautions) are limited to simple masks.

Droplet Precautions are used to provide care to patients with influenza, pertussis, some types of meningitis, undiagnosed respiratory infections, and several other diseases.

## Airborne Precautions

Airborne Precautions are the **only** type that require:

- Airborne Infection Isolation room—AIIR—a negative pressure isolation room
- N-95 respirator or PAPR. See the discussion of tuberculosis, following, for these types of respiratory protection.
- Supplies needed (beyond Standard Precautions) are limited to the appropriate respiratory protection.

AIIRs have very specific requirements and are often available only in acute care facilities. If a disease requiring Airborne Precautions is suspected and an AIIR is not available, place a simple mask on the patient and place him/her in a separate room with its door closed while transfer to a facility with an available AIIR is arranged. Non-acute care settings should have well-known policies for identifying and managing such patients.

If patients must come out of the AIIR, put a simple mask on them, as a tight-fitting respirator may not be tolerated and is not indicated.

Airborne Precautions are used for patients known or suspected of having:

- Tuberculosis, active pulmonary or rule-out
- Chickenpox
- Measles
- Disseminated herpes zoster (shingles of more than one dermatome)
- SARS
- Smallpox

Every year, more than 9 million people worldwide develop TB and nearly 2 million people die from the disease. Tuberculosis is a bacterial infection caused by *Mycobacterium tuberculosis* and is spread in airborne droplets when people with the disease cough or sneeze. Most people with healthy immune systems infected with *M. tuberculosis* never become ill. However, the bacteria remain dormant within the body and can cause tuberculosis years later if host immunity declines.

The person who is most likely to transmit tuberculosis is the person who has not been diagnosed—the unknown carrier. Identification without delay of the person with active tuberculosis is critical so that isolation and treatment can prevent transmission to others.

Active TB does have symptoms, which depend on where in the body the TB bacteria are growing. Tubercular disease in the lungs may cause symptoms such as a bad cough that lasts 3 weeks or longer, pain in the chest, or coughing up blood or sputum (phlegm from deep inside the lungs). Other symptoms of active TB disease are weakness or fatigue, weight loss, no appetite, chills, fever, or sweating at night (CDC, 2005).



Diagnostic tests for the disease include chest x-rays, the tuberculin skin test, and sputum cultures. Tuberculosis can usually be cured by taking several powerful antibiotics daily for several months (Escombe et al., 2008).

Because tuberculosis is the primary disease transmitted by a true airborne route, and because it is the undiagnosed person who is most likely to transmit disease, the CDC recommends a three-level hierarchy of controls: administrative, environmental, and respiratory protection controls.

**Administrative controls** specify who is in charge of the facility's TB control program, including critical infrastructure such as laboratories as well as other services needed to maintain an effective program. A key component is having a plan to ensure prompt detection, airborne precautions, and treatment of persons who have suspected or confirmed TB disease. Diagnose, isolate, and treat to prevent exposing others.

**Environmental controls** are responsible for containing the source of exposure, primarily by the use of Airborne Infection Isolation (AII) rooms that provide negative-pressure ventilation.

**Respiratory controls** address the protection of people who must be protected from contaminated air when they enter the AII room. Most facilities provide N-95 respirators, which must be fit-tested. Some facilities exclusively use powered air-purifying respirators (PAPRs, see below) for all staff; they do not require fit testing. Check your facility's policies for what respiratory protection is made available for visitors.

Tuberculosis infectiousness usually declines within weeks of beginning treatment. The patient must show clear clinical improvement before isolation is discontinued because the patient with resistant organisms remains infectious if initial treatment is not effective. Airborne Precautions for tuberculosis may be discontinued when both of the following criteria have been met: (1) clinical improvement, and (2) three consecutive sputum smears negative for acid-fast bacilli (TB germs).

Each of the three sputum specimens should be collected in eight 24-hour intervals and at least one specimen should be an early morning specimen.

For current guidelines, consult CDC Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings.

### Powered Air-Purifying Respirator Hood



Multidrug-resistant TB (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) have become more common and are highly infectious. Treatment of drug-resistant TB is much more difficult than normal tuberculosis, requiring even more antibiotics, and for long periods, up to 2 years and beyond. In addition, because HIV weakens the immune system, HIV-positive people are much more likely to develop active tuberculosis (and to die from the disease, which speeds the development of AIDS) than people with a healthy immune system (Enscombe et al., 2008).

## Hand Hygiene

The term **hand hygiene** includes both the use of an alcohol-based hand rub and washing with soap and water.

The chain of infection makes it clear why hand hygiene is critical. For generations, handwashing with soap and water has been the standard measure of personal hygiene. The concept of cleansing hands with an antiseptic agent probably emerged in the early nineteenth century. As early as 1822, a French pharmacist demonstrated that solutions containing chlorides of lime or soda could eradicate the foul odors associated with human corpses and that such solutions could be used as disinfectants and antiseptics. In a paper published in 1825 this pharmacist stated that physicians and other persons attending patients with contagious diseases would benefit from moistening their hands with a liquid chloride solution (CDC, 2002).

2002 CDC Guidelines for Hand Hygiene brought a major change in hand hygiene practices. While washing with soap and water is still required in some situations, now the use of an alcohol-based hand rub is preferred for routine use.

Despite the simplicity and effectiveness of hand hygiene in preventing the spread of infectious disease, adherence to hand hygiene practice remains unacceptably low throughout the world. Although measuring hand hygiene adherence is not a simple task, an oft-cited study by Pittet (2001) noted that adherence varies among professional categories of healthcare workers and between hospital departments but is usually estimated as less than 50%.

CDC (2002) has described observed and self-reported factors that influence adherence to hand hygiene practices.

### Observed Risk Factors for Poor Adherence

- Physician (rather than nurse)
- Nursing assistant (rather than nurse)
- Male gender

- Working in intensive care unit
- Working during the week (rather than weekend)
- Wearing gowns/glove
- Automated sink
- Activities with high risk of cross contamination
- High number of hand hygiene opportunities per hour of patient care

### Self-Reported Factors for Poor Adherence

- Handwashing agents cause irritation and dryness
- Sinks inconveniently located
- Lack of soap and paper towels
- Too busy
- Understaffing or overcrowding
- Patient needs take priority
- Hand hygiene interferes with patient/healthcare worker relationship
- Low risk of acquiring infection from patient
- Believing that wearing gloves means hand hygiene is unnecessary
- Lack of knowledge
- Forgetfulness
- Lack of role model
- Skepticism about need for hand hygiene
- Disagreement with recommendations
- Lack of scientific data to back up need for hand hygiene

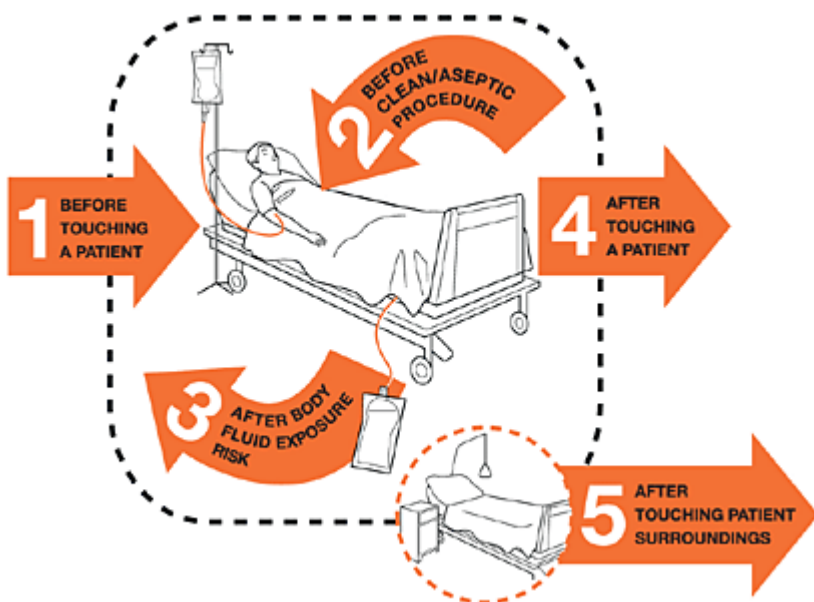
For healthcare workers, adherence to hand hygiene guidelines protects both the patient and the worker. Hand hygiene should be done when:

- You first come on duty
- Before you touch your first patient or clean equipment
- Before and after every patient contact, including after touching intact skin
- Before any clean or invasive procedure
- Before putting on sterile gloves
- Before contact with any portal of entry, your patient's or your own

- After contact with any body fluids, including your own
- After unprotected contact with mucous membranes or non-intact skin
- Each time you remove your gloves
- When leaving an isolation room
- When going from a dirtier to a cleaner part of the patient
- When your hands feel or look dirty
- After contact with contaminated things or environments, such as charts
- After handling used equipment or linen
- After using the bathroom
- Before and after eating
- Before going off duty

## My 5 Moments for Hand Hygiene

The **My 5 Moments for Hand Hygiene** approach defines the key moments when healthcare workers should perform hand hygiene. This evidence-based, field-tested, user-centered approach is designed to be easy to learn, logical, and applicable in a wide range of settings.



Source: Copyright © World Health Organization, 2009. All rights reserved.

## Alcohol Sanitizer or Soap and Water

If you can see dirt on your hands—whether from blood, body fluid, or other visible soiling—wash your hands with soap and water, which physically removes the dirt from your hands. Washing with soap and water **does not** kill germs.

Alcohol hand rubs **do** kill most germs including viruses, but they **do not** remove dirt and debris from your hands. If you use alcohol, choose a hand hygiene product that contains alcohol; plain alcohol should not be used because it evaporates too quickly to provide enough contact time to kill germs.

How to do hand hygiene right:

- If using soap, wet your hands first to minimize skin irritation.
- Use friction on all surfaces to loosen dirt and germs.
- Scrub for at least 15 seconds (*Row, Row, Row Your Boat*, twice).
- Use a comfortable water temperature; water hot enough to kill germs would injure your skin.
- Use alcohol hand rubs on dry skin only.
- Use one measured amount of alcohol sanitizer, and rub until hands are completely dry; do not wipe off with a paper towel.

For routine hand hygiene, alcohol products are preferred. They are better than soap and water because:

- They kill germs more effectively
- They leave skin in better condition
- They are quicker and easier so are used more frequently

When dealing with diarrhea that may be infectious, use soap and water. Both *Clostridium difficile* and norovirus cause diarrhea and neither is well-killed by alcohol-based hand rubs.

Because alcohol products are effective antimicrobial agents, the CDC does not specify an antimicrobial soap for routine hand hygiene. Antimicrobial soaps are often more irritating to the skin, are more expensive, and tend to build up in the environment. "Plain" soap removes germs from the hands as well as an antimicrobial product.

## Hand Washing Video



[Click here](#) or on the image to view the video. Source: CDC.

# Element III: Engineering and Work Practice Controls

**The use of engineering and work practice controls to reduce the opportunity for patient and healthcare worker exposure to potentially infectious material should be standard practice in all healthcare settings, not only in hospitals. Facilities are required to address and manage high-risk practices and procedures capable of causing healthcare-acquired infections (HAIs) from bloodborne pathogens.**

[The following information is taken from the OSHA Bloodborne Pathogens Standard, 1910.1030.]

**Engineering controls** such as sharps disposal containers, self-sheathing needles, and safer medical devices (sharps with engineered sharps injury protections and needleless systems) isolate or remove the bloodborne pathogens hazard from the workplace.

**Work practice controls** reduce the likelihood of exposure by altering the manner in which a task is performed (eg, prohibiting recapping of needles by a two-handed technique).

Engineering and work practice controls are intended to eliminate or minimize employee exposure. They must be examined and maintained or replaced on a regular schedule to ensure their effectiveness. Engineering controls usually involve an object, such as a safer chemical, syringe with engineered safety protection, sharps container, or splash guard. Work practice controls reduce risk by altering the way a task is performed. Work practice controls tell how to do the job safely, and should be described in written procedures. Engineering and work practice controls are designed to reduce risk of percutaneous, mucous membrane/non-intact skin or parenteral exposures of workers.

**Percutaneous** (through the skin) **exposures** can occur during handling, disassembly, disposal, and reprocessing of contaminated needles and other sharp objects, or via human bites, cuts, and abrasions.

Activities which risk percutaneous exposures include manipulating contaminated needles and other sharp objects by hand, removing scalpel blades from holders, and removing needles from syringes can lead to a percutaneous injury.

Delaying or improperly disposing of sharps, leaving contaminated needles or sharp objects on counters or workspaces, or disposing of sharps in nonpuncture-resistant receptacles can lead to injury. Recapping contaminated needles and other sharp objects using a two-handed technique is a common cause of injury. Percutaneous exposures can also occur when performing procedures where there is poor visualization—such as blind suturing, non-dominant hand positioned opposed or next to a sharp, and performing procedures where bone spicules or metal fragments are produced.

**Mucous membrane/non-intact skin exposures** occur when there is direct blood or body fluids contact with the eyes, nose, mouth, or other mucous membranes. This can occur via contact with contaminated hands, contact with open skin lesions/dermatitis, and from splashes or sprays of blood or body fluids (eg, during irrigation or suctioning).

**Parenteral** refers to a route of transmission or administration that involves piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions. A **parenteral exposure** occurs as a result of injection with infectious material, which can occur during administration of parenteral medication, sharing of blood monitoring devices such as glucometers, hemoglobinometers, lancets, and lancet platforms/pens, and infusion of contaminated blood products or fluids.

According to OSHA, nurses sustain the most needlestick injuries, and as many as one-third of all sharps injuries occur during disposal. The CDC estimates that 62% to 88% of sharps injuries can be prevented simply by using safer medical devices.

## Safe Injection Practices: Protecting Patients

Needles, cannulae and syringes are sterile, single-use items—any use will result in these items being contaminated. They are contaminated once they are used to enter or connect to any component of a patient's intravenous infusion set. After use, immediately dispose of all needles and syringes into a leak-proof, puncture-resistant, closable container. Develop policies and procedures to prevent sharps injuries among staff and review them regularly (NYSDOH, 2008).

## Medications and Solutions

A pathogen can be indirectly transmitted through contaminated medications and injection equipment. For this reason, medications and solutions must be properly handled whether they are single or multidose. To prevent cross contamination, preparation and disposing of medications should be handled in areas designated for that purpose.

The reuse of needles or syringes and the misuse of medication vials are serious threats to public health. Healthcare providers should never reuse a needle or syringe, either from one patient to another or to withdraw medicine from a vial. Both needle and syringe must be discarded once they have been used. It is not safe to change the needle and reuse the syringe—reuse of needles or syringes to access medication can result in contamination of the medicine with infectious material that can be spread to others when the medicine is used again (CDC, 2011b).

### **Injectable Device**



Neither portion of the injectable device may be reused under any circumstances.  
Source: CDC.

### **Single-Dose Vials**

A single-use vial is a bottle of liquid medication that is given to a patient through a needle and syringe. Single-use vials contain only one dose of medication and should only be used once for one patient, using a clean needle and clean syringe. Use single-dose vials for parenteral medications whenever possible. Do not administer medications from single-dose vials or ampoules to multiple patients or combine leftover contents for later (CDC, 2011b).

### **Multidose Vials**

A multidose vial is a small sealed container holding more than one dose of medication, vaccine or fluid. The advantages of multidose vials include being able to adjust dosage of medication easily, less waste of left-over medication, cost savings in packaging, and ease of use. For the medication to remain sterile and safe for use between patients, a new sterile needle and syringe must be used every time the vial is entered.



CDC has investigated many outbreaks associated with syringe reuse and other lapses in recommended infection control practices. For example, in 2008 CDC investigated a Las Vegas endoscopy clinic and identified six cases of HCV infection among patients who had undergone procedures at the clinic in the 35 to 90 days prior to onset of symptoms. On investigation of the clinic, officials observed practices that had the potential to transmit HCV. On the basis of these findings, CDC and the Southern Nevada Health District notified 40,000 patients who had potentially been exposed to HCV and other infectious diseases through that clinic (CDC, 2009).

A recent review of HBV and HCV outbreak information in 12 outpatient clinics, 16 hemodialysis centers, and 15 long-term care facilities revealed that 448 people became infected with HBV or HCV between 1998 and 2008 as a result of poor infection control practices or failure to use aseptic technique (Thompson et al., 2009).

To prevent these sorts of breaches, **minimize the use of multidose vials whenever possible**. If multidose vials must be used, always use aseptic technique. Use a new needle or cannula and a new syringe to access the multidose vial. Do not keep the vials in the immediate patient treatment area. Do not use bags or bottles of IV solution as a common source of medication or fluid for multiple patients. Use infusion sets (ie, intravenous bags, tubing, and connectors) for one patient only and dispose appropriately after use (NYSDOH, 2008).

## Aseptic Technique

Aseptic technique involves the handling, preparation, and storage of medications in a manner that prevents microbial contamination. It also applies to the handling of all supplies used for injections and infusions, including syringes, needles, and IV tubing. To avoid contamination, medications should be drawn up in a clean medication preparation area. Any item that may have come in contact with blood or bodily fluids should be kept separate from medications. Incorrect practices that have resulted in transmission of hepatitis C or hepatitis B virus include using:

- The same syringe to administer medication to more than one patient, even if the needle was changed
- The same medication vial for more than one patient, and accessing the vial with a syringe that has already been used to administer medication to a patient
- A common bag of saline or other IV fluid for more than one patient, and accessing the bag with a syringe that has already been used to flush a patient's catheter

In addition to strictly adhering to aseptic technique, ensure that all staff perform proper hand hygiene before and after gloving, between patients, and whenever hands are soiled. Avoid cross contamination with soiled gloves. Provide adequate soap and water, disposable paper towels, and waterless alcohol-based hand rubs throughout all medical facilities (NYSDOH, 2008).

## Safe Injection Practices

[This section is derived largely from NYSDOH, 2010.]

Safe injection practices are designed to prevent disease transmission from patient to patient and healthcare worker to patient. The absence of visible blood or signs of contamination in a used syringe, IV tubing, multidose medication vial, or blood glucose monitoring device does *not* mean the item is free from potentially infectious agents. Bacteria and other microbes can be present without clouding or other visible evidence of contamination. All used injection supplies and materials are potentially contaminated and should be discarded.

Many cases reported to the CDC in which a bloodborne pathogen was transmitted as a result of improper injection practices have common themes and findings. Often aseptic technique and Standard Precautions were not carefully followed. In many cases infection control programs were lacking or responsibilities were unclear. Lack of recognition of an IC breach led to prolonged transmission and a growing number of infected patients. In all cases, investigations were time-consuming and costly and required the notification, testing, and counseling of hundreds and sometimes thousands of patients.

To ensure safe injection practices, providers should use aseptic technique throughout all aspects of injection preparation and administration. Medications should be drawn up in a designated “clean” medication area that is not adjacent to areas where potentially contaminated items are placed. In addition:

- Use a new sterile syringe and needle to draw up medications for each patient. Prevent contact between the injection materials and the non-sterile environment.
- Practice proper hand hygiene before handling medications.
- Disinfect the rubber septum of a medication vial with alcohol prior to piercing.
- Discard medication vials upon expiration or any time there are concerns regarding the sterility of the medication.

Never leave a needle or other device inserted into a medication vial septum, IV bag, or bottle for multiple uses. This provides a direct route for microorganisms to enter the vial and contaminate the fluid. Medications should never be administered from the same syringe to more than one patient, even if the needle is changed. Never use the same syringe or needle to administer IV medications to more than one patient, even if the medication is administered into the IV tubing, regardless of the distance from the IV insertion site.

Keep in mind that all of the infusion components from the infusate to the patient's catheter are a single interconnected unit. All of the components are directly or indirectly exposed to the patient's blood and cannot be used for another patient. Syringes and needles that intersect through any port in the IV system also become contaminated and cannot be used for another patient or used to re-enter a nonpatient-specific multidose vial. Separation from the patient's IV by distance, gravity, or positive infusion pressure does not ensure that small amounts of blood are not present in these items.

Dedicate vials of medication to a single patient. Never enter a vial with a syringe or needle that has been used for a patient if the same medication vial might be used for another patient. Medications packaged as single-use must never be used for more than one patient. Never combine leftover contents for later use. Medications packaged as multi-use should be assigned to a single patient whenever possible. Never use bags or bottles of IV solution as a common source of supply for more than one patient.

Peripheral capillary blood monitoring devices packaged for single-patient use should never be used on more than one patient. Restrict use of peripheral capillary blood sampling devices to individual patients. Never reuse lancets. Consider selecting single-use lancets that permanently retract upon puncture. Whenever possible evaluate and select safer devices to prevent sharps injuries (NYSDOH, 2010).

## **Sharps Safety: Protecting Healthcare Workers**

[This section is derived from NYSDOH, 2010.]

There has been increased focus on removing sharps hazards through the development and use of engineering controls. In November 2000 the Federal Needlestick Safety and Prevention Act authorized OSHA's revision of its Bloodborne Pathogens Standard to require the use of safety-engineered sharp devices (see below). The CDC has provided guidance on the design, implementation, and evaluation of a comprehensive sharps injury prevention program. This includes measures to handle needles and other sharp devices in a manner that will prevent injury to the user and to others who may encounter the device during or after a procedure.

Healthcare workers must follow proper technique when using and handling needles, cannulae, and syringes. Whenever possible, use sharps with engineered sharps injury protections—for example, non-needle sharp or needle devices with built-in safety features or mechanisms that effectively reduce the risk of an exposure incident. Do not disable or circumvent the safety feature on devices.

Always activate safety features—do not circumvent them. Modify procedures if necessary to avoid injury. For example:

- Use forceps, suture holders, or other instruments for suturing.
- Avoid holding tissue with fingers when suturing or cutting.
- Avoid leaving exposed sharps of any kind on patient procedure or treatment work surfaces.
- Use appropriate safety devices whenever available.

### Sharps with Safety Features Exposed (left) and Covered (right)



Source: CDC.

In surgical and obstetrical settings where the use of exposed sharps cannot be avoided, work-practice controls are an important adjunct for preventing blood exposures, including percutaneous injuries. Operating room controls include:

- Using instruments, rather than fingers, to grasp needles, retract tissue, and load/unload needles and scalpels
- Giving verbal announcements when passing sharps
- Avoiding hand-to-hand passage of sharp instruments by using a basin or neutral zone
- Using alternative cutting methods such as blunt electrocautery and laser devices when appropriate
- Substituting endoscopic surgery for open surgery when possible
- Using round-tipped scalpel blades instead of sharp-tipped blades (CDC, 1999)

The use of blunt suture needles, an engineering control, is also shown to reduce injuries in this setting. These measures help protect both the healthcare provider and the patient from exposure to the other's blood (CDC, 1999).

Puncture-resistant containers located at the point of use are used to discard sharps, including needles and syringes, scalpel blades, unused sterile sharps, and discarded slides or tubes with small amounts of blood. To prevent needlestick injuries, needles and other contaminated sharps should not be recapped, purposefully bent, or broken by hand.

As part of their responsibility for providing a safe workplace, employers must provide handwashing facilities that are readily accessible to employees. If it is not feasible to provide handwashing facilities, the employer must provide antiseptic hand cleanser and clean cloth or paper towels, or antiseptic towelettes. When antiseptic hand cleansers or towelettes are used, hands should be washed with soap and running water as soon as possible.

## **Work Practice Controls: How to Do the Job Safely**

Contaminated needles and other contaminated sharps should not be bent, recapped, or removed unless the employer can demonstrate that there is no alternative or that such action is required by a specific procedure. Shearing or breaking of contaminated needles is prohibited.

Any required manipulation must be accomplished through the use of a mechanical device or a one-handed technique.

Immediately, or as soon as possible after use, contaminated reusable sharps must be placed in appropriate containers until properly reprocessed. These containers must be:

- Puncture resistant
- Labeled or color-coded in accordance with this standard

- Leakproof on the sides and bottom
- Maintained in accordance with OSHA requirements for reusable sharps

Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure. Food and drink should not be kept in refrigerators, freezers, shelves, cabinets, or on countertops or bench tops where blood or OPIM are present. It may be useful to designate areas to be kept free of body fluids (no specimens or gloves) where drinks may be permitted.

All procedures involving blood or other potentially infectious materials must be performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances. Mouth pipetting or suctioning of blood or OPIM is prohibited.

Specimens of blood or other potentially infectious materials must be placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping. The container must be labeled or color-coded according to OSHA guidelines. When a facility utilizes Standard Precautions in the handling of all specimens, the labeling or color-coding of specimens is not necessary provided containers are recognizable as containing specimens, although this exemption only applies while such specimens or containers remain within the facility. Labeling or color-coding is required when such specimens or containers leave the facility.

If outside contamination of the primary container occurs, the primary container must be placed within a second container that prevents leakage during handling, processing, storage, transport, or shipping, and is labeled or color-coded according to the requirements of this standard. If the specimen could puncture the primary container, the primary container shall be placed within a secondary container that is puncture-resistant in addition to the above characteristics.

Equipment that may become contaminated with blood or other potentially infectious materials must be examined before servicing or shipping and be decontaminated as necessary, unless the employer can demonstrate that decontamination of such equipment or portions of such equipment is not feasible. A readily observable label must be attached to the equipment stating which portions remain contaminated.

The employer must ensure that this information is conveyed to all affected employees, the servicing representative, and the manufacturer before handling, servicing, or shipping, so that appropriate precautions will be taken.

Use splatter shields on medical equipment associated with risk-prone procedures (eg, locking centrifuge lids). Gloves used for the task of sorting laundry should be of sufficient thickness to minimize sharps injuries.

### General Practices for the Workplace

- Use proper hand hygiene, including the appropriate circumstances in which alcohol-based hand sanitizers and soap-and-water handwashing should be used.
- Use proper procedures for cleaning of blood and bodily fluid spills, including initial removal of bulk material followed by disinfection with an appropriate disinfectant.
- Practice proper handling and disposal of blood and bodily fluids, including contaminated patient care items.
- Select, put on, take off, and dispose of PPE as trained.
- Protect work surfaces in direct proximity to patient procedure treatment areas with appropriate barriers to prevent instruments from becoming contaminated with bloodborne pathogens.
- Prevent percutaneous exposures by avoiding unnecessary use of needles and other sharp objects.
- Use care in the handling and disposing of needles and other sharp objects.

## Evaluation/Surveillance of Exposure Incidents

Employers must identify those at risk for exposure and what devices cause exposure. **All** sharp devices can cause injury and disease transmission if not used and disposed of properly. For example, hollow-bore needles have a higher disease transmission risk, while butterfly-type IV catheters, devices with recoil action, and blood glucose monitoring devices (lancet platforms/pens) have a higher injury rate.

## Where Exposures Occur

Sharps injuries don't just occur in hospitals and labs—they can occur in other healthcare settings, such as nursing homes, clinics, emergency care services, and private homes. Although it is estimated that more than 350,000 sharps injuries occur each year in the United States, the CDC estimates 50% or more of healthcare personnel do not report occupational percutaneous injuries (CDC, 2008). Six sharps devices are responsible for nearly 80% of all injuries. These are:

- Disposable syringes (30%)
- Suture needles (20%)

- Winged steel needles (12%)
- Scalpel blades (8%)
- Intravenous (IV) catheter stylets (5%)
- Phlebotomy needles (3%)

Devices requiring manipulation or disassembly after use (such as needles attached to IV tubing, winged steel needles, and IV catheter stylets) are associated with a higher rate of injury than the hypodermic needle or syringe. Injuries from hollow-bore needles, especially those used for blood collection or IV catheter insertion, are of particular concern. These devices are likely to contain residual blood and are associated with an increased risk for HIV transmission. Overall, hollow-bore needles are responsible for 56% of all sharps injuries (CDC, 2008).

The largest percentage (39%) of sharps injuries occur on inpatient units, particularly medical floors and intensive care units. The operating room is the second most common environment in which sharps injuries occur, accounting for 27% of injuries overall. Injuries most often occur:

- After use and before disposal of a sharp device (40%)
- During use of a sharp device on a patient (41%)
- During or after disposal (15%) (CDC, 2008)

Although nurses sustain the highest number of percutaneous injuries, other patient-care providers, laboratory staff, and support personnel are also at risk. Nurses are the predominant occupational group injured by needles and other sharps, in part because they are the largest segment of the workforce at most hospitals (CDC, 2008).

## Element IV: Personal Protective Equipment

**Selection and use of barriers and/or personal protective equipment (PPE) for preventing patient and healthcare worker contact with potentially infectious material.**

Personal protective equipment (PPE) includes barriers such as gloves, gowns, masks, goggles, and face shields. They protect patients and workers from exposure to bloodborne pathogens and tuberculosis on the job. Use of PPE is part of Standard Precautions, used with **all** patients, and is required by OSHA.



Under OSHA's General Duty Clause, PPE is also required for any potential infectious disease exposure. Employers must provide their employees with appropriate PPE and ensure its proper disposal. If reusable, it must be properly cleaned or laundered, repaired, and stored after use (CDC, 2004).

## Selecting PPE

Selection of PPE—particularly the combination of more than one type of protective equipment—is determined by the category of the patient's isolation precautions and the type of anticipated exposure. Touch, splashes or sprays, or large volumes of blood or bodily fluids might penetrate protective clothing. Anticipated exposure will affect whether PPE needs to be fluid resistant, fluid proof, or neither. When selecting protective equipment, consider its durability and appropriateness for the task (CDC, 2004).

Procedures that generate splashes or sprays of blood, body fluids, secretions, or excretions—such as endotracheal suctioning, bronchoscopy, invasive vascular procedures—require either a face shield (disposable or reusable) or mask and goggles. The wearing of masks, eye protection, and face shields in specified circumstances when blood or bodily fluid exposures are likely to occur is mandated by the OSHA Bloodborne Pathogens Standard. Use sterile barriers for invasive procedures and masks for the prevention of droplet contamination.

## Types of PPE/Barriers

**Personal protective equipment (PPE)** is “specialized clothing or equipment worn by an employee for protection against infectious materials.” In addition to the familiar gloves and gowns, PPE includes a variety of barriers and respirators used alone or in combination to protect skin, mucous membranes, and airways from contact with infectious agents. The selection of PPE is based on the nature of the patient interaction and the likely mode of transmission (CDC, 2004).

### Gloves

Wear gloves:

- When contact with blood, body fluid, mucous membranes or non-intact skin is anticipated
- When performing vascular access procedures
- For contact with contaminated items or surfaces (OSHA)

Always change gloves between patients!

- Always do hand hygiene following removal of gloves, in case of:
- unsuspected holes in the gloves
- contamination of the hands during glove removal

Gloves used in the healthcare setting are subject to FDA evaluation and clearance. Nonsterile disposable medical gloves made of latex or nitrile should be available for routine patient care.

In the non-surgical setting, the selection of glove type is based on the task to be performed, anticipated contact with chemicals and chemotherapeutic agents, latex sensitivity, sizing, and facility policies for creating a latex-free environment. For contact with blood and body fluids, a single pair of gloves generally provides adequate barrier protection (CDC, 2004).

There is considerable variability among gloves. Both the quality of the manufacturing process and type of material influence their effectiveness. While there is little difference in the barrier properties of unused intact gloves, studies have repeatedly shown that vinyl gloves have higher failure rates than latex or nitrile gloves when tested under simulated and actual clinical conditions. For this reason either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity or will involve more than brief patient contact. Heavier, reusable utility gloves are indicated for non-patient care activities, such as handling or cleaning contaminated equipment or surfaces (CDC, 2004).

During patient care, transmission of infectious organisms can be reduced by adhering to the principles of working from “clean” to “dirty,” and confining or limiting contamination to surfaces that are directly needed for patient care. It may be necessary to change gloves during the care of a single patient to prevent cross-contamination of body sites. It also may be necessary to change gloves if the patient interaction involves touching portable computer keyboards or other mobile equipment that is transported from room to room (CDC, 2004).

Gloves **must be changed** between patients to prevent transmission of infectious material. They should never be washed and reused because microorganisms cannot be removed reliably from glove surfaces and continued glove integrity cannot be ensured. Glove reuse has been associated with transmission of MRSA and gram-negative bacilli (CDC, 2004).

## **Proper Procedure for Donning Gloves**

When gloves are worn in combination with other PPE, put them on last. Gloves that fit snugly around the wrist are preferred for use with an isolation gown because they can cover the gown cuff and provide a more reliable continuous barrier for the arms, wrists, and hands (below). Gloves that are removed properly will prevent hand contamination. Hand hygiene following glove removal further ensures that the hands will not carry potentially infectious material that might have penetrated through unrecognized tears or that could contaminate the hands during glove removal (CDC, 2004).



Extend gloves over isolation gown cuffs to provide a more reliable and continuous barrier for the arms, wrists, and hands. Source: CDC.

## Cover Garb: Gowns and Lab Coats

Wear a gown or fluid-resistant lab coat whenever soiling of skin or clothing is anticipated. Remember that a gown may be needed during the care of a patient on Standard Precautions.

Gowns are intended to protect your arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material (Figure 5). The type of Gown selection is based on the nature of the patient interaction, including the anticipated degree of contact with infectious material and potential for blood and bodily fluid penetration of the barrier. Clinical and laboratory coats or jackets worn over personal clothing for comfort or purposes of identity are not considered PPE (CDC, 2004).

Gowns are always worn in combination with gloves, and with other PPE when indicated. Gowns are usually the first piece of PPE to be donned. Full coverage of the arms and body front, from neck to the mid-thigh or below, will ensure that clothing and exposed upper body areas are protected. Several gown sizes should be available in a healthcare facility to ensure appropriate coverage for staff members.

Gowns should be removed before leaving the patient care area to prevent possible contamination of the environment outside the patient's room. Gowns should be removed in a manner that prevents contamination of clothing or skin. The outer, "contaminated" side of the gown is turned inward and rolled into a bundle, and then discarded into a designated container for waste or linen to contain contamination. **Do not reuse gowns** (CDC, 2004).

## Masks

Masks by themselves are used for three primary purposes in healthcare settings: (1) to protect workers from contact with infectious material from patients, eg, respiratory secretions; (2) to protect patients from exposure to infectious agents carried in the workers' mouths or noses when they are engaged in procedures requiring sterile technique, and (3) to put on coughing patients, to limit potential dissemination of infectious respiratory secretions from the patient to others, as part of Respiratory Hygiene (CDC, 2004).

**A mask may be worn without eye protection, but eye protection must be worn with a mask** (OSHA). Masks should not be confused with respirators that are used to prevent inhalation of small particles that may contain infectious agents transmitted via the airborne route (CDC, 2004).

When Airborne Precautions are used, a respirator is required. It may be an N-95 respirator, which requires fit testing, or a positive air-purifying respirator (PAPR), which does not require fit testing. These are discussed in Element II in the section on tuberculosis.

There are many types of disposable particulate respirators, also known as air-purifying respirators because they protect by filtering particles out of the air as you breathe. These respirators protect only against particles—not gases or vapors. Since airborne biological agents such as bacteria or viruses are particles, they can be filtered by particulate respirators. An N-95 respirator is an example of a particulate respirator; it must be fit-tested as required by OSHA to verify a good seal. Facial hair may interfere with a good seal, requiring use of a positive-pressure respirator that does not require a seal.

### An N-95 Respirator



Source: CDC.

## Face Shields and Goggles

Masks in combination with eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, shall be worn whenever splashes, spatter, or droplets of blood or other potentially infectious material may be generated and eye, nose, or mouth contamination can be reasonably anticipated (OSHA).

Note: A mask always accompanies eye protection unless a face shield is used.

The eye protection chosen for specific work situations—for example, goggles or face shield—depends upon the circumstances of exposure, other PPE used, and personal vision needs. Personal eyeglasses and contact lenses are not considered adequate eye protection. Eye protection must be comfortable, allow for sufficient peripheral vision, and be adjustable to ensure a secure fit (CDC, 2004).

Indirectly vented goggles with a manufacturer's anti-fog coating may provide the most reliable practical eye protection from splashes, sprays, and respiratory droplets from multiple angles. Newer styles of goggles may provide better indirect airflow properties to reduce fogging, as well as better peripheral vision and more size options for fitting goggles to various workers (see below). Many styles of goggles fit adequately over prescription glasses with minimal gaps. While effective as eye protection, goggles do not provide splash or spray protection to other parts of the face (CDC, 2004).

## Safety Goggles



Goggles for splash or fine dust protection should have indirect venting.

Source: CDC.

As compared with goggles, a face shield can provide protection to other facial areas in addition to the eyes. Face shields extending from chin to forehead provide better face and eye protection from splashes and sprays; face shields that wrap around the sides may reduce splashes around the edge of the shield. Removal of a face shield, goggles and mask can be performed safely after gloves have been removed and hand hygiene performed. The ties, ear pieces, and/or headband used to secure the equipment to the head are considered "clean" and therefore safe to touch with bare hands. The front of a mask, goggles, or face shield is considered contaminated (CDC, 2004).

## Application of PPE

Personal protective equipment must fit the individual user, and it is up to the employer to ensure that all PPE are available in sizes appropriate for the workforce to be protected. Gloves should fit the user's hands comfortably—they should not be too loose or too tight. They also should not tear or be easily damaged. If contamination of the arms can be anticipated, a gown should be selected. Gowns should fully cover the torso, fit comfortably over the body, and have long sleeves that fit snugly at the wrist.

Masks should fit snugly and fully cover the nose and mouth to prevent fluid penetration. For this reason, masks that have a flexible nose piece and can be secured to the head with string ties or elastic are preferable. Goggles provide barrier protection for the eyes and should fit snugly over and around the eyes or personal prescription lenses. Personal prescription lenses do not provide optimal eye protection and should not be used as a substitute for goggles. Goggles with prescription lenses are available.

Before you use a respirator, your employer is required to have you medically evaluated to determine that it is safe for you to wear a respirator, to fit test you for the appropriate respirator size and type, and to train you on how and when to use a respirator. **You** are responsible for fit checking your respirator before **every** use to make sure it has a proper seal.

In addition to providing employees with appropriate PPE, employers are responsible for its proper disposal. If protective equipment is reusable it must be properly cleaned or laundered, repaired, and stored after use. Many types of PPE, such as latex gloves and disposable gowns are used once and then discarded in an appropriate receptacle. Other types of PPE, such as cloth gowns or reusable heavy duty latex or nitrile gloves, can be cleaned and reused. If goggles or face shields are reusable, they must be placed in a designated receptacle for subsequent reprocessing. If they are not reusable they may be discarded in a waste receptacle.

PPE is a potential source of cross-contamination if not changed between patients. To avoid cross-contamination:

- Don PPE before contact with the patient, generally before entering the room
- Use carefully—don't spread contamination. Avoid touching the environment with soiled gloves.
- Remove and discard carefully, either at the doorway or immediately outside the patient room
- Remove respirator outside the room
- Immediately perform hand hygiene

The use of personal protective equipment is not a substitute for safe work practices. Avoid contaminating yourself by keeping your hands away from your face and not touching or adjusting PPE. Also, remove your gloves if they become torn and perform hand hygiene before putting on a new pair of gloves. Avoid spreading contamination by limiting surfaces and items touched with contaminated gloves.

## **Element V: Cleaning, Disinfection, and Sterilization**

**Creation and maintenance of a safe environment for patient care in all healthcare settings through application of infection control principles and practices for cleaning, disinfection, and sterilization.**

Application of accepted infection control principles helps maintain a safe environment for both patients and healthcare workers. This includes proper use of Standard Precautions and an understanding ability to apply proper techniques for cleaning, disinfection, sterilization, and reprocessing of medical equipment.

## **Environmental Control Measures**

[The following section is derived from CDC (2003).]

Microorganisms are present in great numbers in moist, organic environments, and some can persist under dry conditions. Contaminated surfaces have been associated with transmission of infections.

The transfer of a microorganism from an environmental surface to a patient is largely via hand contact with the surface. Although hand hygiene is important to minimize the impact of this transfer, cleaning and disinfecting environmental surfaces is fundamental in reducing their potential contribution to the incidence of HAIs.

## **Environmental Cleaning**

All work areas must be maintained in a clean and sanitary condition. The employer is required to determine and implement a written schedule for cleaning and disinfection based on the location within the facility, type of surface to be cleaned, type of soil present, and tasks or procedures being performed. All equipment, environmental and working surfaces must be properly cleaned and disinfected after contact with blood or other infectious material. Contaminated broken glassware must be removed using mechanical means, like a brush and dustpan or vacuum cleaner.

Chemical germicides and disinfectants at recommended dilutions must be used to decontaminate environmental surfaces. Consult the Environmental Protection Agency (EPA) lists of registered sterilants, tuberculocidal disinfectants, and antimicrobials with HIV/HBV efficacy claims to ensure that the disinfectant is appropriate.

## **Laundry**

OSHA defines contaminated laundry as “laundry which has been soiled with blood or other potentially infectious materials or may contain sharps.” Contaminated textiles and fabrics often contain high numbers of microorganisms from body substances, including blood, skin, stool, urine, vomitus, and other body tissues and fluids. Disease transmission attributed to healthcare laundry has involved contaminated fabrics that were handled inappropriately (eg, the shaking of soiled linens). Bacteria, viruses, fungi, and ectoparasites such as scabies presumably have been transmitted from contaminated textiles and fabrics to workers either via direct contact or via aerosols of contaminated lint generated from sorting and handling contaminated textiles.

Fabrics, textiles, and clothing used in healthcare settings are disinfected during laundering and generally rendered free of vegetative pathogens (hygienically clean), but they are not sterile. The antimicrobial action of the laundering process results from a combination of mechanical, thermal, and chemical factors. Dilution and agitation in water remove substantial quantities of microorganisms. Soaps and detergents function to suspend soils and also exhibit some microbicidal properties. Hot water provides an effective means of destroying microorganisms. Chlorine bleach is an economical, broad-spectrum chemical germicide that enhances the effectiveness of the laundering process.

Laundry that is or may be soiled with blood or other potentially infectious material, or may contain contaminated sharps, must be treated as though contaminated. Contaminated laundry must be bagged at the location where it was used, and should not be sorted or rinsed in patient-care areas. It must be placed and transported in bags that are labeled or color-coded.

Laundry workers must wear protective gloves and other appropriate personal protective clothing when handling potentially contaminated laundry. All contaminated laundry must be cleaned or laundered so that any infectious agents are destroyed.

Infectious material may be present on the clothing of healthcare workers. In a study examining the microbial contamination of medical students’ white coats, the students perceived the coats as “clean” as long as the garments were not visibly contaminated with body substances, even after wearing the coats for several weeks. The heaviest bacterial load was found on the sleeves and the pockets of these garments; the organisms most frequently isolated were *Staphylococcus aureus*, diphtheroids, and *Acinetobacter spp.*

## **Appropriate Ventilation**



Engineering controls to contain or prevent the spread of airborne contaminants center on local exhaust ventilation, general ventilation, and air cleaning. General ventilation encompasses: (a) dilution and removal of contaminants via well-mixed air distribution of filtered air; (b) directing contaminants toward exhaust registers and grilles via uniform, non-mixed airflow patterns; (c) pressurization of individual spaces relative to other spaces; and (d) pressurization of buildings relative to the outdoors and other attached buildings.

## Waste Management

Both science and regulation address the management of waste from healthcare. In addition to complying with regulation, the most practical approach to medical waste management is to identify wastes that represent a sufficient potential risk of causing infection during handling and disposal and for which some precautions are likely prudent. Healthcare facility medical wastes targeted for handling and disposal precautions include microbiology laboratory waste, pathology and anatomy waste, blood specimens from clinics and laboratories, blood products, and other body-fluid specimens.

Although any item that has had contact with blood, exudates, or secretions may carry pathogens, treating all such waste as infective is neither practical nor necessary. Federal, state, and local guidelines and regulations specify the categories of medical waste that are subject to regulation and outline the requirements associated with treatment and disposal. The categorization of these wastes has generated the term **regulated medical waste**, which is defined as any of the following:

- Liquid or semi-liquid blood or other potentially infectious materials (OPIM)
- Contaminated items that would release blood or OPIM in a liquid or semi-liquid state, if compressed
- Items that are caked with dried blood or OPIM and are capable of releasing these materials during handling
- Contaminated sharps
- Pathological and microbiological wastes containing blood or OPIM

Medical wastes require careful disposal and containment before collection and consolidation for treatment. OSHA has dictated initial measures for discarding regulated medical-waste items. These measures are designed to protect the workers who generate medical wastes and who manage the wastes from point of generation to disposal. A single, red, leak-resistant biohazard bag is usually adequate for containment of regulated medical wastes, provided the bag is sturdy and the waste can be discarded without contaminating the bag's exterior. If the outside of the primary bag is contaminated or punctured, it must be placed into a second biohazard bag. All bags should be securely closed for disposal.

Puncture-resistant containers located at the point of use are used to discard sharps, including needles and syringes, scalpel blades, unused sterile sharps, and discarded slides or tubes with small amounts of blood. To prevent needlestick injuries, needles and other contaminated sharps should not be recapped, purposefully bent, or broken by hand.

Transporting and storing regulated medical wastes within the healthcare facility while awaiting terminal treatment is often necessary. Both federal and state regulations address the safe transport and storage of on- and off-site regulated medical wastes. Healthcare facilities are **required** to dispose of medical wastes regularly to avoid accumulation.

Medical wastes requiring storage should be kept in labeled, leakproof, puncture-resistant containers under conditions that minimize or prevent foul odors. The storage area should be well ventilated and be inaccessible to pests. Any facility that generates regulated medical wastes should have a regulated medical waste management plan to ensure health and environmental safety as per federal, state, and local regulations (CDC, 2003).

Of all the categories comprising regulated medical waste, microbiologic wastes such as untreated cultures, stocks, and amplified microbial populations pose the greatest potential for infectious disease transmission, while sharps pose the greatest risk for injuries (CDC, 2003).

## Sterilization and Disinfection

In the United States, nearly 50 million surgical procedures and even more invasive medical procedures—including more than 5 million gastrointestinal endoscopies—are performed each year. Each procedure involves contact by a medical device or surgical instrument with a patient's sterile tissue or mucous membranes. A major risk of all such procedures is the introduction of pathogens that can lead to infection. Failure to properly disinfect or sterilize equipment carries not only risk associated with breach of host barriers but also risk for person-to-person transmission and transmission of environmental pathogens such as *Pseudomonas aeruginosa* (Rutala et al., 2008).

Because sterilization of all patient-care items is not necessary, healthcare policies must identify—primarily on the basis of the items' intended use—whether cleaning, disinfection, or sterilization is indicated. Multiple studies in many countries have documented lack of compliance with established guidelines for disinfection and sterilization. Failure to comply with scientifically based guidelines has led to numerous outbreaks (Rutala et al., 2008).

**Sterilization** is a process that destroys or eliminates all forms of microbial life and is carried out in healthcare facilities by physical or chemical methods. *Sterile* and *non-sterile* are absolute concepts—black and white with no gray. If a sterile item is touched by anything non-sterile, the formerly sterile item is no longer sterile.

**Disinfection** is a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. In healthcare settings, objects are usually disinfected using liquid chemicals or wet pasteurization. When selecting a disinfectant, consider its properties. There are two levels of disinfection:

- High-level disinfection—used to clean patient-care equipment that touches mucous membranes
- Low-level disinfection—used to clean the hospital environment or items that touch intact skin

Products for sterilization and disinfection are licensed for the appropriate use by the FDA. Always be sure the product you plan to use is licensed for the intended purpose. And always use the lowest level of product that will do the job, since all disinfectants are toxic by their nature.

**Cleaning** is the removal of visible soil (organic and inorganic material) from objects and surfaces; normally it is accomplished manually or mechanically using water with detergents or enzymatic products. Thorough cleaning is essential before high-level disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes.

**Decontamination** removes pathogenic microorganisms from objects so they are safe to handle, use, or discard (Rutala et al., 2008).

## Reprocessing Reusable Medical Equipment

[This section is taken largely from NYS DOH, 2010.]

Healthcare facilities should follow manufacturer's recommendations for proper cleaning, disinfection, and sterilization of all reusable equipment. In addition, good practices suggest the following:

- Designate staff responsible for maintaining proper reprocessing procedures.
- Ensure designated staff members are properly trained in reprocessing each piece of equipment.
- Follow FDA guidelines for reprocessing equipment designated for single use.
- Maintain a log of all equipment reprocessing.

Instruments, medical devices, and equipment should be managed and reprocessed according to recommended and appropriate methods regardless of a patient's diagnosis except for cases of suspected prion disease. Special procedures are required for handling brain, spinal, or nerve tissue from patients with known or suspected prion disease (such as Creutzfeldt-Jakob disease). Consultation with infection control experts before performing procedures on such patients is recommended.

Industry guidelines as well as equipment and chemical manufacturer recommendations should be used to develop and update reprocessing policies and procedures. Written instructions should be available for each instrument, medical device, and equipment reprocessed. Potential for contamination is dependent upon:

- Type of device or environmental surface
- Potential for external or internal contamination
- Frequency of hand contact with device or surface
- Potential for contamination with body substances or environmental sources of microorganisms
- Level of contamination

Reprocessing of medical equipment involves several steps: (1) pre-cleaning, (2) cleaning, and (3) disinfection or sterilization. **Pre-cleaning**, which removes soil, debris, and lubricants from internal and external surfaces should be done as soon as possible after use. **Cleaning** can be done either manually (scrubbing with brushes) or mechanically using automated washers.

Equipment used for cleaning must be used appropriately and cleaning solutions must be changed according to the manufacturer's guidelines. Once cleaning is completed, equipment must be **disinfected** or **sterilized** depending on the intended use of the item. Disinfection requires sufficient contact time with chemical solution, while sterilization requires sufficient exposure time to heat, chemicals, or gases.

**Critical items**, instruments and medical devices, require sterilization. Critical items are those items that enter sterile spaces—they must be sterile. Critical items confer a high risk for infection if they are contaminated with any microorganism. This category includes surgical instruments, cardiac and urinary catheters, implants, and ultrasound probes used in sterile body cavities (Rutala et al., 2008).

**Semi-critical items** are those items that touch intact mucous membranes—they must receive **at least** high-level disinfection, which kills all microbial life except spores. This category includes respiratory therapy and anesthesia equipment, some endoscopes, laryngoscope blades, esophageal manometry probes, cystoscopes, anorectal manometry catheters, and diaphragm fitting rings (Rutala et al., 2008).

**Non-critical items** are those items that touch intact skin but not mucous membranes. Intact skin acts as an effective barrier to most microorganisms; therefore, the sterility of items coming in contact with intact skin is “not critical.” Examples of noncritical patient-care items are bedpans, blood pressure cuffs, crutches, and computers. In contrast to critical and some semi-critical items, most non-critical reusable items may be decontaminated where they are used and do not need to be transported to a central processing area (Rutala et al., 2008).

## Factors That Contribute to Contamination During Reprocessing

At any point in reprocessing or handling, breaks in infection control practices can compromise the integrity of instruments, medical devices, or equipment. Specific factors include:

- Failure to reprocess or dispose of items between patients
- Inadequate cleaning, disinfection, or sterilization
- Contamination of disinfectant or rinse solutions
- Improper packaging, storage, and handling
- Inadequate or inaccurate record keeping of reprocessing requirements

Differing levels of disinfection and sterilization methods and agents are based on the area of professional practice, setting, and scope of responsibilities. Professionals who practice in settings where handling, cleaning, and reprocessing is performed elsewhere should understand core infection control concepts and principles. A thorough understanding of Standard Precautions, personal protective equipment, and principles of cleaning, disinfection, and sterilization are essential.

Designation and physical separation of patient care areas from cleaning and reprocessing areas are strongly recommended. Each medical facility must determine appropriate reprocessing practices and select appropriate methods, taking into consideration:

- Antimicrobial efficacy
- Time constraints and requirements for various methods
- Compatibility of equipment and materials

- Toxicity
- Residual effect (the product's antimicrobial effect when used repeatedly over a number of days)
- Ease of use
- Stability (concentration, potency, efficacy of use, and effect of organic material)
- Odor
- Cost
- Monitoring requirements

## Single-Use Devices

A single-use device (SUD) is a device that is intended for one use or on a single patient during a single procedure. An unused SUD is referred to as an **original** device. A **reprocessed** SUD is an original device that has previously been used on a patient and has been subjected to additional processing and manufacturing for the purpose of an additional single use on a patient (FDA, 2006). Approximately twenty to thirty percent of U.S. hospitals report that they reuse at least one type of SUD.

The reprocessing of certain SUDs is permitted in the United States under the Federal Food, Drug, and Cosmetic Act. In 2002 the Medical Device User Fee and Modernization Act established regulations requiring that all reprocessed SUDs be clearly labelled as "reprocessed" and contain the name of the reprocessor. The act also directed the FDA to increase its oversight of these devices by identifying reprocessed SUDs that should not be marketed unless the reprocessing company first provided data demonstrating effective cleaning, sterilization, and functional performance (GAO, 2008).

Many sources have repeatedly warned about the potential risks of infection from reprocessed SUDs or their failure to function properly, and their use has been controversial for more than two decades. The American public has expressed increasing concern regarding the risk of infection and injury when reusing medical devices intended and labeled for single use (Rutala et al., 2008). Reprocessing of SUDs is banned in France and strongly discouraged in Great Britain and other countries in Europe. The Department of Veterans Affairs, which operates one of the largest healthcare systems in the United States, prohibits their use entirely (GAO, 2008).

## Element VI: Protecting Healthcare Workers

**Prevention and management of infectious or communicable diseases in healthcare workers.**

Healthcare personnel are all paid and unpaid persons working in healthcare settings who have the potential for exposure to infectious materials, including body substances, contaminated medical supplies and equipment, contaminated environmental surfaces, or contaminated air. These personnel include those involved in direct patient care, students and trainees, contractual staff, and personnel not directly involved in patient care but potentially exposed to infectious agents (CDC, 1998).

Protecting healthcare workers should be an integral part of a healthcare organization's general program for infection control and prevention. The objectives usually include:

- Educating personnel about the principles of IC and stressing individual responsibility for IC.
- Collaborating with the IC department in monitoring and investigating potentially harmful infectious exposures and outbreaks among personnel.
- Providing care to personnel for work-related illnesses or exposures.
- Identifying work-related infection risks and instituting appropriate preventive measures.
- Containing costs by preventing infectious diseases that result in absenteeism and disability (CDC, 1998)

## **Infection Control Training**

The federal government, through OSHA, requires that all new employees, or employees being transferred into jobs involving potential exposure to blood or OPIM, must receive bloodborne pathogen training before assignment to tasks where an occupational exposure may occur. Retraining is required annually, or when changes in procedures or tasks affecting occupational exposure occur. Employees must be provided access to a qualified trainer during the training session to respond as questions arise.

The training program shall contain at a minimum the following elements:

- An accessible copy of the regulatory text of the OSHA Bloodborne Pathogens Standard and an explanation of its contents
- A general explanation of the epidemiology and symptoms of bloodborne diseases
- An explanation of the modes of transmission of bloodborne pathogens
- An explanation of the employer's exposure control plan and the means by which the employee can obtain a copy of the written plan
- An explanation of the appropriate methods for recognizing tasks and other activities that may involve exposure to blood and other potentially infectious materials

- An explanation of the use and limitations of methods that will prevent or reduce exposure including appropriate engineering controls, work practices, and personal protective equipment
- Information on the types, proper use, location, removal, handling, decontamination and disposal of personal protective equipment
- An explanation of the basis for selection of personal protective equipment
- Information on the hepatitis B vaccine, including information on its efficacy, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge
- Information on the appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials;
- An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the medical follow-up that will be made available
- Information on the post-exposure evaluation and follow-up that the employer is required to provide for the employee following an exposure incident;
- An explanation of the signs and labels and/or color coding required
- An opportunity for interactive questions and answers with the person conducting the training session (OSHA)

Healthcare workers must be informed of the possible health effects of exposure to infectious agents such as hepatitis B and C, HIV, and chemicals such as ethylene oxide (EtO) and formaldehyde. The information should be consistent with OSHA requirements and identify the areas and tasks in which potential exists for exposure (Rutala et al., 2008).

Healthcare workers must receive training in the selection and proper use of PPE, and employers must ensure that workers wear appropriate PPE to prevent exposure to infectious agents or chemicals. The employer is responsible for making such equipment and training available to their employees. Healthcare facilities must establish a program for monitoring occupational exposure to regulated chemicals that adheres to state and federal regulations. Healthcare workers with weeping dermatitis of hands must be excluded from direct contact with patient-care equipment (Rutala et al., 2008).

## **Assessments and Vaccines**



Most states require healthcare workers to be medically evaluated prior to employment in hospitals and diagnostic and treatment centers. The evaluation must include screening for tuberculosis and other common communicable diseases. The medical evaluation should determine immunization status and include a history of any conditions that might predispose personnel to acquiring or transmitting communicable diseases. This information will assist in decisions about immunizations or post-exposure management. Requirements may include screening and/or vaccinations (as appropriate) for tuberculosis (TB); measles, mumps, and rubella; hepatitis B Virus (HBV); Hepatitis C Virus (HBC); influenza; varicella (chickenpox); Tdap (tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis).

## Occupational Exposure to Bloodborne Pathogens

The need to protect healthcare workers from bloodborne exposures resulted in OSHA's publication in 1991 of the Bloodborne Pathogens Standard. The Standard requires employers whose employees have exposure to blood to provide safe work practices, education, and barriers to exposure. The Standard was later amended to add requirements for the safe use of sharps devices.

Important factors that influence the overall risk for occupational exposures to bloodborne pathogens include the number of infected individuals in the patient population and the type and number of blood contacts. Most exposures do not result in infection. Following a specific exposure, the risk of infection may vary, depending upon the:

- Pathogen involved
- Type of exposure
- Amount of blood involved in the exposure
- Amount of virus in the patient's blood at the time of exposure (CDC, 2003b)

An **occupational exposure** is defined as a percutaneous injury or contact of mucous membrane or non-intact skin with blood, tissue, or OPIM. The risk of infection varies case by case. Factors influencing the risk of infection include:

- Whether the exposure was from a hollow-bore needle or other sharp instrument
- Whether the exposure was to non-intact skin or mucus membranes
- The amount of blood that was involved
- The amount of virus present in the source's blood

If a sharps injury occurs, as soon as safely possible,

- Wash the affected area with soap and water.

- Do not “milk” or squeeze the wound.
- Application of antiseptics should not be a substitute for washing. There is no evidence that using antiseptics (like hydrogen peroxide) will reduce the risk of transmission for any bloodborne pathogens; however, the use of antiseptics is not contraindicated.
- The risk of contracting HIV from a sharps injury is estimated to be 0.3%.

If there is exposure to the eyes, nose, or mouth,

- Flush thoroughly with water, saline, or sterile irrigants.
- Remove any potentially contaminated clothing as soon as possible.
- Familiarize yourself with existing protocols and the location of emergency eyewash or showers and other stations within your facility in advance of need.
- The risk of contracting HIV through this type of exposure is estimated to be 0.09%.

## **Guidelines for Post Exposure Prophylaxis**

Organizations that employ health professionals or other persons who are at risk for occupational exposure to blood, body fluids, or OPIM are generally required to establish policies and procedures that guide the management of such exposures. Private employers subject to OSHA must conform to the OSHA Bloodborne Pathogen Standard. These regulations require that a management plan be in place (HIVGuidelines.org, 2010).

The employer should ensure that any employee who sustains an occupational exposure has access to post-exposure services within 1 to 2 hours of a reported event. Services must be available 24 hours a day, every day. Organizations that do not have on-site occupational health services are required to form agreements or contracts with another facility, emergency department, or private practitioner for such services (HIVGuidelines.org, 2010).

Post-exposure services for exposures to all bloodborne pathogens include but are not limited to:

- Post-exposure evaluation and follow-up post-exposure medications and/or vaccinations, as indicated
- A full course of post-exposure prophylaxis medications, at no cost to the employee
- Care provided under the supervision of a licensed physician or other licensed healthcare professional
- The performance of laboratory tests by an accredited laboratory
- Supportive counseling (HIVGuidelines.org, 2010)

The National Needlestick Hotline is available 24 hours per day at 888-448-4911, without cost, for consultation by treating providers. Documentation of consultation may be prudent if PEP is being considered.

Federal law requires covered employers to ensure that all medical evaluations and procedures, vaccines, and post-exposure prophylaxis are made available to the employee within a reasonable time and place and are made available at no cost to the employee.

OSHA's Bloodborne Pathogen Standard make the covered employer responsible for all costs associated with an exposure incident. **An employer may not require the employee to pay any out-of-pocket expenses**, such as requiring the employee to use workers' compensation if prepayment is required, or compelling an employee to use health insurance (unless the employer pays all premiums and deductible costs associated with their employee's health insurance). In addition to the services listed above, NYS Guidelines, "HIV Prophylaxis Following Occupational Exposure," state that, when establishing plans for providing PEP for exposures to HIV, the employer must ensure that:

- PEP will be made available within 1 to 2 hours of exposure, ideally within 1 hour.
- A "starter kit," or three-day supply of the PEP, will be made available to the employee.
- A mechanism is in place to provide the balance of the PEP medications needed to complete the 4-week regimen to the employee at no cost. (HIVGuidelines.org, 2010)

Post-exposure prophylaxis (PEP) provides medications to someone who has had a substantial exposure, usually to blood. PEP has been the standard of care for occupationally exposed healthcare workers with substantial exposures since 1996. Animal models suggest that cellular HIV infection happens within 2 days of exposure to HIV and the virus in blood is detectable within 5 days. Therefore, PEP against HIV should be started as soon as possible—within hours, not days—after exposure and continued for 28 days if indicated. However, PEP for HIV does not provide prevention of other bloodborne diseases like HBV or HCV.

Hepatitis B PEP for susceptible persons would include administration of hepatitis B immune globulin and HBV vaccine. This should occur as soon as possible and no later than 7 days post exposure.

For a susceptible person, the risk from a single needlestick or cut exposure to HBV-infected blood ranges from 6 to 30 percent and depends on the hepatitis Be antigen (HBeAg) status of the source individual. Hepatitis B surface antigen (HBsAg)-positive individuals who are also HBeAg-positive have more virus in their blood and are more likely to transmit HBV than those who are HBeAg-negative. While there is a risk for HBV infection from exposures of mucous membranes or non-intact skin, there is no known risk for HBV infection from exposure to intact skin (CDC, 2003b).

The average risk of HIV infection after a needlestick or cut exposure to HIV-infected blood is 0.3%. Stated another way, 99.7% of needlestick or cut exposures do not lead to infection. The risk after exposure of the eye, nose, or mouth to HIV-infected blood is estimated to be, on average, 0.1%. The risk after exposure of non-intact skin to HIV-infected blood is estimated to be less than 0.1%. A small amount of blood on intact skin probably poses no risk at all. There have been no documented cases of HIV transmission due to an exposure involving a small amount of blood on intact skin (a few drops of blood on skin for a short period of time) (CDC, 2003b).

The average risk for infection after a needlestick or cut exposure to HCV-infected blood is approximately 1.8%. The risk following a blood exposure to the eye, nose, or mouth is unknown, but is believed to be very small; however, HCV infection from blood splash to the eye has been reported. There also has been a report of HCV transmission that may have resulted from exposure to non-intact skin, but no known risk from exposure to intact skin (CDC, 2003b).

As of July 2011, there is no approved PEP against HCV. The benefit of the use of antiviral agents to prevent HCV infection is unknown and antiviral are not currently approved by the Federal Drug Administration (FDA)—approved for prophylaxis. Because of the frequent advances in treatment, doses and medications are not listed here.

Post exposure prophylaxis can only be obtained from a licensed healthcare provider. Your facility may have recommendations and a chain of command in place for you to obtain PEP. After evaluation of the exposure route and other risk factors, certain medications may be prescribed. The national bloodborne pathogen hotline provides 24-hour consultation for clinicians who have been exposed on the job.

Post-exposure prophylaxis is not as simple as swallowing one pill. The medications must be started as soon as possible and continued for 28 days. Many people experience significant side effects. It is essential to report occupational exposure to the department at your workplace that is responsible for managing exposure. If post-exposure treatment is recommended, it should be started as soon as possible. In rural areas, police, firefighters, and other at-risk emergency providers should identify a 24-hour source for PEP.

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# Post Test

Use the answer sheet following the test to record your answers.

1. Common risk factors for HAIs include:
  - a. Any use of antibiotics.
  - b. Air-conditioned facilities.
  - c. Indwelling medical devices.
  - d. Uncontrolled visitation by families and friends.
  
2. The number of HAIs exceeds the number of cases of any other notifiable disease.:
  - a. True
  - b. False
  
3. Hospitals currently measure their infection control practices by:
  - a. Benchmarks.
  - b. Zero tolerance.
  - c. Patient population statistics.
  - d. Funding considerations.
  
4. In recent years antibiotic-resistant organisms have included all but:
  - a. *H. pylori*.
  - b. *C. difficile*.
  - c. VRE.
  - d. *S. aureus*.
  
5. Which of the following is NOT a link in the Chain of Infection?:
  - a. Pathogenic micro-organism.
  - b. Reservoir.
  - c. Means of attachment.
  - d. Host susceptibility.
  
6. Which of the following is not true about bacteria?:
  - a. They are single-celled organisms.



- b. There are no strains that are resistant to antibiotics.
- c. The vast majority are harmless or even beneficial.
- d. Some protect us from infection.

7. Viruses are about 100 times smaller than bacteria, and they:

- a. Are more susceptible to antibiotics than modern-day bacteria.
- b. All cause disease.
- c. Can only be spread by direct contact.
- d. Can reproduce only inside a host cell.

8. Most fungi are harmless, but some are life-threatening. Among those causing trouble is *Aspergillus spp.*, which:

- a. Produces bursts of airborne fungal spores.
- b. Is found in asparagus and other produce served to patients.
- c. Is an anaerobic fungus that thrives where oxygen is in use.
- d. Contaminates primarily the clothing and bedding of the patient.

9. A reservoir is a place where germs live and grow. The most common reservoirs in healthcare facilities are:

- a. Patient call buttons.
- b. People.
- c. Bathrooms.
- d. IV stands.

10. A pathogen leaves its reservoir or host through a:

- a. Mode of transmission.
- b. Portal of entrance.
- c. Portal of exit.
- d. Natural anatomic opening.

11. The indirect means of transmission of a pathogen:

- a. May be accomplished through kissing or biting.
- b. Occurs only through airborne particles.
- c. Can be through sexual intercourse.

- d. Involves an intermediate person or item.
12. The portal of entry, the location through which a pathogen enters a susceptible host:
- a. Can be the same in the new host as the portal of exit in the source host.
  - b. Is not important because any portal can admit a pathogen that causes illness.
  - c. Is not important because any portal can admit a pathogen that causes illness.
  - d. Must be the same in the new host as the portal of exit in the source host.
13. Factors that influence the outcome of an exposure in a susceptible host include:
- a. Socioeconomic level.
  - b. Underlying disease.
  - c. Living conditions.
  - d. Genetics.
14. A central tenet of the OSHA Bloodborne Pathogens Standard is:
- a. Take all Precautions and proceed with confidence.
  - b. Use Universal Precautions rather than Standard Precautions.
  - c. Consider all patients to be potentially infected with a bloodborne pathogen.
  - d. Consider all patients to be noninfected until there is evidence to the contrary.
15. When adopting transmission-based precautions, including Contact, Droplet, or Airborne Precautions:
- a. Refer to your facility's policies for details.
  - b. Follow the CDC Guideline for Isolation Precautions first and foremost.
  - c. Post a sign on the patient's door stating diagnosis and Precautions being followed.
  - d. Never transport the patient outside of the room.
16. Airborne Precautions are the only type that require a negative pressure isolation room.:
- a. True
  - b. False
17. Because tuberculosis is the primary disease transmitted by a true airborne route, the CDC recommends three levels of TB controls:
- a. Environmental, airborne, and respiratory protection controls.

- b. Droplet, airborne, and administrative controls.
- c. Administrative, environmental, and respiratory protection controls.
- d. Droplet, airborne, and respiratory protection controls.

18. To achieve accepted hand hygiene, the recommended technique is:

- a. Soap and water.
- b. Alcohol-based rub.
- c. Pure alcohol.
- d. Alcohol-based rub followed by a water rinse.

19. My 5 Moments of Hand Hygiene include all but one of the following:

- a. After leaving a patient room:
- b. Before clean or aseptic procedures.
- c. After touching patient surroundings.
- d. Before touching a patient.

20. Alcohol hand rubs:

- a. Kill bacteria but not viruses.
- b. Are preferred to everything but plain alcohol.
- c. Do not remove dirt and debris from your hands.
- d. Are preferred to everything but soap and water.

21. To do hand hygiene correctly, you should scrub your hands for at least:

- a. 5 seconds.
- b. 10 seconds.
- c. 20 seconds.
- d. 15 seconds.

22. Work practice controls reduce the likelihood of exposure by altering the manner in which a task is performed, while engineering controls:

- a. Isolate or remove the hazard as with self-sheathing needles.
- b. Address hazards from heating and air conditioning systems.
- c. Have to do with optimal layout of facilities to ensure hygienic conditions.
- d. Relate to methods engineered to produce better environments for patients.

23. With regard to the reuse of needles and syringes:
- The syringe may be reused but the needle may not.
  - Neither the needle nor the syringe may ever be reused.
  - Needles may be reused if they are properly disinfected.
  - Syringes may be reused if they are properly disinfected.
24. Aseptic technique to ensure safe injection practices includes:
- Disinfecting the rubber septum of a medication vial with soap and water.
  - Use a new or properly disinfected syringe and needle to draw up medications.
  - Placing medication prep areas next to lunchrooms for greatest cleanliness.
  - Practice proper hand hygiene before handling medications.
25. Following sharps safety procedures in obstetrical and surgical settings entails:
- Passing sharps quietly and quickly while maintaining eye contact with the recipient.
  - Using instruments rather than fingers to grasp sharps.
  - Passing instruments hand to hand for greater confidence.
  - Choosing open surgery for its greater visual field and accuracy.
26. Personal protective equipment (PPE) provided by the employer for protection against infectious materials ordinarily includes all but:
- Gowns and lab coats.
  - Gloves.
  - Masks, face shields, and goggles.
  - Wetsuits.
27. All work areas must be maintained in a clean and sanitary condition. This function is called:
- Protective cleaning.
  - Environmental cleaning.
  - Facility cleaning.
  - Housekeeping.
28. Healthcare facility medical wastes targeted for handling and disposal precautions include:

- a. Restroom trash.
- b. Cafeteria waste.
- c. Blood products.
- d. Staff wastebaskets.

29. High-level disinfection is used to clean:

- a. Items that touch mucous membranes.
- b. Items that come into the facility from outdoors.
- c. Items that touch the skin.
- d. The hospital environment.

30. OSHA requires that all new employees or transfers:

- a. Take an examination to determine whether they understand the Chain of Infection.
- b. Receive bloodborne pathogen training if occupational exposure may occur.
- c. Be retrained every five years on bloodborne pathogens.
- d. Take a one-time course in environmental cleaning.

31. OSHA standards require that employers provide access to post exposure services within:

- a. 15 minutes.
- b. 30 minutes.
- c. 45 minutes.
- d. 1 to 2 hours.

# Answer Sheet

## Infection Control and Prevention

Name (Please print your name): \_\_\_\_\_

Date: \_\_\_\_\_

Passing score is 80%

1. \_\_\_\_\_
2. \_\_\_\_\_
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31. \_\_\_\_\_

# Course Evaluation

Please use this scale for your course evaluation. Items with asterisks \* are required.

- 5 = Strongly agree
- 4 = Agree
- 3 = Neutral
- 2 = Disagree
- 1 = Strongly disagree

\* Upon completion of the course, I was able to:

a. Summarize the most prevalent risk factors for healthcare-associated infections (HAIs) and their related sites of infection.

5  4  3  2  1

b. Identify and explain six essential elements of infection control.

5  4  3  2  1

c. Recall and explain each of the six links in the Chain of Infection.

5  4  3  2  1

d. Describe prevention strategies in terms of Standard and Universal Precautions, Transmission-Based Precautions, Contact Precautions, Droplet Precautions, and Airborne Precautions.

5  4  3  2  1

e. Explain the importance and proper practice of hand hygiene for preventing HAIs.

5  4  3  2  1

f. Discuss safe injection practices and sharps disposal as they relate to patient and worker health.

5  4  3  2  1

g. Outline the use of engineering and work practice controls to reduce the opportunity for exposure to potentially infectious material (PIM).



5  4  3  2  1

h. Demonstrate the selection and use of personal protective equipment (PPE).

5  4  3  2  1

i. Define the principles and practices for cleaning, disinfection, and sterilization.

5  4  3  2  1

j. Spell out guidelines for post exposure prophylaxis.

5  4  3  2  1

\* The author(s) are knowledgeable about the subject matter.

5  4  3  2  1

\* The author(s) cited evidence that supported the material presented.

5  4  3  2  1

\* Did this course contain discriminatory or prejudicial language?

Yes  No

\* Was the course free of commercial bias and product promotion?

Yes  No

\* As a result of what you have learned, do you intend to make any changes in your practice?

Yes  No

If you answered Yes above, what changes do you intend to make? If you answered No, please explain why.

\* Do you intend to return to ATrain for your ongoing CE needs?

Yes, within the next 30 days.

Yes, during my next renewal cycle.

Maybe, not sure.

No, I only needed this one course.

\* Would you recommend ATrain Education to a friend, co-worker, or colleague?

Yes, definitely.

Possibly.

No, not at this time.

\* What is your overall satisfaction with this learning activity?

5  4  3  2  1

\* Navigating the ATrain Education website was:

Easy.

Somewhat easy.

Not at all easy.

\* How long did it take you to complete this course, posttest, and course evaluation?

60 minutes (or more) per contact hour

50-59 minutes per contact hour

40-49 minutes per contact hour

30-39 minutes per contact hour

Less than 30 minutes per contact hour

I heard about ATrain Education from:

Government or Department of Health website.

State board or professional association.

Searching the Internet.

- A friend.
- An advertisement.
- I am a returning customer.
- My employer.
- Other
- Social Media (FB, Twitter, LinkedIn, etc)

Please let us know your age group to help us meet your professional needs.

- 18 to 30
- 31 to 45
- 46+

I completed this course on:

- My own or a friend's computer.
- A computer at work.
- A library computer.
- A tablet.
- A cellphone.
- A paper copy of the course.

Please enter your comments or suggestions here: \_\_\_\_\_

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# Registration Form

Please print and answer all of the following questions (\* required).

\* Name: \_\_\_\_\_

\* Email: \_\_\_\_\_

\* Address: \_\_\_\_\_

\* City: \_\_\_\_\_ \* State: \_\_\_\_\_ \* Zip: \_\_\_\_\_

\* Country: \_\_\_\_\_

\* Phone: \_\_\_\_\_

\* Professional Credentials/Designations:

\_\_\_\_\_

Your name and credentials/designations will appear on your certificate.

\* License Number and State: \_\_\_\_\_

\* Please email my certificate:

Yes  No

(If you request an email certificate we will not send a copy of the certificate by US Mail.)

## Payment Options

You may pay by credit card or by check.

Fill out this section only if you are **paying by credit card**.

5 contact hours: \$29

## Credit card information

\* Name: \_\_\_\_\_

Address (if different from above): \_\_\_\_\_

\* City: \_\_\_\_\_ \* State: \_\_\_\_\_ \* Zip: \_\_\_\_\_

\* Card type:

Visa  Master Card  American Express  Discover

\* Card number: \_\_\_\_\_

\* CVS#: \_\_\_\_\_

\* Expiration date: \_\_\_\_\_