Infection Control

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COURSE OBJECTIVE: The purpose of this course is to prepare healthcare workers to prevent and control the spread of infection using current, evidence-based knowledge of the chain of infection, Standard Precautions and transmission-based precautions, and engineering and work practice controls.

LEARNING OBJECTIVES
Upon completion of this course, you will be able to:

• Summarize the concepts of infection prevention and control.
• Identify the economic and social impact of healthcare-associated infections on individuals, their designated support persons, and the community.
• Describe the chain of infection as it applies to infection prevention and control.
• Describe workplace practices to protect the patient from healthcare-associated infections.
• Discuss workplace practices designed to minimize the risk of healthcare workers’ occupational exposures to infectious diseases.
• Explain the difference between Standard Precautions and transmission-based precautions.
• Discuss types of personal protective equipment, work practices, and engineering controls that protect against healthcare-associated infections.
• Identify healthcare-associated situations requiring enhanced infection control precautions.

THE NEED FOR INFECTION PREVENTION AND CONTROL PRACTICES

Preventing the spread of infection has been a key component of healthcare since the work of Semmelweis in the 1840s. Dr. Semmelweis dramatically reduced postpartum fever—a major
cause of maternal mortality at the time—by instructing physicians to disinfect their hands before touching their patients. Fast-forward to the 1980s and the emergence of HIV/AIDS and infection control gained an importance that continues today and has expanded to include prevention of the transmission of hepatitis B and C viruses and many other agents within healthcare settings.

In 1999, the patient safety movement began with the publication of *To Err Is Human* by the Institute of Medicine (IOM, 1999). This brought much-needed attention to the problem of medical errors and healthcare-associated infections. Since September 11, 2001, concern about bioterrorism has heightened awareness of infection control. American soldiers treated in field hospitals during the Iraq war returned with highly resistant infections such as *Acinetobacter baumanii*, a microbe that is now epidemic in hospitals worldwide (Hospenthal, 2011). In 2003, the epidemic of severe adult respiratory syndrome (SARS) focused global attention on the need for infection control.

Currently, the problem of multidrug-resistant organisms (MDROs)—“superbugs” such as methicillin-resistant *Staphylococcus aureus* (MRSA) and extensively drug-resistant tuberculosis (XDR-TB)—is the subject of attention, as transmission becomes a wider problem both in the healthcare system and in the community. MDROs are increasing in prevalence. Providers working within the healthcare setting can make a difference by being aware of patients at high risk for developing MDROs and by employing measures to prevent the spread of infection.

Education regarding early detection, infection control, and hand hygiene are key elements to consider. Reducing risk for patients is also important; this includes reducing exposure to long-term invasive devices and being aware of patients who are on long-term antibiotic regimens. On a larger scale, programs that promote antibiotic stewardship at all levels in the healthcare system have the potential to reduce the overall incidence of MDROs.

In addition to the emergence of new pathogens, dramatic changes in how and where healthcare is delivered require that infection prevention and control be a high priority outside the hospital. Patients often move from one healthcare setting to others as part of the continuum of care. As increasing numbers of patients receive healthcare in outpatient surgical centers, dialysis centers, outpatient rehab clinics, nursing homes, and at home, the need for infection prevention and control measures in these settings has increased to protect both patients and healthcare workers. The key to elimination of healthcare-associated infections is full adherence to recommendations across the continuum of care.

**Healthcare-Associated Infections (HAIs)**

Healthcare-associated infections are among the most common adverse events in hospitals, and the morbidity and mortality associated with them are significant. The Centers for Disease Control and Prevention (CDC) estimate that 1 out of every 25 hospitalized patients develop a healthcare-associated infection each year. In 2011, over 700,000 HAIs occurred in U.S. hospitals, with 75,000 patients dying from complications of HAIs (CDC, 2014a).
HOSPITAL HEALTHCARE-ASSOCIATED INFECTIONS, 2011

<table>
<thead>
<tr>
<th>Type of Infection</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary tract infections</td>
<td>93,300</td>
</tr>
<tr>
<td>Bloodstream infections</td>
<td>71,900</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>157,500</td>
</tr>
<tr>
<td>Gastrointestinal illness</td>
<td>123,100</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>157,500</td>
</tr>
<tr>
<td>Other infection sites</td>
<td>118,500</td>
</tr>
<tr>
<td>Total</td>
<td>721,800</td>
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</tbody>
</table>

Source: CDC, 2014a.

The total burden of HAIs is likely to be even higher, since the CDC estimates indicated above do not include nursing homes, home health care, rehabilitation centers, dialysis centers, outpatient acute care facilities, and so on.

Patients in long-term care facilities are at risk for developing HAIs, particularly if they have invasive medical devices such as urinary catheters or central venous catheters in place. In the United States, 1 to 3 million infections occur each year in long-term care facilities—almost as many HAIs as in acute care hospitals (CDC, 2014b). Infections are a primary cause of hospitalization and death in this population. About 380,000 people die of infections acquired in long-term care facilities each year (CDC, 2014b).

In the United States, people are living longer, with the average life expectancy increasing each year. With an increase in the elderly population, the need for long-term care facilities will continue to rise. Today and in the future, long-term care facilities care not only for elderly patients with chronic illness but also provide care for patients who are admitted for short-term rehabilitation following surgical procedures such as joint replacements. These patients may be at increased risk for surgical site infections due to cross contamination of pathogens in the long-term care setting (Korniewicz, 2014).

**KEY TERMS**

**Asymptomatic infection**
Absence of symptoms or signs of illness in the infected person. (Synonyms: subclinical infection, unapparent infection.)

**Body substance isolation (BSI)**
An infection prevention method that defines all body fluids and substances as infectious.

**Chain of infection**
An epidemiologic model explaining the process of transmission of an infectious agent; links in the “chain” include the infectious organism, reservoir, portal of exit, means of transmission, portal of entry, and vulnerable host.
Cleaning
The process of removing all foreign material (i.e., dirt, body fluids, lubricants) from objects by using water and detergents or soaps and washing or scrubbing the object.

Colonization
Proliferation of microorganisms on or within body sites without detectable host immune response, cellular damage, or clinical expression (i.e., without symptoms or signs of disease). The presence of a microorganism within a host may occur with varying duration but may become a source of potential transmission. (Synonyms: carriage, carrier state.)

Common vehicle
Contaminated material, product, or substance that serves as a mode of transmission by which an infectious agent is transported to multiple susceptible hosts. Outbreaks of disease are linked to common vehicles, such as bacteremia resulting from use of intravenous fluids contaminated with a gram-negative organism or gastroenteritis resulting from food contaminated with E. coli.

Communicable disease
An illness due to a specific infectious agent that arises through transmission of that agent from an infected person, animal, or inanimate reservoir to a susceptible host. (Synonym: infectious disease.)

Contamination
The presence of microorganisms on an item or surface.

Critical device
An item that enters sterile spaces such as the intravascular system or joint spaces. Examples include surgical instruments. Critical items must be sterile.

Decontamination
The use of physical or chemical means to remove, inactivate, or destroy disease-producing microorganisms on a surface or item to the point where they are no longer capable of transmitting infectious particles.

Disinfection
The use of a chemical procedure that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms, such as bacterial endospores, on inanimate objects.

Fomite
An inanimate object that conveys infection because it has been contaminated by pathogenic organisms. Examples include tissues, doorknobs, telephones, bed linens, toilet seats, and clothing. Any healthcare equipment, supplies, or surfaces that have become contaminated with pathogens can become a fomite.
Healthcare-associated disease transmission
Transmission of infectious agents that results in the development of HAIs.

Healthcare-associated infection (HAI)
Infection associated with healthcare delivery in any setting (e.g., hospitals, long-term care facilities, outpatient clinics, ambulatory settings, home care). Patients may acquire HAIs while receiving treatment for other conditions, i.e., HAIs are not present or incubating in patients at the time of entry into the healthcare process. Because patients often receive medical care in more than one setting, infection control is increasingly important outside acute care hospitals (e.g., long-term care facilities). (Synonym: nosocomial infection.)

Healthcare facility epidemiology
The use of scientific methodology to measure the need for and efficacy of healthcare facility infection prevention and control strategies.

Healthcare worker (HCW)
Any person who has contact with patients, body fluids, or supplies used for patient care as part of his or her job. This includes physicians, nurses, occupational therapists, and physical therapists as well as administrative, environmental hygiene, and laboratory staff in medical facilities. HCWs also include interns, volunteers, and paid workers/employees who are involved in any aspect of healthcare in any setting. All healthcare workers should be trained in basic infection prevention and control regardless of whether they deliver direct or indirect care to patients.

Mode of transmission
As part of the chain of infection, the ways in which a pathogen is spread from an infected person (reservoir) to another person (susceptible host). Common modes of transmission include carrying pathogens on unwashed hands, contact with surfaces or medical instruments that are not cleaned between patients, droplets released into the environment when an infected person coughs, or for a few diseases, airborne transmission. Most agents have multiple modes of transmission.

Non-critical device
An item that contacts intact skin but not mucous membranes. It requires low-level disinfection. Examples include blood pressure cuffs and crutches.

Occupational health strategies
As applied to infection control, a set of activities intended to assess, prevent, and control infections and communicable diseases in healthcare workers.

Pathogen or causative agent
A biologic agent (organism) capable of causing disease. These include bacteria, viruses, fungi, and protozoa. Sometimes collectively referred to as “germs.”
Portal of entry
As part of the chain of infection, the path by which the causative agent gets into a susceptible host. Common portals of entry include the mouth, nose, eye, skin abrasions, rashes, cuts, needlestick injuries, surgical wounds, and IV sites. A pathogen may have multiple paths for entering the body.

Portal of exit
As part of the chain of infection, the path by which the causative agent gets out of the reservoir. In a person, this is often by a body fluid, however some bacteria, such as MRSA, can live and grow on the skin. An organism may have multiple paths of exit from the body.

Reservoir
As part of the chain of infection, a person, animal, arthropod, plant, soil, or substance (or combination of these) in which a causative agent lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such numbers that it can be transmitted to a susceptible host. Reservoirs can be thought of as the source of the infectious agent.

Semi-critical device
An item that comes in contact with mucous membranes or non-intact skin and requires high-level disinfection. Examples include laryngoscopes, endoscopes, and vaginal ultrasound probes. They should be sterile if possible or receive high-level disinfection if sterilization is not feasible. There should be a single standard of care in regard to processing. The practice of using a sterilized item for the first patient of the day and using high-level disinfection for subsequent patients is inappropriate.

Standard Precautions
An infection control strategy to prevent transmission of infectious agents; recommended for all patient-care delivery settings. It is based on the concept that all blood, body fluids, secretions, excretions (except sweat), non-intact skin, and mucous membranes may contain transmissible infectious agents.

Sterilization
The highest level of disinfection. The use of a physical or chemical process to destroy all microbial life, including highly resistant bacterial spores. Sterilization is required for patient-care equipment that touches sterile spaces of the body.

Susceptible host
As part of the chain of infection, a person or animal lacking effective resistance to a particular infectious agent.

Transmission-based Precautions
Include Contact Precautions, Droplet Precautions, and Airborne Precautions. In addition to consistent use of Standard Precautions, these precautions may be warranted in certain situations depending on the mode of transmission of certain pathogens.
Universal Precautions
An infection control process that involves treating all human blood and other potentially infectious materials as if known to be infectious for bloodborne pathogens.

Instituting Standards

Standards and guidelines are designed to proactively prevent the spread of infection in healthcare settings. This is evident also from a leadership perspective, with the Centers for Disease Control and Prevention focus not only on “disease control” but also on “prevention.” Changes in regulatory, legal, and financial reimbursement systems reflect the growing consensus that HAIs are preventable (Korniewicz, 2014). In 2008, the Centers for Medicare and Medicaid Services implemented a new financial policy that no longer provides payment to hospitals for services related to certain infections not present on admission and deemed preventable (Hoff et al., 2011). Many states now require hospitals to report on specific HAIs as a quality of care indicator.

Prevention of HAIs is the responsibility of all healthcare personnel. Many states and most medical professional organizations have defined standards of professional behavior and responsibility as they pertain to infection control. Healthcare workers—from physicians to dental hygienists—may be sanctioned, including loss of license or practicing privileges, for not following effective infection prevention and control practices.

Standard infection prevention and control guidelines for healthcare settings are a collaborative effort between the CDC, the Joint Commission, the World Health Organization (WHO), and the Occupational Safety and Health Administration (OSHA). The CDC primarily focuses on the surveillance, prevention, and control of HAIs in healthcare settings within the United States. The most recent CDC standards were published in 2007 (CDC, 2007).

The Joint Commission issued the first-ever National Patient Safety Goals in 2003 and updates them annually. Each accredited hospital is required to demonstrate programs that address the reduction of HAIs as a goal for improving patient safety. Goals for 2015 specific to preventing infection in the hospital setting include:

- Using hand-cleaning guidelines from the CDC and WHO
- Using proven guidelines to prevent infections that are difficult to treat
- Using proven guidelines to prevent central line infections
- Using proven guidelines to prevent infection after surgery
- Using proven guidelines to prevent urinary tract infections caused by catheters (Joint Commission, 2015)

The World Health Organization also has specific guidelines for hand hygiene and reporting death or major disability secondary to HAIs.
In 2001, the Occupational Safety and Health Organization, the federal organization regulating workplace safety, issued the Bloodborne Pathogens Standard aimed at preventing transmission of HIV and hepatitis B and C viruses in the workplace. In 2011, OSHA made recommendations for revisions to the standard (OSHA, 2011a). OSHA regularly inspects healthcare agencies for compliance and may fine employers if infractions are identified.

The scientific basis for such infection control guidelines and standards are derived from the work of experts at organizations such as the CDC, the Association for Professionals in Infection Control and Epidemiology, and the Society for Healthcare Epidemiology of America.

Surveillance and outbreak investigations are also key components of hospital epidemiology, including assessing, measuring, and reporting on effective infection prevention and control programs. The National Health Safety Network, based at the CDC, is a voluntary reporting system that monitors the incidence of HAIs. Active surveillance and reporting of HAIs is also a requirement of the Joint Commission’s National Patient Safety Goals; all deaths or major disabilities secondary to HAIs are required to be reported as sentinel events (Sydnor & Perl, 2011).

**Goals of Infection Control and Prevention Training**

The goals of infection control and prevention training are to:

- Educate health professionals in how pathogens can be transmitted in the work environment: from patient to healthcare worker, healthcare worker to patient, patient to patient, and within the same patient (endogenous infection)
- Apply current scientifically accepted infection control principles as appropriate for the specific work environment
- Minimize opportunity for transmission of pathogens to patients and healthcare workers
- Familiarize professionals with the law requiring this training and the professional misconduct charges that may result from failure to comply with the law

**THE CHAIN OF INFECTION**

The process of transmission of an infectious agent can be best explained by the epidemiologic model called the “chain of infection.” An infectious disease results from specific interactions between an agent, host, and environment. Transmission occurs when the infectious agent leaves the reservoir (or host) through a portal of exit, travels by some mode of transmission, and enters through a portal of entry to infect a susceptible host (CDC, 2012a).
A reservoir for an infectious agent is the habitat where the agent normally lives and grows. Reservoirs may be humans, animals, or the environment. In the case of bloodborne infectious diseases, humans are generally the reservoirs.

The portal of exit is the path by which the infectious agent leaves its host. Bloodborne pathogens can exit the host by crossing the placenta from mother to baby or through cuts, open wounds, or needles.

Means of transmission is the mode by which the infectious agent is transmitted from its natural reservoir to a susceptible host. Transmission can occur by a mode that is direct (e.g., OPIM exposure from the reservoir patient directly to exposed nonintact skin or mucous membrane of the host) or indirect (e.g., needlestick).

The portal of entry refers to the way in which the infectious agent enters the host. The portal of entry must provide access to tissues in a way that allows the infectious agent to multiply and thrive.

The final link is the vulnerable host. Susceptibility of a host depends on many factors, including immunity and the individual’s ability to resist infection.

By breaking any link in the chain of infection, healthcare professionals can prevent the occurrence of new infection. Infection prevention measures are designed to break the links and thereby prevent new infections. The chain of infection is the foundation of infection prevention.
Causative Agents/Organisms

**Synonyms:** pathogen, infectious agent, etiologic agent.

The pathogens that cause infections are microorganisms. Bacteria, viruses, fungi, and protozoa ("germs") are very common in the environment, and most of them are harmless or even beneficial to people. Creating an environment with no microorganisms is not a realistic goal outside of highly specialized laboratories.

Most pathogens require an “infectious dose” to cause disease; that is, it usually takes thousands to cause disease, not just one or two. Pathogens also vary in **infectivity** (how easy they are for someone to “catch”) and **virulence** (the level of danger from the infection they cause). Patients in healthcare settings are generally more susceptible to infection due to underlying illness and other factors that weaken their resistance to infection. Therefore, a key goal of infection control programs is to reduce the number of infectious microbes in healthcare settings through hygienic practices such as handwashing and environmental cleaning.

**TYPES OF PATHOGENS**

**Bacteria** are single-celled organisms, some of which can cause disease. All people live with numerous bacteria—referred to as “normal flora” or “resident bacteria”—which usually do not cause disease unless their balance is disturbed or they are moved to a part of the body where they do not belong or to a new susceptible host.

Important bacteria causing human disease include:

- *E. coli* (urinary tract infection, diarrhea)
- *Streptococci* (wound infection, sepsis, death)
- *Clostridium difficile* (severe diarrhea, colitis, death)
- *Mycobacterium* (tuberculosis)
- *Staphylococcus* (skin boils, pneumonia, endocarditis, sepsis, death)

**Bacterial spores (endospores)** are thick-walled cells in a resting state (i.e., not multiplying) formed by bacteria. Their thick outer walls make them able to survive in conditions otherwise not conducive to bacterial growth and reproduction. Spores are resistant to disinfectant and drying conditions (specifically the genera *Bacillus* and *Clostridium*) (CDC, 2007).

**Viruses** are intracellular parasites, that is, they can only reproduce inside a living cell. Viruses such as human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) have the ability to enter and survive in the body for years before symptoms of disease occur. Such viruses can be transmitted to others even when the source person appears to be healthy. Other viruses, such as influenza, quickly announce their presence through characteristic symptoms. All of these viruses are of concern in healthcare settings.
Fungi are prevalent throughout the world, but only a few cause disease in healthy people. Most of these commonly affect the skin, nails, and subcutaneous tissue. Candida is a fungus that causes yeast infections; these infections can be life threatening in critically ill patients. Fungi such as Aspergillus can be life threatening to people with HIV/AIDS and other immunological impairment.

Prions are a form of infectious protein believed to be the cause of Creutzfeldt-Jakob disease, a severe brain disease.

Protozoa are single-celled microorganisms that are larger than bacteria. Examples of disease-causing protozoa include amoebas and giardia, which cause diarrhea, and Pneumocystis carinii, an important cause of pneumonia that is often fatal in people with compromised immune systems, such as those infected with HIV.

Parasites are larger organisms that can infect or infest people. Infestation with arthropods, such as lice and scabies, occurs by direct contact with the arthropod or its eggs. Helminthes include roundworms, tapeworms, and flukes. They infect humans principally through ingestion of eggs or when the larvae penetrate the skin or mucous membranes.

ELIMINATING PATHOGENS

Causative organisms are eliminated by several methods, including:

- Hand hygiene, which physically removes and/or kills germs on the hands
- Sterilizing surgical instruments and anything that touches sterile spaces of the body
- Using good food safety methods
- Providing safe drinking water
- Vaccinating people so they do not become reservoirs for infectious agents
- Treating people who are ill
- Cleaning surfaces and objects

HANDWASHING

Most HAIs are due to lack of proper adherence to established infection control practices. Since most infections occur with direct patient contact, proper hand hygiene (handwashing or using alcohol-based rubs) remains the single most effective way to prevent infection to and from patients. Unfortunately, although HAIs continue to increase, 100% compliance with basic hand hygiene requirements is still lacking. (See also “Hand Hygiene” later in this course.)
Reservoirs

The next link in the chain of infection is the reservoir, the usual “habitat” in which the infectious agent lives and multiplies. Reservoirs are human, animal, and/or environmental sources of infectious agents.

Humans are the most important reservoirs for HAIs. The nose (nostrils, nares) may harbor bacteria and viruses. The skin is another natural reservoir for yeast and bacteria, and both healthcare workers and patients may carry pathogenic MRSA and \textit{Staphylococcus} on their skin. The gastrointestinal (GI) tract is a reservoir for many different types of organisms, including viruses, bacteria, bacterial spores, and parasites. Pathogens can be spread from both sick people as well as those who appear to be healthy.

Animal reservoirs include mammals, insects, and many other species that may transmit infections to humans, such as deer ticks (which may carry Lyme disease bacteria), raccoons (which may carry the rabies virus), or fish (which may carry parasites that humans ingest). Because animals and insects are not usually present in healthcare environments, they are not important causes of HAIs.

Environmental reservoirs include inanimate materials, substances, and objects—such as soil, water, air filters, food, soiled linens, and soiled gloves—which provide favorable conditions for the survival and multiplication of infectious agents.

Microbes often require moisture to grow and reproduce, so infectious agents often live in moist or wet areas of the reservoirs. In general, if an area is wet, it is probably a reservoir. However, many important human pathogens survive in dry conditions, including those that live on the skin (e.g., yeast, strep, staph, MRSA) and in the environment.

- Bacterial spores survive in dry environments but often require moisture to multiply (e.g., \textit{C. difficile} spores survive long periods on dry surfaces in medical environments; tetanus and anthrax spores survive in soil).
- Hepatitis B virus has been demonstrated to survive in dried blood at room temperature on environmental surfaces for at least one week (CDC, 2014c).
- \textit{Acinetobacter} can live on the skin and may survive in the environment for several days.

HUMAN RESERVOIRS

There are two types of human reservoirs: people who are sick (symptomatic) and people who are well (asymptomatic). Infections can be transmitted from either a symptomatic or asymptomatic person. This is a critically important concept in infection control because many infections are transmitted from people who have no symptoms of disease.
Following exposure to a pathogen, there is a spectrum of possible clinical outcomes:

- Some people never develop symptomatic illness.
- Some people develop mild illness.
- Some people become severely ill or die.

Some individuals are prone to becoming transiently or permanently colonized with organisms they have been exposed to. A person colonized by (or “carrying”) an organism may or may not ever develop symptoms of infection, but they are an important source of transmission to others. *Staphylococcus* and *C. difficile* are important examples of HAIs that colonize. Both patients and healthcare workers can become asymptotically colonized with MRSA and be a source of infection to others.

Host and microbial factors influence whether an infection becomes symptomatic or asymptomatic and whether a person is able to eliminate or clear an infection or becomes a carrier. An important host factor is immunity. An important microbial factor is its ability to evade host defense mechanisms. Certain aspects of transmission are also important—such as the amount of an infectious agent the person is exposed to (infective dose, or inoculum) and the route of exposure.

Not all people who are infected with a pathogen have symptoms or signs of disease at the time they transmit the infection to others. In other words, many infections are transmitted from people who have no symptoms at all; that is, they are asymptomatic. Transmission of an infectious agent from a person who does not have symptoms is referred to as asymptomatic transmission.

Asymptomatic transmission can also occur during the incubation period of an infection. The incubation period is the time between exposure to an infectious agent and the development of symptoms. Different infectious agents have different incubation periods. For example, the incubation period for HIV can be a few months to many years. For the common cold virus, symptoms usually appear 1 to 2 days after exposure.

People who are sick often release microbes into the environment through infected body fluids and substances. For example, sneezing releases influenza virus in secretions from the respiratory tract. Coughing releases tuberculosis bacteria from the lungs. Diarrhea releases *C. difficile* and many pathogens from the bowel. Exudates from skin lesions release *Staphylococcus* in pus from boils or herpes virus from fluid in sores around the mouth, hands, or other body areas.
EXAMPLES OF TRANSMISSION FROM HUMAN RESERVOIRS

*Staphylococcus (S. aureus, MRSA)*

- Body sources: normal skin, nasal passages, exudates (pus) from boils, drainage from wounds, surgical incisions
- Modes of transmission: direct skin-to-skin contact; indirect contact via contaminated surfaces, hands, and medical devices
- Disease(s) produced: skin infection, surgical wound infection, sepsis, death

*Clostridium difficile*

- Body sources: GI tract, feces, colonized skin
- Modes of transmission: orally via ingestion of bacteria or spores from contaminated hands or environmental fomites, direct contact with skin
- Disease(s) produced: severe diarrhea, colitis, death

*E. coli and Enterococci*

- Body sources: GI tract, feces
- Modes of transmission: orally via ingestion of bacteria in fecally contaminated food or water, endogenous spread from one body area to another (via catheters or poor hygiene)
- Disease(s) produced: urinary tract infection, gastrointestinal illness, bloodstream infection, sepsis, death

*HIV*

- Body sources: blood, semen, vaginal secretions, breast milk, other body fluids and tissue
- Modes of transmission: direct contact with body fluids during sex; breastfeeding; blood splashes to eyes or other mucous membranes; indirect contact thru percutaneous exposure (e.g., needlestick injury, shared needles or equipment)
- Disease(s) produced: AIDS-related illnesses, death

*Influenza*

- Body sources: respiratory tract secretions, droplets from sneeze and cough
- Modes of transmission: indirect contact via contaminated fomites, direct contact with nose
- Disease(s) produced: respiratory illness, pneumonia, death (especially in the elderly)
The important point to remember is that **infectious agents are transmitted every day from people who are sick as well as from those who appear to be healthy.** In fact, colonized persons (or “carriers”) and persons who are incubating an infection may present more risk for disease transmission than persons who are sick because:

- They are not aware of their infection.
- Their contacts are not aware of their infection.
- Their activities are not restricted by illness.
- They do not have symptoms and therefore do not seek treatment.

It is usually not known if a person is carrying or incubating an infection. Therefore, a series of infection control methods called Standard Precautions are required for all patient contact, regardless of their diagnosis or health status. Standard Precautions protect healthcare workers and patients from infection (see “Standard Precautions” later in this course).

**ENVIRONMENTAL RESERVOIRS**

Inanimate materials, substances, and objects in the environment can serve as environmental reservoirs. For example, water supplies may carry *Legionella spp.*, and inadequate air exchange can allow pathogens such as *Mycobacterium tuberculosis* and varicella-zoster virus (chicken
pox) to contaminate air supplies. Appropriate environmental infection-control measures and engineering controls can remove microbes from the environmental reservoirs (see “Practices and Controls” later in this course).

Environmental reservoirs in healthcare facilities include:

- Soil in plants
- Water from fish tanks or flower vases, which may contain pathogens and are especially dangerous for compromised patients
- Air filters that have not been properly maintained
- Soiled linens
- Soiled gloves

Actions to eliminate reservoirs include:

- Handling and disposing of soiled items responsibly
- Storing equipment dry
- Cleaning the healthcare environment using appropriate disinfectants
- Monitoring soil and contaminated water in sensitive areas of the facility and washing hands carefully after contact with either
- Eliminating soil and standing water from areas where susceptible patients receive care, such as intensive care units

**Portal of Exit**

The portal of exit is the route (or routes) by which the causative agent gets out of the reservoir.

In human reservoirs, skin is an important portal of exit. Breaks in the skin such as sores, wounds, and cuts may be the portal of exit of infectious microbes, but germs may exit the host from intact skin as well. MRSA and *Streptococcus* are potent germs that live on skin and thus can easily exit their reservoir. Any body fluid or matter may carry microorganisms out of the body. Blood, feces, respiratory secretions, and nasal exudates are examples of body fluids and matter that enable pathogens to exit the body.

Body fluids and matter from various body systems are important sources of infection in healthcare settings. Examples of portals of exit from the human body include:

- Respiratory tract
- Gastrointestinal (or alimentary) tract
- Skin
• Genitourinary tract
• Circulatory system (e.g., blood)

Medical treatments and procedures and illnesses often increase the opportunities for organisms to exit the body, thereby increasing exposure to infectious agents. A common example of this is blood drawing, which allows bloodborne pathogens to exit the circulatory system of the reservoir. Diarrheal disease caused by prolonged treatment with antibiotics is an example of an illness that increases exit of pathogens (such as *C. diff*) from the GI tract.

Actions to reduce risk from portals of exit include:
• Covering coughs and sneezes with a tissue or coughing or sneezing into the antecubital area
• Handling bodily fluids with gloves, then practicing hand hygiene
• Keeping draining wounds covered with a dressing
• Not working when one has exudative (wet) lesions or weeping dermatitis

**Modes of Transmission**

In order for an organism to get from one person to another or from one place in the body to another, it must have a way of getting there, or a mode of transmission. For any single agent, there are often many different ways it can be transmitted.

The mode of transmission is the weakest link in the chain of transmission, and it is the only link that healthcare providers can hope to eliminate entirely. Therefore, a great many infection control efforts are aimed at avoiding carrying germs from the reservoir to the susceptible host. Because people touch so many things with their hands, hand hygiene is still the single most important strategy for preventing the spread of infection.

Transmission can occur by a number of mechanisms.

• **Direct contact** is person-to-person transmission of pathogens through touching, biting, kissing, or sexual contact.

• **Indirect contact** is the spread of pathogens by a person or an inanimate go-between, an intermediary between the portal of exit from the reservoir and the portal of entry to the host. Transmission by unwashed hands is a form of indirect contact. Contaminated objects—such as patient-care equipment, cooking or eating utensils, handkerchiefs and tissues, soiled laundry, and doorknobs that can transmit infection—are called fomites. Gloves that touch two or more patients have been shown to carry pathogens. (This practice will result in disciplinary action in most facilities.)

• **Droplet transmission** can spread diseases such as influenza, pertussis (whooping cough), and some forms of bacterial meningitis. Droplets are produced when the infected person...
coughs, sneezes, or speaks, and they travel about three to six feet before drying out or falling to the ground or another surface.

- **Airborne transmission** can occur when respiratory droplets evaporate, leaving behind droplet nuclei that are so small they remain suspended in the air. Very few diseases are transmitted by the true airborne route, since most organisms cannot survive drying. Diseases transmitted by this route include tuberculosis, chickenpox, measles, possibly SARS, and smallpox.

Sometimes people become infected with microbes from their own natural flora; that is, their own germs get in the wrong place. This is referred to as an **endogenous infection**, meaning that the organism came from the same person. Endogenous infections are an important cause of HAIs and occur when invasive procedures create opportunities for microbes to get into new places.

For example, if sterile techniques are not used, surgical wounds may become infected with bacteria transferred from another area of the person’s body, such as *Staphylococcus*, which is commonly present on the skin. The urinary tract may be infected with microbes from the gastrointestinal tract, such as *Enterococcus* and *E. coli*. Indwelling urinary catheters are an important risk factor for urinary tract infections (UTIs) caused by endogenous microbes from the GI tract.

Transmission of infection by vectors (such as mosquitoes and ticks) is not an important mode of transmission in most healthcare settings. Common-source vehicles such as contaminated food or water are also not common modes of transmission in healthcare settings. However, shared medical equipment that has not been properly cleaned between patient uses has been implicated in many common-source outbreaks in healthcare settings.

Actions to eliminate the mode of transmission include:

- Hand hygiene
- Wearing gloves to minimize contamination of hands and discarding them after each patient
- Using Standard Precautions with all patients
- Maintaining 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

**Portals of Entry**

The term *portal of entry* refers to the anatomical route (or routes) by which an infectious organism gains entry to a susceptible host. The portal of entry is often the same as the portal of exit from the reservoir but may include other portals of entry as well.
For example, the flu virus exits the respiratory tract when a person sneezes and enters the respiratory tract of a new host who inhales the infectious virus released into the air. Flu viruses can also exit the body when a person blows his or her nose in a tissue. If another person touches the contaminated tissue and then touches his nose, the portal of exit from the reservoir and the portal of entrance is the same.

However, sometimes the exit and entry portals are different. For example, staph bacteria may escape one person’s respiratory tract or nose to infect another person’s skin. Or a wound infected with MRSA may infect another person’s nasal passage. *E. coli*, hepatitis A, and many other microbes exit the bowel in feces and infect a new host via the oral route.

Medical and surgical procedures often introduce new portals or facilitate the entry of infectious agents. Examples include IV catheters, surgical wounds, intubation, and percutaneous injuries. Healthcare workers may develop dermatitis from frequent handwashing or allergy to latex gloves, thereby creating new portals of entry for infection. They may receive needlestick injuries that allow microbes access to their bloodstream. Any invasive procedure may facilitate entry of microbes into the host.

Examples of portals of entry include:

- Mouth, nose, and eyes
- Other anatomical openings
- Skin “breaks” (cuts, rashes, or less-visible microabrasions)
- Surgical wounds
- Intravenous sites
- Anatomical openings with tubes in place (more susceptible than those without)
- Needle puncture injuries

Actions to protect portals of entry (in healthcare workers and patients) include:

- Dressings on surgical wounds
- IV site dressings and care
- Elimination of tubes as soon as possible
- Masks, gloves, goggles, and face shields
- Keeping unwashed hands and objects away from the mouth and eyes
- Actions and safety devices to prevent needlesticks
- Food and water safety

**Susceptible Host**

The final link in the chain of infection is the susceptible host. Susceptibility can be reduced in several ways. For some diseases, there are effective vaccines. Other diseases produce lasting
immunity after illness. People have better resistance to disease when they are well rested, well fed, and relatively stress free. People who have healthy immune systems are often able to resist infection even when microorganisms do invade.

Host factors that influence the outcome of an exposure include the presence or absence of natural barriers, the functional state of the immune system, and the presence or absence of an invasive device.

**NATURAL BARRIERS**

Natural barriers that protect from infection include:

- Intact skin and mucous membranes
- Cilia (small, hair-like projections that line the respiratory system, filtering inhaled air and trapping microorganisms)
- Lung macrophages (large white blood cells that ingest microorganisms, other cells, and foreign particles in a process called phagocytosis)
- Antibodies (humoral immunity) resulting from immunization or previous disease
- Acidic environment in the stomach, urine, and vaginal secretions
- Normal flora that provide competition to pathogens; an upset to the balance of normal flora can allow pathogens to cause infection, such as when a yeast infection follows a course of antibiotics
- The immune system, a complex network of cells, tissues, and organs that interact to defend the body against infections; defense mechanisms can be nonspecific or specific and include humoral immunity (antibodies that circulate in the blood), cell-mediated immunity (white blood cells), and the inflammatory response, which brings an increase in these infection-fighting defenses to the site of infection

**INFECTION AND THE IMMUNE SYSTEM**

A person with normal immune system function is described as being immunocompetent. Someone whose immune system is impaired by illness or age-related factors is said to be immunocompromised. For example, a person with HIV/AIDS is immunocompromised.

The very young and the very old are at risk for compromised immune function. Infections are a major cause of death among newborns. Although babies receive certain temporary immunities from their mothers through the placenta and in breast milk, their immune systems are still developing, making them vulnerable to infection. Older people (>65 years) are at higher risk of infection too because the immune system becomes less responsive with age. Very old people are more likely to have other health problems or normal declines related to aging that render them more susceptible to infection.
Nutritional status is a key factor in immune function. A person who is poorly nourished may not be able to fight off an infection.

People with chronic disease may also be immunocompromised. People with diabetes mellitus or peripheral vascular disease are at high risk for infection because of impaired circulation.

Certain medications can impair immunity. For example, cancer drugs and anti-inflammatory medications such as corticosteroids can interfere with normal immune function.

INVASIVE DEVICES

Any surgical procedure carries the risk of infection because it penetrates the skin. Special precautions are required for wound care to prevent surgical site infections (SSIs). Diagnostic or therapeutic procedures that involve an invasive device such as a urinary catheter or an intravascular (IV) catheter also increase the risk of infection. Caring for patients with these devices demands strict attention to infection control standards and continuous monitoring for any sign of infection.

To reduce risk of infections associated with these devices, the device should be discontinued as soon as the patient no longer needs it. Any foreign body, even a joint prosthesis, can act as a focus for infection and increases the risk of infection.

CASE

Robert Turner is an 80-year-old patient admitted to the general medical unit for onset of new delirium and treatment of a pressure ulcer on his sacrum. Because of his declining cognitive condition, he is not able to recognize the urge to urinate. To protect the healing ulcer from his urine, the medical team orders the placement of an indwelling urinary catheter. Mr. Turner is a “susceptible host” at risk of infection because of his advanced age, the fact that he is in the hospital, and because of the indwelling urinary catheter. Complicating this is his delirium, which may mean that he is not able to communicate specific symptoms in a verbal manner.

During the first three days of Mr. Turner’s hospital stay, the medical assessment reveals that a new medication was causing his delirium. The medication is stopped on the third day and on the fifth day his delirium begins to decrease. As his cognitive state improves, the patient is slowly able to participate in activities of daily living (ADLs) with the help of his caregivers. Until his pressure ulcer has sufficiently begun healing, his physicians feel it is in his overall best interest to leave the indwelling urinary catheter in place.

On day seven of his hospital stay, his nurse notices an abrupt change in the patient. He is more confused, agitated, and feels warm to the touch. On assessment, his temperature is 38.1 °C and he is slightly hypotensive. The medical team suspects a UTI may be the cause of a new infection. The urinary catheter is removed, with cultures performed showing positive results for E. coli. Mr. Turner is started on antibiotics and IV fluids and recovers over the next three days.
MINIMIZING RISK

Actions to minimize risk to susceptible hosts include:

- Vaccinating people against infections before they are exposed
- Preventing new exposure to infection in people who are already ill, are receiving immunocompromising treatment, or are infected with HIV
- Maintaining good nutrition
- Maintaining good skin condition
- Covering skin breaks
- Encouraging rest and balance in one’s life

As mentioned above, the reservoir and the susceptible host may be the same person, such as when an individual’s normal flora travels into the “wrong” part of the body and causes disease. Examples of this situation include:

- Oral flora in the lungs, causing aspiration pneumonia
- Skin flora in an IV site, causing a site infection or even a bloodstream infection
- Fecal flora in the urinary tract, causing a UTI

Thus, to avoid spreading germs between different body sites of the same patient, it is important to change gloves and wash hands when moving from a contaminated area to a different body site. It is also recommended to go from clean to dirty.

TRANSMISSION RISKS

Infectious pathogens transmitted in healthcare settings are the primary target of prevention and control because of the potential impact on both patients and providers. The CDC (2007) recommends implementing infection control and prevention guidelines to prevent the transmission of epidemiologically important organisms with the following characteristics:

- Propensity for transmission within the healthcare environment (e.g., *C. difficile*, norovirus, respiratory syncytial virus, influenza, *Enterobacter*, group A streptococcus)
- Severity of illness, including increased morbidity and mortality (e.g., HIV, hepatitis)
- Difficulty in treating due to antimicrobial resistance to first-line therapies (e.g., MRSA, VRSA, VRE)
- Emerging or reemerging pathogen (e.g., Ebola virus, smallpox)

In addition, ensuring the safety of providers within the healthcare setting is of utmost importance. A multi-faceted approach is needed to reduce the risk of occupational exposure to
bloodborne pathogens. The CDC estimates that 5.6 million workers in the healthcare industry and related occupations are at risk of occupational exposure to bloodborne pathogens, including HIV, HBV, HCV, and others (OSHA, 2014).

For example, the CDC estimates that around 385,000 needlesticks and other sharps-related injuries are sustained by hospital-based healthcare personnel on an annual basis (CDC, 2013). Such exposures can occur in other healthcare settings, such as nursing homes, clinics, emergency departments, and homes. Sharps injuries are primarily associated with occupational transmission of HBV, HCV, and HIV, but they may also be involved in the transmission of other pathogens.

**High-Risk Settings**

Every area of the healthcare facility and every type of patient care holds the potential for exposure to pathogens, but some settings and practices hold greater risk than others. High-risk settings include:

- Intensive care units
- Burn units
- Pediatric units and newborn nurseries
- Operating rooms
- Long-term care facilities
- Clinical laboratories

Transmission risks within the various healthcare settings are influenced by the characteristics of the population (e.g., immunocompromised patients, exposure to indwelling devices and procedures), intensity of care, exposure to environmental sources, length of stay, and interaction among and between other patients as well as healthcare providers.

Within the hospital setting, certain settings and patient populations have conditions that are considered high risk. **Intensive care units (ICUs)** care for patients who may be immunocompromised or have other life-threatening conditions (e.g., major trauma, transplant, organ failure, myocardial infarction). The ICU setting also puts patients at increased risk because of the use of invasive medical devices (e.g., mechanical ventilation, central venous catheters, and urinary catheters) as well as the frequency of contact with healthcare providers and prolonged length of stay.

Patients on **burn units** may have open wounds that provide the opportunity for colonization, infection, and transmission of pathogens. Infections involving *Staphylococcus aureus*, MRSA, **enterococci**, gram-negative bacteria, and candida are leading pathogens.

**Newborn nurseries and pediatric units** may have high-risk patients, including low birth weight babies, premature infants, or infants who do not yet have an established immune system. This population may also be exposed to medical devices and procedures that increase their risk. Common infections in this population include respiratory infections, influenza, adenoviruses, rubeola, varicella, and rotavirus.
The **operating room** setting places both the patient and provider at higher risk for transmission of infectious pathogens. Invasive procedures with instruments (scalpel and other sharps) and tissue and blood exposure are the primary risks at play in this setting.

Patients who reside in **long-term care settings** may be at increased risk due to close contact with other residents as well as age-related decline in immunity, immobility, chronic disease, and malnutrition. Common infectious disease outbreaks include influenza, norovirus, pneumonia, and pertussis.

For healthcare providers working in a **laboratory setting**, the increased risk is evident for potential exposure to blood and other potentially infectious materials (OPIM), which can put them at risk for infectious diseases from bloodborne pathogens (e.g., HIV, hepatitis).

**High-Risk Practices**

High-risk practices and procedures that increase the opportunity for healthcare worker and patient exposure to potentially infectious materials include percutaneous, mucous membrane/non-intact skin, and parenteral exposures from:

- **Injuries with contaminated sharps**, which can result from sharps being left undiscarded when a procedure has been completed, failure to activate safety sharps after use, recapping used needles using both hands, and removing scalpel blades from their handles by hand.

- **Poor visualization** during certain procedures also poses a hazard to both patient and healthcare worker. These procedures include blind suturing, a nondominant hand opposing or next to a sharp, and removal of bone or metal fragments. Situations involving use of sharps with poor visualization should be minimized or eliminated when possible.

- Procedures which may **expose the mucous membranes** of eyes, nose, mouth, or other mucous membranes to spray or splatter of blood or OPIM (such as irrigation or suctioning), contact with contaminated hands or gloves, or contact with open skin lesions or dermatitis.

- **Accidental injection** of infectious material via shared devices (e.g., blood glucose monitoring devices such as glucometers or lancets), shared injectable medication vials, or infusion of contaminated fluids.

All sharps devices can cause injury and disease transmission if not used and disposed of properly. Some characteristics of sharps make them potentially more dangerous, such as:

- Devices with a hollow bore, such as needles for injection, can contain blood and carry higher risk to transmit infection.

- Some devices, such as “butterfly” needles, devices with recoil action, and lancets, may be more likely to cause injury.
INFECTION CONTROL PRECAUTIONS

The nature of healthcare settings makes them likely environments for the spread of infections because they bring together many ill people who are both reservoirs and susceptible hosts. Staff are also both reservoirs and susceptible hosts. It is not possible to eliminate the reservoirs and susceptible hosts; therefore, it is important to prevent the mode of transmission.

Preventing the spread of infectious organisms includes:

- Using Standard Precautions with every patient
- Practicing hand hygiene before and after every patient contact, including dry skin contact
- Promptly isolating the patient when indicated, using the appropriate type of precautions
- Quickly identifying an infectious organism and initiating appropriate treatment

The CDC (2007) describes four types of infection control precautions:

1. Standard Precautions
2. Contact Precautions
3. Droplet Precautions
4. Airborne Precautions

The first of these, Standard Precautions, applies to all patients and all healthcare workers in all settings without any specific infectious process or diagnosis identified. Contact, Droplet, and Airborne Precautions are transmission-based precautions that should be applied when a specific infectious agent is known or suspected to be present in a patient. Each transmission-based precaution is used in conjunction with Standard Precautions (e.g., Standard Precautions plus Contact Precautions).

Standard Precautions

Standard Precautions are an infection control strategy to prevent transmission of infectious agents and are recommended for all patient-care delivery settings. They are based on the concept that all blood, body fluids, secretions, excretions (except sweat), non-intact skin, and mucous membranes may contain transmissible infectious agents.
BLOOD AND OTHER POTENTIALLY INFECTIOUS MATERIAL (OPIM)

All occupational exposures to blood or other potentially infectious materials place healthcare providers at risk for infection with bloodborne pathogens. Standard Precautions are designed to eliminate exposure to blood and OPIM.

OSHA defines blood as:

- Human blood
- Human blood components
- Products made from human blood

Other potentially infectious materials (OPIM) include:

- 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
- Any unfixed tissue or organ (other than intact skin) from a human (living or dead)
- HBV- and HIV-containing cell or tissue cultures, organ cultures, and HBV- or HIV-containing culture medium or other solutions
- Blood, organs, or other tissues from experimental animals infected with HBV or HIV


Standard Precautions include proper hand hygiene and use of gloves, gown, mask, eye protection, face shield, and safe injection practices. Equipment or items used in the patient environment that may be contaminated with infectious body fluids are also handled in a manner to prevent transmission of infection, including cleaning, disinfecting, and sterilizing before use on another patient.

Application of Standard Precautions is determined by the type of care interaction anticipated. For some interactions (e.g., venipuncture), only gloves may be needed. During other interactions (e.g., intubation or tracheostomy care), use of gloves, gown, face shield, or mask and goggles are needed (CDC, 2007).
Long-established Standard Precautions include the following:

**HAND HYGIENE**

- Wash hands with plain soap and water when visibly soiled or with alcohol-based product after touching blood, body fluids, and contaminated items, whether or not gloves are worn.
- Wash hands or use an alcohol-based product immediately after gloves are removed, between patient contacts, and when otherwise indicated.
- Wash hands between tasks and procedures on the same patient to prevent cross-contamination of different body sites.
- Avoid unnecessary touching of surfaces near the patient to prevent contaminating clean hands and to prevent transmission of pathogens from contaminated hands to surfaces.
- Do not wear artificial fingernails or extenders.

(See also “Summary of Hand Hygiene” below.)

**GLOVES**

- Wear clean gloves when touching blood, body fluids, and contaminated items.
- Put on clean gloves just before touching mucous membranes and nonintact skin.
- Change gloves between tasks and procedures on the same patient after contact with material that may contain a high concentration of microorganisms.
- Remove gloves promptly after use and do hand hygiene immediately before touching non-contaminated items and environmental surfaces, and before going to another patient. (See also “Summary of Hand Hygiene” below.)

**MASK, EYE PROTECTION, FACE SHIELD**

- Wear a mask and eye protection or a face shield to protect mucous membranes of the eyes, nose, and mouth during activities that are likely to generate splashes or sprays of blood or body fluids (such as suctioning, irrigation, or delivery of a newborn).

**GOWN**

- Wear a gown to protect skin and to prevent soiling of clothing during activities that are likely to generate splashes or sprays of blood or body fluids.
- Select a gown that is appropriate for the amount of fluid likely to be encountered.
- Remove the soiled gown as promptly as possible and do hand hygiene.
PATIENT-CARE EQUIPMENT

- Handle used patient-care equipment soiled with blood or body fluids in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of microorganisms to other patients and environments.
- Clean or reprocess reusable equipment before using it for the care of another patient.
- Ensure that single-use items are discarded properly.

ENVIRONMENTAL CONTROL

- Follow hospital procedures for the routine care, cleaning, and disinfection of environmental surfaces, beds, bedrails, bedside equipment, and other frequently touched surfaces.

LINEN

- Handle, transport, and process used linen soiled with blood or body fluids in a manner that prevents skin and mucous membrane exposures and contamination of clothing and that avoids transfer of microorganisms to other patients and environments.

OCCUPATIONAL HEALTH AND BLOODBORNE PATHOGENS

- Take care to prevent injuries when using or disposing of needles, scalpels, and other sharp instruments or devices.
- Never recap used needles using both hands or use any other technique that involves directing the point of a needle toward any part of the body.
- Do not manipulate used needles by hand.
- Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers that are located as close as practical to the area in which the items were used.
- Use mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation methods in areas where the need for resuscitation is predictable.

PATIENT PLACEMENT

- Place a patient who contaminates the environment or who does not assist in maintaining appropriate hygiene (children, patients with altered mental status) in a single-patient room.
- If a single-patient room is not available, consult with infection control professionals regarding patient placement or other alternatives.
• If it is necessary for an infected patient to share a room with a noninfected patient, it is important that roommates are selected carefully and that patients, personnel, and visitors take precautions to prevent the spread of infection.

CASE
Sharon is a nurse working the night shift in respiratory ICU. Her assignment for the night includes three patients, one of whom is currently intubated. As her shift begins, Sharon realizes that she needs to check in on her patient who is intubated and perform tracheotomy care and suctioning. Even though she is behind schedule, she takes the time to consider that the suctioning procedure may expose her to the patient’s secretions. Considering which level of Standard Precautions to apply, she dons personal protective equipment (PPE), including a gown, gloves, mask, and goggles, prior to performing the tracheotomy care with the patient. After caring for the patient, she disposes properly of all PPE and washes her hands prior to moving on to care for her next patient.

In 2007 three new elements were added to Standard Precautions:

• Respiratory hygiene
• Safe injection practices
• Lumbar puncture procedures

RESPIRATORY HYGIENE

Respiratory hygiene is a relatively new concept introduced after the SARS outbreak in 2003, comprising vigilance and prompt implementation of infection control measures at the first point of encounter within a healthcare setting (reception and triage areas, outpatient clinics, and physician offices). It is directed to patients and family members with signs of respiratory illness such as cough, congestion, or increased respiratory secretion. Components include:

• Educate healthcare workers on the importance of source-control methods to contain respiratory secretions, especially during outbreaks of respiratory illness such as influenza.
• Post signs at entrances in languages appropriate to the population served asking patients and family members to cover the mouth and nose when coughing or sneezing or to wear a mask and to do hand hygiene after contact with respiratory secretions.
• Provide tissues, masks, hand hygiene products, and waste receptacles convenient to patients entering the facility and assign responsibility for maintaining the supplies.
• Maintain separation, ideally by at least 3 feet, between ill persons and others. Move ill patients to rooms promptly to remove them from common waiting areas.
• Healthcare personnel should use Droplet Precautions (wear a simple mask) and do hand hygiene when caring for any patient with symptoms of respiratory infection unless those symptoms are known due to a noninfectious cause.
• Healthcare workers with respiratory infection should avoid patient contact if possible and should wear a mask if contact cannot be avoided.

SAFE INJECTION PRACTICES

Infection control problems identified in the course of outbreak investigations sometimes indicate the need for reinforcement of existing infection control recommendations to protect patients. Failure to adhere to recommendations for safe injection practices has resulted in several outbreaks of hepatitis B and C. Lack of oversight of personnel and failure to follow up on reported breaches of practice have contributed to these outbreaks.

The CDC recommends that these practices be incorporated into institutional policies that are monitored for adherence:

• Use aseptic technique to avoid contamination of sterile injection equipment.
• Do not administer medications from a syringe to multiple patients.
• Needles, cannulae, and syringes are single-patient-use items.
• Use IV bags, tubing, and connectors for one patient only.
• Do not use bags of IV solution as common source of supply for multiple patients.
• Consider a syringe or needle/cannula contaminated after it has entered an IV bag or set.
• Use single-dose vials whenever possible.
• Do not use one single-dose vial for several patients or combine contents of several vials.
• If multidose vials must be used, both the needle/cannula and syringe used to access them must be sterile.
• Do not keep multidose vials (such as insulin) in the immediate patient-care areas. Store as recommended by the manufacturer and discard if sterility is compromised.

(See also “Sharps-Related Controls” later in this course.)

LUMBAR PUNCTURE PROCEDURES

Healthcare providers should wear a surgical mask when placing a catheter or injecting material into the spinal canal or subdural space. This infection control practice is two-fold, protecting both the patient and healthcare provider from potential exposure. In 2011, the CDC reported on the results of investigating an outbreak of bacterial meningitis in patients and discovered that the infections occurred in patients who had spinal or lumbar puncture procedures performed by an infected healthcare provider who did not wear a surgical mask. The findings reinforce the risk of droplet-based transmission of oral flora from healthcare providers to patients during spinal or lumbar puncture procedures (CDC, 2011a).
Transmission-Based Precautions: Contact, Droplet, and Airborne

In addition to Standard Precautions, which are used with all patients, some patients require additional precautions known as transmission-based precautions. There are three types of transmission-based precautions: Contact, Droplet, and Airborne.

CONTACT PRECAUTIONS

Contact Precautions are designed to minimize transmission of organisms that are easily spread by contact with hands or objects. The 2007 CDC Guidelines made changes to recommended practices for Contact Precautions. Among these changes is the direction to “wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient’s environment.”

CDC Contact Precautions are summarized below:

• **Patient placement.** In acute care hospitals, place the patient in a single-patient room when available. When a single-patient room is not available, place the patient in a room with a patient(s) who has active infection with the same microorganism but with no other infection (cohorting). Consultation with infection control professionals is advised before cohorting.

• **Gloves and handwashing.** Wear gloves to enter the room. Change gloves after contact with infective material that may contain high concentrations of microorganisms, such as fecal material or wound drainage. Do not soil the environment with used gloves. Remove gloves before leaving the patient’s room and wash hands immediately. After glove removal and handwashing, ensure that hands do not touch potentially contaminated environmental surfaces or items in the patient’s room.

• **Gown.** Wear a gown to enter the room. Remove the gown before leaving the patient’s environment. After gown removal, ensure that clothing does not contact potentially contaminated environmental surfaces. Do not reuse gowns, even for repeated contacts with the same patient.

• **Environmental measures.** Ensure that rooms of patients on Contact Precautions are prioritized for frequent cleaning and disinfection (at least daily) with a focus on frequently touched surfaces (e.g., bed rails, over-bed table, bedside commode, lavatory, doorknobs) and equipment in the immediate vicinity of the patient.

• **Patient transport.** Limit the movement and transport of the patient from the room to medically necessary purposes. When transport is necessary, ensure that infected or colonized areas of the patient’s body are contained and covered. Remove and dispose of contaminated PPE and perform hand hygiene prior to transporting patients on Contact Precautions. Notify the receiving department of precautions prior to transport. Check hospital policy regarding ambulatory patients on Contact Precautions. At a minimum, the patient must perform hand hygiene before leaving the isolation room.
• **Patient-care equipment.** When possible, dedicate the use of noncritical patient-care equipment (stethoscope, BP cuff, thermometer, etc.) to a single patient or cohort of patients to avoid sharing among patients. Clean and disinfect any equipment that must be brought out of the room before use with others.

• **Equipment needed for Contact Precautions.** Gloves, gowns, dedicated patient equipment, disinfectant wipes or equivalent.

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**CASE**

Mrs. Alberts is a patient on the hospital surgical unit who is recovering from a complicated hip replacement surgery. She has been on antibiotics during the pre- and post-operative periods. On day four, she develops watery diarrhea, which tests positive for *C. difficile*.

The charge nurse recognizes that new infection precautions are needed to care for Mrs. Alberts. The nurse initiates Contact Precautions and communicates with Mrs. Albert’s physician to confirm the order. Contact Precautions require all visitors and care providers to wear a gown and gloves when entering the patient’s room. Mrs. Alberts will also need to have dedicated equipment that is used only for her, such as a blood pressure cuff, stethoscope, and other equipment that may be needed for her care. Hand hygiene, including handwashing versus using hand sanitizer, is also a precaution taken by all providers who care for Mrs. Alberts.

**DROPLET PRECAUTIONS**

Droplet Precautions are designed to prevent transmission of diseases easily spread by large-particle droplets produced when the patient coughs, sneezes, or talks, or during the performance of procedures.

**Droplet Precautions** are summarized below:

• **Patient placement.** In acute care hospitals, place the patient in a single-patient room when available.
  
  o When a single-patient room is not available, place the patient in a room with a patient(s) who has active infection with the same microorganism but with no other infection (cohorting).
  
  o Refer to the 2007 CDC Guidelines for recommendations for cohorting and for patient placement recommendations in long-term care settings.
  
  o In ambulatory settings, place patients who require Droplet Precautions in an examination room or cubicle as soon as possible and instruct them to use respiratory hygiene.
When a single-patient room is not available and cohorting is not achievable, maintain spatial separation of greater than 3 feet and keep cubicle curtains drawn between patient beds.

A negative-pressure room is not necessary, and the door may remain open.

- **Mask.** Wear a mask (a simple surgical or procedure mask, not an N-95 respirator) upon entry into the patient room or cubicle.

- **Patient transport.** Limit the movement and transport of the patient from the room to medically necessary purposes. Ask the patient to wear a mask and follow respiratory hygiene. No mask is required for persons transporting patients on Droplet Precautions. Notify the receiving department of precautions prior to transport.

- **Equipment needed for Droplet Precautions.** Isolation masks (i.e., simple masks, not N-95 respirators).

**AIRBORNE PRECAUTIONS**

Airborne Precautions are designed to prevent transmission of diseases spread by the true airborne route. These organisms are released from the patient in respiratory droplets, which evaporate shortly after release. Most organisms die when they dry out, but the organisms of these few diseases—tuberculosis, chickenpox, measles, SARS, and smallpox—can survive drying out. The droplet nuclei (small-particle residue of evaporated droplets) remain suspended in the air and can be dispersed widely by air currents within a room or even over a long distance.

Airborne Precautions are the only type that requires a negative-pressure airborne infection isolation room (AIIR) with door kept closed and use of an N-95 respirator.

**Airborne Precautions** are summarized below:

- **Patient placement.** Place the patient in a designated AIIR. See the 2007 CDC Guidelines for specifications for these rooms. Keep the room door closed and the patient in the room, as feasible. While the room is in use for Airborne Precautions, air pressure must be monitored daily with a visual indicator regardless of the presence of differential pressure sensing devices.

- **When an AIIR is not available,** transfer the patient to a facility that has an available AIIR. In the event of an outbreak involving large numbers of patients who require Airborne Precautions, consult with infection control professionals or the Department of Health.

- **In ambulatory settings,** develop systems (signage, etc.) to identify patients on Airborne Precautions. Place the patient in an AIIR if available. If none is available, place a surgical mask on the patient and put him/her in an examination room. After the patient leaves, that room should remain vacant with the door closed to allow for a full exchange of air, generally for one hour.
• **Respiratory protection.** Wear a fit-tested NIOSH-approved N-95 or higher-level respirator when entering the room of a patient with known or suspected infectious pulmonary tuberculosis. Refer to the 2007 CDC Guidelines for Isolation for recommendations regarding respiratory protection against smallpox. (See additional information about N-95 respirators below.)

• **Alternative respiratory protection.** Many facilities provide powered air-purifying respirators (PAPRs) in addition to or instead of N-95 respirators. PAPRs have the advantage that they do not require fit testing and can be used by people with facial hair that precludes wearing of an N-95. PAPRs do require training and maintenance. Check your facility’s policy if you may need to use them.

• **Susceptible persons** should not enter the room of patients known or suspected to have measles or chickenpox if immune caregivers are available. The 2007 CDC Guidelines do not make recommendations for respiratory protection of people believed to be immune to measles or chickenpox or for those believed to be susceptible to those diseases. Refer to facility policies.

• **Patient transport.** Limit the movement and transport of the patient from the room to medically necessary purposes. If transport or movement is necessary, place a surgical mask on the patient, if possible. Notify the receiving department of precautions prior to transport. In general, do not place an N-95 respirator on a patient, as it is not likely to be tolerated and is not indicated. **Never** place a PAPR on a patient on Airborne Precautions, as that device disperses the air from the wearer.

• **Additional precautions for preventing transmission of tuberculosis.** Consult CDC’s Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings (CDC, 2012c) for additional prevention strategies.

• **Equipment needed for Airborne Precautions.** N-95 respirators and/or PAPRs.

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**Hand Hygiene**

It bears repeating that hand hygiene is the single most important procedure for preventing the spread of infection.

Hand hygiene includes both using alcohol-based hand hygiene products and washing with soap and water. Alcohol-based hand hygiene products are often preferred over soap and water because they are faster and easier to use, so people use them more. Also, most studies have found them to be more effective in killing microorganisms, except *C. difficile* spores and noroviruses.

Handwashing with soap and water is required when hands are visibly soiled. Handwashing with soap and water may also be recommended when in contact with patients suspected or known to be infected with *C. difficile* and norovirus because of their resistance to alcohol-based hand rubs. Washing with soap and water physically removes microbes from the hands. Check with your facility for its policy.
ARTIFICIAL FINGERNAILS
The CDC Hand Hygiene Guideline specifies: Do not wear artificial fingernails or extenders when having direct contact with patients at high risk. Check with your facility for their policy. Nails should be unpolished and less than 1/4-inch long. Chipped nail polish, long nails, artificial fingernails, or nail extenders may tear gloves and can harbor pathogens, even after careful handwashing or the use of surgical scrubs.

Source: CDC, 2012b.

SUMMARY OF HAND HYGIENE

Hands or other exposed skin should be thoroughly washed as soon as possible following a known or possible exposure incident. Hands should also be washed immediately or as soon as feasible after removing gloves or other PPE.

Use soft antibacterial soap, if possible. Avoid harsh abrasive soaps, as these may open fragile scabs or other sores. Because handwashing is so important, it is wise to be familiar with the nearest handwashing facilities. Public restrooms, janitor closets, and so forth may be used for handwashing if they are normally supplied with soap and clean paper towels.

When one is working in an area without access to such facilities, an antiseptic cleanser or antiseptic hand wipes (“hand sanitizers”) may be used in conjunction with clean cloth/paper towels. If these alternative methods are used, hands should be washed with soap and running water as soon as feasible (OSHA, 2011a).

HAND CLEANSING TECHNIQUE

The following steps outline techniques for hand hygiene with soap and water. Caregivers are advised to follow the manufacturer’s recommendations about the product they are using.

Duration of the entire procedure: 40–60 seconds

1. Wet hands with water.
2. Apply the amount of soap product necessary to cover all hand surfaces.
3. Rub hands palm to palm.
4. Rub right palm over left dorsum with interlaced fingers, and vice versa.
5. Rub palm to palm with fingers interlaced.
6. Rub backs of fingers to opposing palms with fingers interlocked.
7. Rub left thumb rotationally while clasped in right palm, and vice versa.
8. Rub clasped fingers of right hand rotationally in left palm, backwards and forwards, and vice versa.
9. Rinse hands with water. Avoid using hot water in order to decrease the risk of dermatitis.
10. Dry hands thoroughly with a single-use towel.

11. Use towel to turn off faucet.  
   (WHO, 2009)

The same technique is used when decontaminating hands with an alcohol-based hand rub (ABHR), however no water is used. Similarly, towels are not used for drying, as hands will quickly dry on their own. When using alcohol-based hand rubs, the CDC recommends healthcare personnel rub their hands until the alcohol evaporates and the hands are dry.

For surgical hand antisepsis:

- Remove rings, watches, and bracelets before beginning to scrub.
- Clean under nails using a cleaner under running water.
- Use either an antimicrobial soap or an alcohol-based hand rub with persistent activity before donning sterile gloves. Wash with soap and dry thoroughly before using the alcohol-based surgical scrub, then allow hands to dry completely after using the alcohol-based hand rub and before donning sterile gloves.
- When using soap, scrub hands and forearms for the length of time recommended by the manufacturer.  
  (CDC, 2012b)

PRACTICES AND CONTROLS

In addition to the precautions described above, other practices and controls can be employed to prevent and control infection. These include:

- Engineering controls
- Workplace controls
- Environmental controls

**Engineering controls** isolate (contain) or remove the pathogens hazard from the workplace. Examples include sharps disposal containers, self-sheathing needles, and sharps with engineered sharps injury protection and needleless systems. Likewise, splatter shields on medical equipment associated with risk-prone procedures or locking centrifuge lids isolate or contain the hazard. Hand hygiene is also an engineering control, since it removes microorganisms from the workplace.

**Work practice controls** reduce the likelihood of exposure to pathogens by changing the way a task is performed, such as appropriate practices for handling and disposing of contaminated sharps. Work practice controls refer to the processes and procedures used to ensure that work is conducted in a safe and healthy manner. Work practice controls are an essential component of a safe work environment.
Work practices to learn and follow include:

- Hand hygiene, to protect both patients and workers
- Following Standard Precautions
- Minimizing splashing or spraying of any potentially infectious material
- Proper decontamination and sterilization of equipment and supplies
- Cleanup, care, and maintenance of supplies and equipment
- Proper disposal of used supplies and equipment
- Keeping all food and drink away from areas where blood or OPIM are present
- Avoiding eating, drinking, smoking, applying cosmetics or lip balm, or handling contact lenses where there is a risk of contamination

**Environmental controls** help prevent the transmission of infection by reducing the concentration of pathogens in the environment. Such measures include environmental cleaning (housekeeping); cleaning, disinfecting, and sterilizing patient equipment; waste management; and linens (textiles) and laundry management.

**Sharps-Related Controls**

Engineering, work practice, and environmental controls have all been developed to prevent and control the spread of infection related to the use of needles and other sharps in the healthcare setting.

In 2000 federal laws were enacted to protect healthcare workers against needlesticks; these laws require that healthcare facilities evaluate and provide safe needles. OSHA’s Bloodborne Pathogens Standard requires that employers:

- Use engineering controls or work practices that “eliminate or minimize exposures” (OSHA 2001, CPL2–2.44D)
- Involve employees in the selection process
- Provide effective safe needles and sharps
- Provide training covering PPE, how to use safe-needle devices, and limitations of such devices

Employers must provide and workers must use safer devices whenever possible to prevent sharps injuries. Those devices must be evaluated and chosen to give preference to:

- Passive protection that does not depend on the worker to activate it
- Mechanisms that provide protection without delay
- Safety mechanisms that are integrated into (built into) the device, not an add-on
Other considerations to minimize risk of sharps injuries include:

- Educating all staff who will use a specific device on its proper use
- Eliminating non-safety alternatives wherever possible
- Using additional specific safety devices, as needed, for specialty areas or settings
- Using puncture-resistant containers for the disposal and transport of needles and other sharp objects

**SHARPS HANDLING**

“Sharps” are items with sharp edges or points capable of cutting or puncturing other items (AORN, 2015). A needlestick or a cut from a contaminated sharp can lead to infection from a bloodborne pathogen. Proper handling and disposal of sharps greatly reduces this risk. Sharps containers should be closable, puncture-resistant, and leak-proof on the sides and the bottom. They must be labeled or color-coded.

- Discard needle/syringe units without attempting to recap the needle whenever possible.
- If a needle must be recapped, **never** use both hands. Use the single-hand “scoop” method.
- Never break or shear needles.
- To move or pick up needles, use a mechanical device or tool, such as forceps, pliers, or broom and dustpan.
- Dispose of needles in labeled sharps containers only.
- When transporting sharps containers, close the containers immediately before removal or replacement to prevent spillage or protrusion of contents during handling or transport.
- Fill a sharps container up to the fill line, or two thirds full. Do not overfill the container.

**SAFE INJECTION PRACTICES**

Safe injection practices are a set of measures taken to provide injections in a manner that is optimally safe for patients, healthcare personnel, and others. Injection safety includes practices intended to prevent transmission of bloodborne pathogens between one patient and another or between a healthcare worker and a patient, and also to reduce risk of needlestick injury to others.

Safe injection practices were added to the CDC’s Standard Precautions in 2007. Many of these practices are not new but were added to Standard Precautions after several outbreaks of disease due to bloodborne pathogens were traced back to compromised aseptic techniques associated with injection therapy, often in outpatient settings.

These lapses have resulted in:
• Transmission of bloodborne viruses, including hepatitis B and C, to patients
• Notification of thousands of patients to possible exposure to these pathogens and recommendation that they be tested for HBV, HBC, and HIV
• Referral of providers to licensing boards for disciplinary action
• Malpractice suits filed by patients

Healthcare providers are required to follow recommended practices for injection and/or IV therapy:

• Ensure proper hand hygiene before handling medications.
• Maintain aseptic technique throughout all aspects of injection preparation and administration.
  o Medications should be prepared (“drawn up”) in a designated clean medication area that is not adjacent to areas where potentially contaminated items are placed. For example, a cart with both used blood glucose testing devices (contaminated) and syringes and insulin (supplies for injection) would not meet this requirement.
  o Use a new sterile syringe and needle to draw up medications, preventing contact between the injection materials and the non-sterile environment.
  o If a medication vial has already been opened, the rubber septum should be disinfected with alcohol prior to piercing it.
  o Never leave a needle or other device (e.g., “spikes”) inserted into a medication vial septum or IV bag/bottle for multiple uses, since this provides a direct route for contamination.
  o Medication vials should be discarded on or before the manufacturer’s expiration date, the date set by facility expiration policy, or any time there are concerns regarding the sterility of the medication.
• Never administer medications 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 IV tubing, regardless of the distance from the IV insertion site.
  o All of the infusion components from the infusate (IV fluid) to the patient’s catheter are a single interconnected unit.
  o All of the components are directly or indirectly exposed to the patient’s blood and cannot be used for another patient.
  o Syringes and needles that enter any port in the IV system are contaminated and cannot be used for another patient or used to re-enter a non-patient-specific multidose vial.
Separation from the patient’s IV by distance, gravity, and/or positive infusion pressure does not ensure that small amounts of blood are not present in these items.

- 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.

- Dedicate vials of medication to a single 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 (such as insulin) should be assigned to a single patient whenever possible.
  - Never use bags or bottles of intravenous solution as a common source of supply for more than one patient.

- Never use peripheral capillary blood monitoring devices (such as lancets or platforms) packaged as single-patient use 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.

Safe injection practices are also described by OSHA. They include:

- Contaminated needles and other contaminated sharps shall not be bent, recapped, or removed except as noted below. Shearing or breaking of contaminated needles is prohibited.

- If an employer can demonstrate that no alternative is feasible or that such an action is required by a specific medical or dental procedure, bending, recapping, or needle removal must be accomplished through the use of a mechanical device or one-handed “scoop” technique.

- Immediately or as soon as possible after use, contaminated reusable sharps shall be placed in appropriate containers until properly reprocessed. Reusable sharps that are contaminated with blood or OPIM shall not be stored or processed in a manner that requires employees to reach by hand into the container.

**EXPOSURE CONTROL PLAN**

Any employer having employee(s) with potential occupational exposure contact with blood or OPIM must have a written exposure control plan to eliminate or minimize risk. “Potential occupational exposure” is defined as “reasonably anticipated skin, eye, mucous membrane, or parenteral (piercing) contact with blood or OPIM that may result from the performance of the employee’s duties.” Among the requirements for this exposure control plan is identification of
which employee groups may be at risk for exposure. In general, any worker who has contact with patients or with body fluids is at risk for exposure.

When accidental exposure occurs in any work setting, employers should document and track:

- Which devices were associated with blood exposures
- Where the exposures occurred (area, setting)
- The circumstances in which exposures occurred
- Post-exposure management taken to prevent infection (see also below under “Post-exposure Prophylaxis”)

CASE

Joanne is a circulating nurse working in the operating room (OR) who has just finished caring for a patient who required a lumbar epidural steroid injection. The anesthesiologist working on the case left the lumbar puncture procedure tray for Joanne to clean up, as he was needed on the next case. Joanne is under pressure to turn over the room quickly because there is a full patient schedule for the day.

As Joanne is cleaning up the tray, she sticks herself with the used lumbar puncture needle, not realizing that the syringe was left in the wrapper of the disposable tray. As per policy, the needle should have been discarded in a sharps container by the anesthesiologist after use. Joanne immediately flushes the needlestick injury and reports the incident to her immediate supervisor. The report includes the fact that the injury occurred in the procedure room of the OR while cleaning up after a lumbar puncture. Her supervisor starts the process of investigation and exposure management.

The infection control team is also alerted and assists with formal reporting, feedback to the anesthesiologist on duty, and recommended post-exposure protocols. The infection control team works with the entire OR team to review and reinforce safe handling of sharps and needlestick prevention as a result of this incident.

Cleaning, Disinfecting, and Sterilizing

The healthcare environment can become easily contaminated with pathogens. The potential for contamination exists in every area of the hospital or other healthcare facility. Contaminated patient-care equipment (wet or soiled dressings), invasive devices that were used in diagnosis and treatment (surgical instruments or endoscopes), and environmental surfaces (doorknobs, floors, toilets) can act as vehicles for the transmission of infection to healthcare workers and/or patients.

Proper cleaning is important in healthcare environments and includes surfaces, furnishings, reusable medical equipment, and patient-care devices. Understanding and applying appropriate
procedures for cleaning, disinfection, and sterilization are essential to maintaining a safe patient-care environment.

**CONTAMINATION AND CROSS-CONTAMINATION**

Potential for contamination is dependent upon:

- Type of instrument, medical device, equipment, or environmental surface (material, configuration, or presence of hinges, crevices, or lumens)
- Frequency of hand contact with the device or surface
- Potential for contamination with body substances or environmental organisms
- Level of contamination, i.e., the types and numbers of microorganisms and potential for cross-contamination

**Cross-contamination** refers to transfer of microorganisms from one person or place to another. Every healthcare professional should recognize potential sources of cross-contamination in the healthcare environment and apply infection control procedures to avoid cross-contamination. These sources include:

- Surfaces or equipment that require cleaning between patients
- Practices that contribute to hand contamination
- Re-use of single-use/disposable instruments, medical devices, or equipment

Lapses in infection control practices resulting in cross-contamination of instruments, medical devices, or equipment have led to reported cases of disease transmission. Identified factors that have led to this cross-contamination include:

- Failure to discard single-use (disposable) items
- Failure to reprocess reusable or reposable items between patients
- Inadequate cleaning
- Inadequate disinfection or sterilization
- Contamination of disinfectant or rinse solutions
- Improper packaging, storage, and handling
- Inadequate or inaccurate recordkeeping of reprocessing requirements

**DISINFECTION**

Care must be taken to use the right disinfectant for the purpose, consistent with its U.S. Food and Drug Administration (FDA) or Environmental Protection Agency (EPA) registration. Some organisms are easily killed while others are highly resistant to disinfection.
Environmental surfaces such as floors and tabletops should be cleaned or disinfected on a regular basis, when spills occur, and when they are visibly soiled. The disinfectant manufacturer’s instructions for dilution, use, and contact time should be followed. (Refer to CDC Guidelines for Environmental Infection Control in Health-Care Facilities, listed in the “References” at the end of this course, for additional detail.)

All disinfectants and sterilizing chemicals have a degree of toxicity necessary to kill the microorganisms. In general, the lowest level of product that will do the job should be used to minimize exposure of healthcare workers to toxic chemicals.

**Low-Level Disinfection**

Low-level disinfection kills some viruses and bacteria using a chemical germicide registered as a hospital disinfectant by the EPA. It is used to clean the environment and items that touch only intact skin. It does not kill bacterial spores and is less active against some gram-negative rods, such as pseudomonas and mycobacteria.

Healthcare workers carrying out low-level disinfection should follow these practices:

- Use EPA-registered disinfectants in accordance with manufacturer’s directions. In general, this is the disinfectant found on the housekeepers’ carts.
- Keep environmental surfaces visibly clean on a regular basis and clean up spills promptly.
- Clean high-touch surfaces (monitor controls, doorknobs, bed rails, light switches) often.
- Avoid cleaning methods that produce aerosols or disperse dust.
- Use barrier protective coverings as appropriate for high-touch surfaces such as computer keyboards.
- Do not use high-level disinfectants for environmental cleaning due to toxicity.

(Refer to CDC Guidelines for Environmental Infection Control in Healthcare Facilities or the AORN Guidelines for Perioperative Practice, listed in the “References” at the end of this course, for additional detail.)

**Intermediate-Level Disinfection**

Intermediate-level disinfection kills most viruses, bacteria, and mycobacteria using a chemical germicide registered as a tuberculocide by the EPA. It does not kill bacterial spores. It is often used to clean blood spills and other environmental cleaning and is not licensed for disinfection of patient-care equipment that touches mucous membranes. These disinfectants are typically labeled as tuberculocidal to give evidence that they kill...
the bacterium that causes tuberculosis as well as HBV and HIV. They may be available as a liquid or as disposable wipes.

Proper procedures for cleaning of blood and body fluid spills begins with initial removal of bulk material using disposable absorbent material (such as paper towels) as needed, followed by disinfection with a product effective against organisms transmitted by blood or other body fluids. These include:

- Products from EPA List D, which contains registered antimicrobial products effective against human HIV-1 and HBV
- Products from EPA List E, which contains registered antimicrobial products effective against Mycobacterium tuberculosis, human HIV-1 and HBV
- Freshly diluted 1:100 sodium hypochlorite (i.e., 1/4 cup bleach to 1 gallon of water)

Blood spills should be cleaned without delay. Wear gloves and other PPE as needed. When cleaning up a blood spill, carefully cover the spill with rags or paper towels. Pour disinfectant solution over the rags or towels and let it sit for 10 minutes, or follow the manufacturer’s recommendations.

Some situations, such as care of the patient on Contact Precautions, may require specified patient-care items to be either dedicated to one patient or patient cohort or subjected to special disinfection procedures between patient uses. This includes items used for patients infected with organisms that are difficult to treat, highly virulent, or easily spread, such as:

- Patients infected with MRSA, vancomycin-resistant enterococci (VRE), C. diff, and other microorganisms of special concern
- Patients infected with highly virulent microorganisms, e.g., viruses causing hemorrhagic fever (e.g., Ebola or Lassa)

Knowing facility policies and/or consulting with infection control staff is important in these situations.

**High-Level Disinfection**

High-level disinfection kills all organisms except high levels of bacterial spores using a chemical germicide cleared for marketing as a sterilant by the FDA. It is used for patient-care equipment that touches intact mucous membranes, called semi-critical devices, such as laryngoscopes or endoscopes. It is used when sterilization is not feasible.

Endoscopes can transmit pathogens to patients by contaminated internal channels even if the exterior has been disinfected, the internal channels have not been adequately cleaned,
or contact of the disinfecting solution with the internal channel is incomplete or does not last long enough.

Appropriate practices for carrying out high-level disinfection include:

- When handling and cleaning contaminated items, wear appropriate PPE, i.e., gloves, eye protection, and/or gown as needed.
- Always clean items thoroughly before reprocessing. First rinse with cold water to remove blood or body fluids, then wash with hot soapy water and rinse again to remove the soap before disinfecting or sterilizing. Cleaning methods may be manual or mechanical and may require a rinse or presoak depending on the nature and amount of blood or body fluids. Once cleaned, avoid cross-contamination by other articles or surfaces.
- For devices with internal lumens, such as endoscopes, methods for verifying contact with all internal channels and components must be monitored.
- Always follow the recommendations of the device/equipment manufacturers of both the device to be disinfected and the disinfectant to be used for reprocessing to ensure that the method chosen is compatible with the components and materials in terms of heat and pressure tolerance and time required for reprocessing (CDC, 2011b).

### DEVICES AND CORRESPONDING DISINFECTION LEVELS

<table>
<thead>
<tr>
<th>Type of Device</th>
<th>Disinfection Level</th>
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<tbody>
<tr>
<td><strong>Critical:</strong> instrument enters sterile spaces or bloodstream</td>
<td>Sterilization (physical or chemical)</td>
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<tr>
<td>Examples:</td>
<td></td>
</tr>
<tr>
<td>• Surgical instruments</td>
<td></td>
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<tr>
<td>• Acupuncture needles</td>
<td></td>
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<tr>
<td>• Foot care instruments</td>
<td></td>
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<tr>
<td><strong>Semi-critical:</strong> instrument comes in contact with mucous membranes or non-intact skin</td>
<td>High-level disinfection, only if sterilization not possible</td>
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<td>Examples:</td>
<td></td>
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<tr>
<td>• Any kind of “scope”</td>
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<tr>
<td>• Rectal or vaginal probes</td>
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<tr>
<td>• Reusable peak flow meters</td>
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</tbody>
</table>
Non-critical: instrument contacts intact skin

Examples:
- Blood pressure cuffs
- Pneumatic tourniquet cuffs
- Hydrotherapy tanks
- Stethoscopes
- Bed pans

Intermediate-level disinfection

Note: The degree of contamination overrides the usual level of disinfection. For example, a reusable pneumatic tourniquet cuff (normally subjected to intermediate-level disinfection) that has been contaminated with blood would require high-level disinfection before it is handled by ungloved healthcare workers or used again for patient care.

REPROCESSING MEDICAL DEVICES

“Reprocessing” is the term used to describe all operations to render a contaminated reusable, reposable (has limited use or a combination of reusable and disposable components), or single-use device patient ready (AORN, 2015).

Reprocessing includes special infection-control procedures for killing microbes on instruments and patient-care equipment that are reused with the same patient or shared between patients. Reprocessing of reusable patient-care equipment may include both high-level disinfection and sterilization, preceded by decontamination and careful, thorough cleaning.

DEVICE PURCHASING DECISIONS

Prior to the decision to purchase an item available in either single-use, reposable, or reusable versions, a facility should consider several factors:

- The frequency with which the item will be used
- Whether any or all components are on the FDA list of items known to require reprocessing (FDA, 2005)
- The ability of the facility to perform complete reprocessing that is fully compliant with FDA guidance and regulations using existing personnel and equipment resources
- What will be needed to augment existing resources to perform appropriate reprocessing
- The total cost to reprocess the item, whether done in-house or by a company that provides reprocessing

Any consideration of reuse of single-use devices should be reviewed by the facility’s risk manager to assure that the requirements of the FDA for such reuse are met. (*See “Resources” at the end of this course.*)
Any reusable device that appears on the FDA list as known to have been reprocessed should **never** be used more than once. The only possible situation in which a non-FDA-listed device should be considered for reprocessing is one in which **all** of the following criteria have been met:

- The item was removed from its packaging without being contaminated during the process.
- All staff in the room confirm that the item was not touched by any member of the team whose gloves were contaminated by blood/OPIM.
- All staff in the room confirm that item did not come into contact with any other supplies or equipment contaminated by blood/OPIM.
- All components of the item are present.
- The facility is willing to accept the responsibilities of being considered a manufacturer if it reprocesses the item
- Alternatively, the facility has a contract in place with an approved third-party reprocessor.

For facilities electing to routinely reprocess single-use items as a cost-savings measure, there can be severe financial penalties if an untoward patient event occurs that can be traced to this practice.

**CASE**

During a cardiac ablation procedure, the surgeon requests that an additional single-use ablation probe be opened. Because the scrub is involved in holding a retractor and cannot accept the device, the circulator opens it on a separate small table and rolls the table near, but not in contact with, the sterile field. Before either the surgeon or scrub retrieve the item, the patient’s condition deteriorates and the procedure is aborted.

After the patient is stabilized and transported to the intensive care unit, the nursing team begins preparing the room for another procedure. The scrub and circulator verify with each other that the table holding the probe has not been touched by any member of the sterile team nor come into contact with any items that were themselves contaminated.

Given the cost of the ablation probe, it meets the facility’s financial criteria for possible reprocessing. The probe, its container, all wrappings, and all included paperwork are placed in a sealable plastic container. The scrub and circulator document the circumstances surrounding the opening and handling of the probe. The probe container and nursing documentation are given to the surgical suite nurse manager, who reviews the documentation and forwards it to the appropriate risk manager for final review and a decision on reprocessing.

The probe meets all criteria for reprocessing and is sent to a third-party reprocessor with which the facility has a contract.
**Determining the Reprocessing Level**

The choice of level of reprocessing (sterilization or high-level disinfection) depends on the intended use of the item (whether it will touch sterile spaces or intact mucous membranes). Intermediate and low-level disinfection are used only for environmental cleaning and items that will touch intact skin.

The choice of reprocessing methods must also consider the manufacturer’s recommendations for compatibility among equipment components and materials and the chemicals to be used, the heat and pressure tolerance of the equipment, and the time and temperature requirements of the reprocessing methods. For example, steam sterilization would not be appropriate for equipment that cannot tolerate heat and moisture.

Industry guidelines and manufacturer recommendations (of both chemicals and equipment) should be used to develop and update reprocessing policies and procedures. Written instructions should be available for each instrument, medical device, and piece of equipment to be reprocessed.

### REPROCESSING STEPS

- **Pre-cleaning** should be done as soon as possible after use, usually at the use location. This removes soil, debris, and lubricants from internal and external surfaces.

- **Cleaning** may be manual (scrubbing with brushes) or mechanical (using an automated washer). Cleaning equipment must be used appropriately (e.g., do not reuse disposable cleaning equipment). Cleaning solutions must be changed as directed by the manufacturer.

- **Disinfection done at the appropriate level** requires sufficient contact time of all internal and external surfaces with the cleaning solution.

- **Sterilization** requires sufficient exposure time to heat, chemicals, or gases.

### Sterilization

Sterilization is required for reusable patient-care instruments that touch sterile spaces in the body. Steam sterilization is the preferred method for sterilizing critical medical and surgical instruments that are not damaged by heat, steam, pressure, or moisture (CDC, 2009). The major sterilizing agents used in hospitals are:

- Moist heat by steam autoclaving (the gold standard, also minimally toxic)
- Ethylene oxide gas (highly toxic; use is decreasing)
- Peracetic acid (used in proprietary machines, often for endoscopes)
- Plasma (newer method with little toxicity)
• Dry heat (used only for items sensitive to both high temperature and to moisture; rarely used, as most such items are readily available prepackaged, sterile, and in unit-dose quantities)

**Measuring Effectiveness**

Effectiveness of reprocessing depends on a number of variables.

• Thorough cleaning is essential before either disinfection or sterilization.
• The right disinfectant product must be chosen. High-level disinfectants require immersion, while surface disinfectants are for environmental use.
• Presence of organic matter (inadequate cleaning) inactivates many disinfectants.
• In general, biofilms are not readily removed by chemicals alone but require mechanical scrubbing. (Biofilms are constructed by some bacteria to protect themselves from hostile environments such as disinfectants. An example of a biofilm is the film on our teeth in the morning, not removed by mouthwash, requiring brushing.)

**Monitoring of disinfection** is essential to document the effectiveness of reprocessing. Factors to be documented include:

• Activity (concentration) of the disinfectant
• Contact time with internal and external components
• Recordkeeping and tracking of equipment usage and reprocessing
• Handling and storage after disinfection to prevent contamination

**Monitoring of sterilization** includes different recordkeeping for different methods:

• Sterilization records should include:
  • The results of the use of biologic monitors that test nonpathogenic organisms exposed to the sterilization process then incubated to verify that the process killed them.
  • Process monitors:
    ▪ **External indicator tape**, which clearly indicates if an item has been subjected to a sterilization process. The tape that matches the process being used on the items should be applied to the package (e.g., if steam-sensitive tape is used on items subjected to another method, it would give an erroneous result).
    ▪ **Internal integrator**: One or more test units placed in the most inaccessible part of the item being sterilized, to provide the greatest degree of challenge to the sterilant.
- Physical monitors (time, temperature, pressure), which document that the physical parameters for sterilization have been met. These are normally automatic printouts generated by the sterilizer.

- Recordkeeping by sterilizer load and a recall system for each item sterilized.

- Packing, handling, and storage after sterilization, including definition of when reprocessing is needed, either by event (the most common) or by time (normally more related to the shelf life of the device, based on its physical composition).

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**REPROCESSING AND PRION DISEASE**

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, such as Creutzfeldt-Jakob disease (CJD), which is the human form of bovine spongiform encephalopathy (“mad cow disease”). Special procedures are required for handling instruments in contact with brain, spinal, or nerve tissue from patients known or suspected to have CJD.

For all practical purposes, the reprocessing performed on devices known or suspected to be contaminated with prions is intended to create waste that is as clean and safe as possible. Once a device has been subjected to the processes that destroy prions, it has been destroyed or rendered unfit for further use.

Consult with infection control experts before performing procedures on such patients.

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**Handling and Storage of Reprocessed Items**

Once devices/equipment have been disinfected, proper handling and storage are required to maintain these items in ready-to-use condition. See the facility’s policies for specific details.

Proper handling and storage after sterilization—including package integrity and shelf life or event-related sterility criteria—are required to maintain these items in a sterile state.

Event-related sterility means that sterilized items do not outdate by an arbitrary date but are judged to be sterile unless an “event” has compromised sterility.

Compromising events include circumstances that break the integrity of the sterile packaging by creating holes or wetting the package, which could carry bacteria into it. This means that the once-sterile package that has come loose, has holes, or shows evidence of wetting, presently or in the past, cannot be used because sterility may have been compromised. The end user of the package is responsible for inspecting its integrity, verifying that no event has compromised sterility.
CASE

Jennifer is a nurse and manager of an outpatient procedure center that performs colonoscopies and endoscopies on a regular basis. In the past three months, the center has had reports of six patients with a diagnosis of a strain of Carbapenem-resistant Enterobacteriaceae (CRE) *Escherichia coli* (*E. coli*) that occurred within a few weeks of their GI procedures. An investigation was initiated by the CDC to identify the source and prevent further transmission to other patients.

The investigators work with Jennifer and the center to review the histories of all patients and discover that each patient had undergone a similar invasive procedure using an endoscope. On reviewing the center’s procedures, CDC officials find that the center has been cleaning and reprocessing the endoscopes according to manufacturer-recommended procedures for disinfecting. However, one endoscope is cultured and found to contain the resistant strain of *E. coli*. Investigators recommend to Jennifer and the center that they switch to a liquid chemical, high-level disinfection system that is appropriate to their endoscope inventory and monitor the effectiveness by following the recommendations of the manufacturers of both the disinfection system and the endoscopes.

Jennifer and her instrument processing personnel meet with their counterparts and an infection preventionist at the hospital with whom their physicians have privileges. Using the expertise and experience of their colleagues, they are able to make recommendations to the management team of their clinic regarding equipment acquisitions and policy/procedure changes.

After the center changes its disinfection procedures, no additional cases of *E. coli* occur and patient safety is maintained. The center invests a significant amount of its capital improvement and inventory budgets to purchase and install the disinfection system and acquire additional endoscopes and accessory instruments because of this outbreak.

HOUSEKEEPING AND SANITATION

Appropriate housekeeping and sanitation practices are essential to reduce the spread of infection, particularly in high-risk areas such as nurseries, operating rooms, and ICUs. The CDC guidelines (2007) include the following recommendations:

- Keep housekeeping surfaces (e.g., floors, walls, tabletops) visibly clean on a regular basis and clean up spills promptly.
- Avoid large-surface cleaning methods that produce mists or aerosols or disperse dust in patient-care areas.
- Follow proper procedures for effective uses of mops, cloths, and cleaning solutions.
Waste Management

There are two categories of hospital waste: regulated medical waste and unregulated waste. About 20% of hospital waste requires special handling. The other 80% is similar to domestic waste (WHO, 2011).

Regulated medical waste requires special precautions in handling and disposal. Regulated medical waste includes:

- Microbiology laboratory waste
- Pathology and anatomy waste
- Bulk blood or blood products
- Sharps items such as used needles or scalpel blades

These items require special handling, transport, and storage procedures. The CDC recommends the following guidelines:

- Personnel responsible for waste management must receive appropriate training in handling and disposal methods in accordance with facility policy.
- Waste generated in isolation areas should be handled using the same methods used for waste from other patient-care areas.
- Disposable syringes with needles—including sterile sharps that are being discarded, scalpel blades, and other sharp items—should be disposed of in puncture-resistant containers located as close as practical to the point of use.
- Do not bend, recap, or break used syringe needles before discarding them into a container.
- Sanitary sewers may be used for safe disposal of blood, suctioned fluids, ground tissues, excretions, and secretions provided that local sewage discharge requirements are met and that the state has declared this to be an acceptable method of disposal.
- Store regulated medical wastes awaiting treatment in a properly ventilated area inaccessible to vertebrate pests. Use waste containers that prevent development of noxious odors.
- If treatment options are not available at the site where the waste is generated, transport regulated medical waste in closed, impervious containers to the on-site treatment location or to another facility for treatment as appropriate.
- Regulated medical waste must be treated by a method (steam sterilization, incineration, interment, or an alternate treatment technology) approved by the appropriate authority (e.g., the state, Veterans Administration, Indian Health Service) before disposal in a sanitary landfill.
**Linens and Laundry**

The risk of actual disease transmission from soiled laundry is negligible. However, the hands of healthcare workers may be contaminated by contact with patient bed linens. Thus, common sense hygienic practices for handling, processing, and storage of textiles are recommended. These practices include:

- Do not shake items or handle them in any way that may aerosolize the infectious agents.
- Avoid contact of one’s own body and personal clothing with the soiled items being handled.
- Wear gloves and other protective equipment, as appropriate, when handling contaminated laundry.
- Contain soiled items in a laundry bag or designated bin at the location where they were used, minimizing leakage.
- Do not sort or rinse textiles in the location of use.
- Label or color-code bags or containers for contaminated waste.
- If laundry chutes are used:
  - Ensure that laundry bags are securely closed before they are placed in the chute.
  - Do not place loose items in the laundry chute.
- For textiles heavily contaminated with blood or other body fluids, bag and transport in a manner that will prevent leakage.
- Do not use dry cleaning for routine laundering in healthcare facilities.
- For clean textiles, handle, transport, and store by methods that will ensure their cleanliness.

OSHA’s Bloodborne Pathogens Standard requires employers to ensure that employees who have contact with contaminated laundry wear protective gloves and other appropriate PPE.

Employers are responsible for laundering reusable PPE. Work clothes such as uniforms are not considered to be PPE. Provided gowns or other PPE should be used to prevent soiling of uniforms.

Training healthcare workers who are responsible for housekeeping and management of linen and waste in appropriate infection control for their particular duties is essential for safe patient care.
Labels

Warning labels are to be affixed to containers of regulated waste; refrigerators and freezers containing blood or OPIM; and other containers used to store, transport, or ship blood or OPIM. These labels are fluorescent orange, red, or orange-red. Bags used to dispose of regulated waste must be red or orange-red, and they too must have the biohazard symbol in a contrasting color readily visible upon them.

CASE

David is a charge nurse in the emergency department (ED) in a rural hospital and is working with a team who is caring for a trauma case. The patient is a farmer who was transported after an accident involving harvesting equipment. The patient is bleeding out from a partially severed arm on arrival, and the ED team stabilizes the patient prior to transfer to the OR.

Once the patient is transferred to the OR, David returns to the ED to work with housekeeping to ensure proper cleanup of the room. The housekeeping team on duty have had their required infection control training, however they have had little experience with this type of trauma cleanup. As the charge nurse on duty, David is responsible for supervising the team and ensuring that proper procedure is followed.

David confirms that the housekeeping team has appropriate PPE donned prior to starting cleanup. All surfaces that are contaminated with blood are first cleaned with recommended disinfectant. All soiled items are contained, placed in biohazard bags, and secured for disposal. David also takes a second look to make sure that any sharps are placed in sharps containers and secured for disposal. Laundry that is contaminated with blood is also secured according to hospital procedures.

After cleanup, PPE is removed and discarded by the team in biohazard bags as well. Each team member monitors their uniform for any soiled items and performs hand hygiene as a final step prior to moving on to their next work assignment.
BARRIERS AND PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is specialized clothing and/or equipment worn by a healthcare worker for protection against a hazard. PPE provides barriers to the transmission of infectious organisms, thereby protecting both the healthcare professional and the patient.

Wearing gloves, gowns, masks, eye, and face/neck protection can significantly reduce health risks for employees exposed to blood and OPIM. Employers are required to provide, clean, and maintain appropriate PPE and clothing free of charge to employees. Latex-free PPE must be made available on request (OSHA, 2011b).

PPE must be readily accessible to employees and available in appropriate sizes. It is important to know which type of PPE is available at work and where it is stored. To protect themselves, healthcare workers must have a barrier between them and any potentially infectious material.

Use of PPE is built in to the descriptions of all four isolation precautions (Standard, Contact, Droplet, and Airborne) described by the CDC. Healthcare workers should use appropriate barriers and/or PPE whenever they may have contact with the blood or body fluids of any patient and to prevent exposure to the droplets from patients with respiratory symptoms.

Selection of PPE should consider the possibility of coming into contact with infectious material from splashes, respiratory droplets, and airborne pathogens, as well as the anticipated volume of exposure. This depends in part on the type of procedures or activity being performed. In addition, consideration should be given to whether protection from exposure is needed for patient safety, healthcare worker safety, or both. When infection control precautions are instituted (e.g. Contact, Droplet, and Airborne Precautions), recommendations for specific PPE should be followed.

Barriers and PPE are most effective when appropriately selected, properly fitted, worn according to manufacturer’s instructions, inspected frequently to verify integrity of the barrier, and changed between patients. The cost of barriers and PPE are far less than the cost of treating preventable infections of patients and personnel.

The type of PPE selected should be based on the procedure and reasonably anticipate events such as:

- Blood or body fluid splash
- Contact with minimal bleeding/drainage/body substances
- Contact with large volume bleeding/drainage/body substances that are likely to soak through the contact area
- Respiratory droplet pathogens
- Airborne pathogens
Some barriers are used to protect the patient, including:

- Sterile barriers for invasive procedures
- Masks for the prevention of droplet contamination

## TYPES OF PPE

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves</td>
<td>Nonsterile, disposable; worn when soiling of the hands with blood or body fluids is likely</td>
</tr>
<tr>
<td>Utility gloves</td>
<td>To prevent injuries during extrication or when working in other hazardous environments where broken glass or sharps may be present</td>
</tr>
<tr>
<td>Gowns</td>
<td>Outerwear to protect from blood and body fluids; worn when soiling of exposed skin or clothing is likely</td>
</tr>
<tr>
<td>Tyvek suit</td>
<td>One-piece, impervious outerwear with zipper; may have hood and booties attached; worn when gross contamination with blood and body fluids is anticipated</td>
</tr>
<tr>
<td>Face shield</td>
<td>One-piece face protection; worn while performing invasive techniques, including IV therapy, suctioning, and intubations, or any time there is an opportunity for blood or body fluids to be splashed, sprayed, or splattered; not to be used for TB protection</td>
</tr>
<tr>
<td>Goggles</td>
<td>Eye protection that includes shielding front, sides, and top; goggles/safety glasses with side and top shields as well as full-face shielding are all acceptable; prescription glasses are acceptable if side shields are added</td>
</tr>
<tr>
<td>Mask (surgical)</td>
<td>Disposable; to be placed over the mouth and nose; worn when splashing of blood or body fluids is likely; worn with eye protection</td>
</tr>
<tr>
<td>Head coverings</td>
<td>Cap that covers hair; worn when splashing of blood or body fluids is possible</td>
</tr>
<tr>
<td>Booties</td>
<td>Outerwear used to cover shoes/boots when exposed to blood and body fluids</td>
</tr>
<tr>
<td>Turnout gear</td>
<td>Fire-resistant coat and pants; may provide protection during extrication</td>
</tr>
<tr>
<td>Steel-toed shoes/boots</td>
<td>Protective footwear</td>
</tr>
<tr>
<td>Hard hats</td>
<td>Protective head covering; worn during extrication</td>
</tr>
<tr>
<td>Body armor</td>
<td>Bulletproof vest; worn for protection in potentially hostile situations</td>
</tr>
</tbody>
</table>

### Gloves

Gloves should be worn when contact with blood or OPIM, mucous membranes, non-intact skin, potentially contaminated skin, or contaminated patient-care equipment is anticipated.

- Wear gloves with fit and durability appropriate to the task, such as disposable exam gloves for patient care and disposable or reusable gloves for cleaning.
• Remove gloves in a manner than minimizes risk of hand contamination.
• Do not wear the same pair of gloves for the care of more than one patient.
• Do not wash disposable gloves.
• Change gloves during the care of one patient if moving from a contaminated body site to a cleaner one. Recommendation is to go from clean to dirty.
  (CDC, 2007)

Gloves are available in several materials, including latex, nitrile, or rubber (utility/housekeeping). Individuals with an allergy to latex should use gloves made of nitrile or another latex-free alternative. Latex or nitrile gloves are preferable over vinyl gloves for clinical procedures since several studies have shown that vinyl gloves have higher failure rates in use (CDC, 2007).

Nitrile or other appropriately protective gloves are always used when handling chemotherapy or other chemicals. Both examination (nonsterile, clean) gloves and surgical (sterile) gloves must be available for specific healthcare tasks. Use of petrolatum-based lotions or creams is to be avoided when using latex gloves since these products may affect the integrity of the gloves.

Gloves are the first line of PPE and can prevent heavy contamination of hands during patient care and transmission of pathogens. However, wearing gloves does not provide complete protection. **Wearing gloves does not replace the need for handwashing** because gloves may have small, unnoticeable defects or may tear during use and hands can become contaminated during glove removal.

Hands should be washed with soap and water immediately after glove removal if hands are visibly soiled or if the glove has torn. In the absence of visible hand contamination, hand hygiene with alcohol hand rubs is appropriate after glove removal (CDC, 2007). Gloves should also be changed any time the healthcare worker switches from contaminated to clean tasks, even with the same patient.

### CASE

Theresa is a nurse in the GI procedure room and is preparing for an emergency endoscopy for a patient who has an active esophageal bleed. The patient is being stabilized in the ED and is expected to arrive for the procedure soon. Theresa reviews the needed PPE in this case and anticipates that the patient may be bleeding out on arrival.

Theresa dons an impervious gown, booties, head covering, mask, full face shield, and gloves as she prepares to receive this patient. She also checks to see that all other team members in the room are prepared with the proper PPE in order to minimize any exposure during the procedure.

As part of the protocol, she also has additional PPE available for other team members as well as sharps containers and biohazard bags for cleanup and disposal of sharps, contaminated materials, and equipment.
Gowns

Gowns are available in both sterile (surgical) and nonsterile (clean) versions and in fabrics of varying permeability (impervious, fluid-resistant, permeable). Gowns protect skin and prevent soiling of clothing during procedures and patient-care activities that are likely to involve contact with or generate splashes or sprays of blood or body fluids. Choose the type of gown that will provide adequate protection for the task planned.

When using Standard Precautions, an isolation gown is worn only as needed to protect the wearer from contact with blood or body fluids. Wear a gown for direct patient contact if the patient has uncontained body substances.

When Contact Precautions are in use, both gown and gloves should be worn on entry into the room to reduce unintentional contact with contaminated surfaces. Do not reuse gowns, even for repeated contacts with the same patient (CDC, 2007).

Respiratory Protection

Masks, respirators, and powered air-purifying respirators (PAPRs) protect the healthcare worker, the patient, or both from transmission of pathogens. Different types of respiratory protection are available for different tasks and purposes, including:

- **Single-use disposable masks** are used for Droplet Precautions. They are also used on patients with respiratory symptoms as part of respiratory hygiene or on patients known or suspected to have TB. Simple masks contain the droplets coming out of the person wearing the mask (covering their portal of exit).

- **Single-use disposable masks with eye shield** should be used when splash and/or splatter is anticipated, such as in the OR. These must be changed if wet or soiled. These protect the patient and sterile field from the exhaled droplets of the surgical staff as well as protecting the eyes of surgical staff.

- **N-95 respirators** are required for staff for Airborne Precautions (e.g., caring for patients known or suspected to have pulmonary tuberculosis). They must make a tight seal against the face and must be fit tested. This type of respirator protects the person wearing it from possible pathogens in the air of the room, protecting their portal of entry. Some N-95 respirators have an exhalation valve; these do not prevent contamination of a sterile field and should not be worn alone in the OR.

- **PAPRs** are used in many facilities in addition to or instead of N-95 respirators as an Airborne Precaution. They do not require fit testing, and they can be used by people with facial hair that precludes wearing of an N-95. PAPRs require training and maintenance. Check your facility’s policy if you may need to use them.

All respiratory protection should cover both the mouth and the nose. If the mask or respirator has a metal strip, it should be fitted securely over the bridge of the nose to prevent inhalation or
exhalation of pathogens and to prevent fogging of eyeglasses. If glasses are worn, the upper edge of the mask should fit under the glasses to prevent fogging.

When wearing a mask with strings, tie both strings securely to prevent strings from coming loose during the procedure. Tie the upper strings at the back of the head and the lower strings at the neck.

N-95 respirators must be worn as specified on the product package or protection may not be provided. Specifically, if the respirator has two straps, they must be placed as directed, not left dangling or placed together.

Face protection with mask plus eye shield, face shield, or goggles is essential to protect the mucous membranes of the eyes, nose, and mouth during procedures that are likely to generate splashes or sprays of blood or body fluids. Although percutaneous injuries (needle sticks) are the most common route for transmission of bloodborne viruses, splashes or sprays to the mucous membranes are the second-most common route. When eye protection is worn, a mask must also be worn (CDC, 2007).

PPE IN THE OPERATING ROOM

Some barriers and PPE are worn to protect the patients from the germs of healthcare professionals, especially in the OR. Sterile drapes are used to create a sterile field in which the operative procedure can take place. Surgical masks reduce risk of droplet contamination of the operative field. Caps and hoods are worn to reduce shedding and promote environmental control. The Association of periOperative Registered Nurses (AORN, 2015) recommends that a cap or hood be worn that fully covers all hair on the head and face when in restricted and semi-restricted areas of the surgical suite.

PPE Rules to Follow

- Know how to use the equipment.
- Always wear PPE in exposure situations.
- Remove and replace PPE that is torn, punctured, or has lost its ability to function.
- Remove clothing that becomes contaminated with blood or OPIM as soon as possible.
- Remove PPE before leaving the work area.
- Handle contaminated laundry as little as possible.
- Place contaminated PPE in appropriately labeled bags or containers until disposed of, decontaminated, or laundered.
- Know where these bags or containers are located in the work area.

The key principle for healthcare workers to remember when removing personal protective equipment is to avoid contact with blood, body fluids, secretions, excretions, and other
contaminants. When hands become contaminated, they should be washed or decontaminated as soon as possible.

**HOW TO REMOVE PPE**

- Using gloved hands, untie the gown string and remove shoe covers.
- Remove gloves (fingers under cuff of second glove to avoid contact between skin and outside of gloves) and discard in an appropriate manner. The phrase “rubber to rubber, skin to skin” is useful to recall the correct sequence and permissible contact.
- Wash hands.
- Remove gown without contaminating clothing underneath.
- Touch only the inside of the gown while removing. Place in appropriate disposal bag.
- Remove goggles, mask, and cap and place in an appropriate container.
- Remove boots (if worn) and place in an appropriate container.
- Wash hands up to the wrists thoroughly.

**ENHANCED PRECAUTIONS AGAINST EBOLA VIRUS TRANSMISSION**

In response to concerns raised by nurses during the 2014 Ebola outbreak, the American Nurses Association (ANA, 2014) made several suggestions to the CDC regarding additional precautions to be used by healthcare workers caring for Ebola patients in the United States. Among their requests were clear, specific PPE standards for both points of entry and after admission of patients suspected to have Ebola; training on effective, evidence-based use of PPE; and more rapid dissemination of any changes to procedures, guidelines, and recommended care.

The CDC subsequently developed new recommendations entitled “Guidance on Personal Protective Equipment to Be Used by Healthcare Workers During Management of Patients with Ebola Virus Disease in U.S. Hospitals, Including Procedures for Putting On (Donning) and Removing (Doffing)” (see “Resources” at the end of this course). This guidance emphasizes the importance of training, practice, competence, and observation of healthcare workers.

- Prior to working with patients with Ebola, all healthcare workers involved in the care of such patients must have received repeated training and have demonstrated competency in performing all Ebola-related infection control practices and procedures, and specifically in donning/doffing proper PPE. A stepwise process should be developed and used during training and daily practice.
- The facility should designate areas for PPE donning and doffing. It is critical that physical barriers (e.g., plastic enclosures) be used where necessary, along with visible signage, to separate distinct areas and ensure a one-way flow of care moving from clean areas (e.g., areas where PPE is donned and unused equipment is stored) to the patient room and to the PPE removal area (areas where PPE is removed and discarded).
• While working in PPE, healthcare workers caring for patients with Ebola should have no skin exposed. PPE must remain in place and be worn correctly for the duration of exposure to potential contamination. PPE should not be adjusted during patient care.

• The overall safe care of patients with Ebola in a facility must be overseen by an onsite manager at all times, and each step of every PPE donning/doffing procedure must be supervised by a trained observer, who will read aloud to the healthcare worker each step in the procedure checklist and visually confirm and document that the step has been completed correctly in order to ensure proper completion of established PPE protocols.

• Healthcare workers are to perform frequent disinfection of gloved hands using an alcohol-based hand rub (ABHR), particularly after handling body fluids. Double gloving is recommended to provide an extra layer of safety during direct patient care and during the PPE removal process.

• If healthcare facilities decide to add additional PPE or modify this PPE guidance, they must consider the risk/benefit of any modification and train healthcare workers on correct donning and doffing in the modified procedures.

Source: CDC, 2014d.

INFECTION CONTROL

INFECTIOUS DISEASES AND OCCUPATIONAL HEALTH STRATEGIES

Prevention of infectious diseases in healthcare workers means protecting them from infections they do not already have. Management of infectious diseases in HCWs means protecting others (including patients) from any infectious or communicable diseases that the HCW may have.

Protecting healthcare workers from disease is accomplished in many ways, including:

• Use of Standard Precautions with all patients, especially hand hygiene
• Use of additional transmission precautions (e.g., Contact, Airborne, Droplet)
• Vaccination (e.g., influenza, hepatitis B)
• Post-exposure control plan and prophylaxis
• Environmental hygiene to reduce exposure to pathogens in healthcare settings

If a healthcare worker has been exposed on the job to a communicable disease, the supervisor and infection control practitioner should be notified without delay. This will allow evaluation of the circumstances and prevent exposure of others, management of the exposure, and appropriate medical follow-up as needed. For some diseases, post-exposure prophylaxis (preventive medication) is available (see below).
Protection of patients and others from the risk of infections from health professionals includes:

- Vaccination programs
- Evaluation of acute symptoms
- Evaluation of safety to work and reassignment or furlough when unsafe
- Strict adherence to infection control guidelines

Preventing transmission of infection is the responsibility of the facility and the individual healthcare worker.

Laws vary from state to state pertaining to occupational hazards for infectious diseases and for healthcare workers with communicable diseases. The following is general information; healthcare providers should check for any regulations in their own state.

**Healthcare Worker Reporting Requirements**

Healthcare workers are responsible for reporting to their supervisor or occupational health service when they have any signs or symptoms of a communicable disease. Symptoms that should be reported and evaluated typically include:

- Fever
- Unusual rash
- Skin infections, such as boils, impetigo, and herpetic whitlow
- Exudative (weeping) dermatitis
- Sore throat with fever
- Gastrointestinal symptoms (vomiting, diarrhea)
- Recent onset of unexplained cough
- Recent onset of congestion suggesting an acute respiratory infection
- Jaundice
- Symptoms suggesting active tuberculosis (chronic productive cough with unexplained weight loss, fever, night sweats, or hemoptysis)

Employees who report symptoms of illness should be removed from duty and medically evaluated to determine their ability to work and the duration of work restrictions. In many states, persons who have mandatory reportable communicable disease must have their illness reported to the local health unit for follow-up.
Other occupational health strategies for preventing transmission of bloodborne pathogens and other communicable diseases to and from healthcare workers include:

- Pre-employment evaluation to screen for:
  - Tuberculosis
  - Rubella (German measles) immunity
  - Measles immunity
- Annual assessment of staff (including surveillance for TB)
- Annual influenza immunization programs
- Removal from work or modification or limitation of work practices

**Healthcare Workers with Hepatitis B, Hepatitis C, or HIV Infection**

The following standards are based on recommendations in the Society for Healthcare Epidemiology of America Guidelines (2011).

Healthcare workers who have or may have HBV, HCV, or HIV should be evaluated for the ability to work safely. This evaluation should be based on the premise that HBV, HCV, or HIV alone is not sufficient justification to limit the worker’s professional duties. Case-by-case evaluation should be done to determine whether an individual healthcare worker poses a risk to patients that warrants job modification, limitation, or restriction. If a patient is exposed to the blood of a healthcare worker, that patient must be informed of the exposure and appropriate follow-up offered.

Periodic re-evaluation of a healthcare worker infected with HBV, HCV, or HIV may be appropriate if the disease progression alters physical or mental functioning. Other factors that may affect the ability of healthcare workers to provide quality healthcare include:

- Lack of compliance with established infection control guidelines
- Appropriateness of techniques as related to performance of procedures
- Any health condition that would pose a significant risk to others

Healthcare facilities are encouraged to establish a mechanism for evaluating healthcare workers with HBV, HCV, or HIV infection. However, this does not include involuntary screening of employees for HBV, HCV, or HIV. Most states prohibit HIV testing of any citizen without written informed consent.

Any modification of work practice must seek to impose the least-restrictive alternative in accordance with federal disability laws. Workers who believe that their employment has been unfairly restricted or terminated may file a complaint, and HIV-infected healthcare workers are entitled to protection under the HIV confidentiality laws, as are other citizens. Such workers are generally not required to disclose their status to patients or employers.
### Immunizations Recommended for Healthcare Workers

**Influenza vaccination** is offered annually, and staff should be encouraged to accept it as a method for protecting themselves and patients. Since 1981 the CDC has recommended healthcare workers receive influenza vaccination, and the coverage among healthcare workers during the 2013–14 flu season was 75.2%. Coverage was highest (97.8%) among healthcare personnel working in settings in which flu vaccination was a requirement for employment (CDC, 2014e).

The Affordable Care Act includes mandates for flu vaccinations of healthcare workers. Beginning in 2015, failure to meet certain percentages of a healthcare facility’s employees vaccinated for influenza will jeopardize federal reimbursement of Medicare and Medicaid funds. The goal is to have 90% compliance for healthcare workers by 2020 (U.S. DHHS, 2011). While it is obvious that recommending and increasing influenza vaccination in healthcare workers is important, it is less obvious how best to achieve this goal. During 2013 there was an increase in the number of healthcare facilities mandating nurses and other healthcare workers to receive flu vaccinations as a condition of employment.

There is great controversy, however, over the issue of mandatory vaccination, with strong arguments for differing points of view regarding individual rights versus the right of patients to be protected from disease transmitted by a healthcare worker.

Federal OSHA law requires that that all employees whose jobs involve participation in tasks or activities with potential exposure to blood/OPIM be offered **hepatitis B vaccination**. The vaccination is free, safe, and highly protective. This vaccine is given in three doses. Serologic testing after vaccination (to verify that the vaccination was effective) is recommended.

Vaccinations recommended by the CDC for healthcare workers who do not have evidence of immunity are shown below.

<table>
<thead>
<tr>
<th>HEALTHCARE PERSONNEL VACCINATION RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vaccine</strong></td>
</tr>
<tr>
<td>Hepatitis B</td>
</tr>
<tr>
<td>Influenza</td>
</tr>
<tr>
<td>MMR (measles, mumps, and rubella)</td>
</tr>
</tbody>
</table>
Varicella (chickenpox) | All healthcare personnel who do not have documented evidence of immunity: 1) documentation of two doses of varicella vaccine given at least 28 days apart, 2) history of chickenpox or shingles based on physician diagnosis, 3) laboratory evidence of immunity, or 4) laboratory confirmation of disease

Tetanus, diphtheria, and pertussis (Td/Tdap) | All healthcare personnel who have not or are unsure if they have received a dose of Tdap; boosters needed every 10 years

Sources: CDC, 2011c, 2010.

In special circumstances, additional immune protection may be advisable, such as for HCWs with increased susceptibility (e.g., asplenic) or increased exposure (e.g., diagnostic laboratory workers) to specific infections.

**Bloodborne Pathogens Training**

OSHA also requires employers to provide bloodborne pathogens training for all workers who may come into contact with blood and OPIM in their jobs.

- This training includes information on bloodborne pathogens and diseases, methods used to minimize risk and control occupational exposure, hepatitis B vaccine, and medical evaluation and post-exposure follow-up procedures.

- Employers must offer this training on initial assignment, at least annually thereafter, and when new or modified tasks or procedures affect a worker’s occupational exposure.

- HIV and HBV laboratory and production facility workers must receive specialized initial training in addition to the training provided to all workers with occupational exposure. Workers must have the opportunity to ask the trainer questions. Training must be presented at an educational level and in a language that workers understand.

Although HBV and HIV are specifically identified in the OSHA Bloodborne Pathogens Standard, bloodborne pathogens include any pathogen present in human blood or OPIM that can infect and cause disease in people exposed to the pathogen. There are approximately 20 additional pathogens that can be transmitted by blood, including HCV, malaria, West Nile virus, syphilis, babesiosis, brucellosis, leptospirosis, arboviral infections, relapsing fever, Creutzfeldt-Jakob disease, adult T-cell leukemia/lymphoma (caused by HTLV-I), HTLV-I–associated myelopathy, diseases associated with HTLV-II, and Ebola (also known as Ebola hemorrhagic fever).

To prevent transmission of bloodborne pathogens to healthcare workers, the CDC recommends:

- Strict adherence to sharps safety guidelines and Standard Precautions
- Hepatitis B vaccination of healthcare workers
• Post-exposure prophylaxis and counseling in the event of exposure incident

Exposure Control Plan

Employers are required to develop and share an exposure control plan (ECP). The plan is in place to protect employees from health hazards associated with bloodborne pathogens and provide appropriate treatment and counseling if an exposure incident occurs. Employees should know where their facility’s exposure control plan is located and what it includes.

The exposure control plan includes detailed information about the ways an employer provides a safe and healthy work environment, including:

• Who is responsible for implementing the plan
• Determination of employee exposure incidents
• Methods of exposure control, such as Standard Precautions; environmental, engineering, and work practice controls; PPE; and housekeeping methods
• Hepatitis B vaccination programs
• Post-exposure evaluation and follow-up, as well as the procedures for evaluating the circumstances surrounding an exposure incident
• Communication of hazards to employees
• Training and recordkeeping

Employers are required to implement these preventive measures to reduce or eliminate the risk of exposure to bloodborne pathogens.

CDC GUIDELINES FOLLOWING EXPOSURE TO BLOODBORNE PATHOGENS

Any healthcare worker who receives a needle or other significant exposure to potential HIV, HBV, or HCV infection should follow the guidelines issued by CDC.

• Immediately after exposure to blood or potentially infectious fluids:
  o Wash exposed area with soap and water.
  o Flush splashes to the mucous membranes with water.
  o Irrigate eyes with clean water, saline, or sterile irrigants.
• Immediately report the incident to personnel within your agency (usually employee health and/or the ED) who are responsible for managing exposures.
• Complete an injury and/or other report, as dictated by facility policy.
• Evaluate the exposure. The risk of transmission depends on the type of exposure (e.g., blood versus other body fluid, splash to skin versus percutaneous injury), the amount of
the exposure, infection status of the source patient, and susceptibility of the healthcare worker exposed.

- Seek medical evaluation and follow-up, which includes the following:
  - Identification and documentation of the source individual when feasible and legal
  - Testing the source individual’s blood when feasible and consent is given (if the source will not voluntarily submit to HIV testing and a blood sample is not available, medical and non-medical personnel may seek a court order directing the source of the exposure to submit to HIV testing)
  - Making results of the test available to the source individual’s healthcare provider
  - Collection and testing of blood (with consent) of exposed healthcare provider; follow-up testing at six weeks, three months, and six months

- Post-exposure prophylaxis (PEP), if medically indicated, should be started as soon as possible after exposure.
  - PEP with antiviral medication should be initiated immediately if source is known to be HIV positive.
  - Expert consultation on occupation exposure to HIV, HBV, and HCV is available free, 24 hours a day, seven days a week, via the PEP-line sponsored by the CDC. This phone number should be readily available in all areas where PEP may be prescribed. *(See “Resources” at the end of this course.)*
  - Hepatitis B vaccine is available for HBV exposure.
  - There is no vaccine for hepatitis C and no treatment that will prevent infection.

- Medical follow-up should be provided, including counseling to address personal risk of infection or risk of infecting others. Blood tests for HIV, HBV, and HCV should be repeated during the follow-up period.

**Source:** CDC, 2011d.

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**Post-Exposure Prophylaxis (PEP)**

In the event of an exposure incident to pathogens, healthcare workers should be assessed for possible post-exposure prophylaxis.
### POST-EXPOSURE PROPHYLAXIS FOR SELECTED INFECTIOUS DISEASES

<table>
<thead>
<tr>
<th>Disease</th>
<th>Indication</th>
</tr>
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<tbody>
<tr>
<td>HIV/AIDS</td>
<td>Those with percutaneous or mucous-membrane exposure to blood or OPIM</td>
</tr>
<tr>
<td></td>
<td>(immediate treatment if source known to be HIV +)</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>Those exposed to diphtheria or identified as carriers</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>Those exposed to feces of infected persons during outbreaks</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Those who are HBV-susceptible and with percutaneous or mucous-membrane</td>
</tr>
<tr>
<td></td>
<td>exposure to blood known to be HBsAg seropositive</td>
</tr>
<tr>
<td>Meningococcal disease</td>
<td>Those with direct contact with respiratory secretions from infected persons</td>
</tr>
<tr>
<td></td>
<td>without the use of proper precautions (e.g., mouth-to-mouth resuscitation,</td>
</tr>
<tr>
<td></td>
<td>endotracheal intubation, endotracheal tube management, or close examination</td>
</tr>
<tr>
<td></td>
<td>of oropharynx)</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Those with direct contact with respiratory secretions or large aerosol</td>
</tr>
<tr>
<td></td>
<td>droplets from respiratory tract of infected persons</td>
</tr>
<tr>
<td>Rabies</td>
<td>Those bitten by a human being or animal with rabies or with scratches,</td>
</tr>
<tr>
<td></td>
<td>abrasions, open wounds, or mucous membranes contaminated with saliva or</td>
</tr>
<tr>
<td></td>
<td>other potentially infective material (e.g., brain tissue)</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Those with unprotected close contact to a patient with active TB</td>
</tr>
<tr>
<td>Varicella zoster virus</td>
<td>Those known or likely to be susceptible to varicella and who have had close</td>
</tr>
<tr>
<td></td>
<td>and prolonged exposure to an infectious healthcare worker or patient,</td>
</tr>
<tr>
<td></td>
<td>particularly those at high risk for complications, such as pregnant or</td>
</tr>
<tr>
<td></td>
<td>immunocompromised persons</td>
</tr>
</tbody>
</table>

Source: CDC, 2010.

The CDC recommends that healthcare facilities monitor the effects of PEP and track safety and acceptability of different PEP regimens that include new antiretroviral agents. Communication prior to treatment about possible side effects and follow-up during treatment with PEP increase adherence.

Employers must provide a written report explaining how a bloodborne pathogen might have entered the healthcare worker’s body and a description of risk during the exposure. The employer must identify the source individual (the patient involved in the exposure) unless the source individual is unknown or state or local law prohibits disclosure. If the source person is known, many states require that the person be tested for HBV and HIV and notified of the results. The healthcare worker’s blood must also be collected and tested after they have agreed to the test.

Medical care as the result of an exposure is provided by the employer at no charge to the healthcare worker. All test records are confidential. The exposed worker must be given a copy of the healthcare professional’s written opinion with 15 days after the medical evaluation is finished. Post-exposure prophylaxis may be administered if medically necessary, as
recommended by the U.S. Public Health Service. The healthcare worker should also be offered counseling that includes recommendations for transmission and prevention of HIV.

**CASE**

Robert is a nurse who works in the emergency department. He is in the trauma bay when a patient arrives who has been in a car accident. The patient is actively bleeding out from the abdomen. Robert dons a gown, gloves, mask, and goggles as he cares for the patient. During the process of care, Robert applies pressure to the traumatic wound prior to stabilizing the patient. His gown and gloves become covered in blood as he works with the patient.

Later, as he is taking off the gloves, Robert notices that there is a hole in his left-hand glove and that his hands have been exposed to the patient’s blood. He also remembers that the day prior, he cut his left hand at home while he was chopping vegetables in his kitchen and forgot to cover the cut prior to starting his shift. The ED is so busy that he goes on with his shift and does not report the exposure.

The next day, the ED supervisor reports that the patient was found to be positive for HIV and asks the team to report any concerns. Robert is now faced with the possibility that he was exposed to HIV-positive blood. He immediately reports the blood exposure incident from the previous day. His supervisor takes all of the information and together they work closely with the infection control nurse to implement testing, post-exposure prophylaxis, and surveillance. As Robert starts his medical care, he also receives counseling to understand his risk for developing HIV as a result of the exposure.

The supervisor reinforces to Robert that it was important for him to report the exposure as soon as it happened. The supervisor also debriefs the remainder of the team to do the same any time an exposure occurs. The supervisor stresses the importance of protecting employee health and well-being as well as reviews the reporting requirements of the OSHA Bloodborne Pathogens Standard.

**CONCLUSION**

During the past four decades, healthcare-associated infections have emerged as a significant risk to patient and healthcare provider safety. In order to ensure both patient and healthcare provider safety, infection control and prevention strategies are needed in all healthcare settings. Outcomes of infection control programs should be continually assessed and reported for their effectiveness.

Healthcare workers need to understand the chain of infection as it applies to basic infection prevention and control concepts. Effective infection control programs include an emphasis on Standard and transmission-based Precautions, along with updates on the most current recommendations for PPE, work practices, and engineering controls. As seen in recent infectious disease outbreaks, such as the 2014 Ebola virus outbreak, there is a need to recognize unique situations requiring enhanced infection control precautions.
RESOURCES

AORN (Association of periOperative Registered Nurses)
http://www.aorn.org

APIC (Association for Professionals in Infection Control and Epidemiology)
http://www.apic.org

Ebola PPE procedures (CDC)
http://www.cdc.gov/vhf/ebola/hcp/procedures-for-ppe.html

Healthcare-associated infections (CDC)
http://www.cdc.gov/hai/

OSHA Bloodborne Pathogens Standard

PEPline Poster (CDC)
http://www.cdc.gov/niosh/topics/bbp/PEPline_poster.pdf

Reprocessing single-use devices (FDA)

Selected EPA-registered disinfectants (Environmental Protection Agency)
http://www.epa.gov/oppad001/chemregindex.htm

SHEA (Society for Healthcare Epidemiology of America)
http://www.shea-online.org

REFERENCES


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1. With an increasing number of older adult patients, a focus on prevention and monitoring of healthcare-associated infections is paramount in which healthcare setting?
   a. Outpatient surgical centers
   b. Physical therapy clinics
   c. Outpatient cancer centers
   d. Long-term care facilities

2. To prevent or reduce the risk of healthcare-associated infections, a hospital epidemiology program includes the key component of:
   a. Surveillance and outbreak investigations.
   b. Small group interviews of noninfected patients.
   c. OSHA pre-employment drug screening.
   d. Medical device efficacy and safety testing.

3. Which two diseases are a focus of OSHA’s Bloodborne Pathogens Standard for healthcare workers?
   a. Syphilis and tuberculosis
   b. Hepatitis A infection and influenza
   c. Hepatitis C infection and pneumonia
   d. Hepatitis B infection and HIV infection

4. Which is an incorrect statement describing the chain of infection as it applies to bloodborne diseases?
   a. The reservoir can be a patient who currently has and/or has had the disease in the past.
   b. Transmission may occur by direct or indirect means.
   c. Any amount of transmitted blood or OPIM can cause an infection in any host.
   d. The host’s immunity and general ability to resist infection can influence susceptibility.

5. Which is not considered a method to eliminate causative organisms?
   a. Hand hygiene
   b. Reducing long-term exposure to intravenous catheters
   c. Sterilizing surgical instruments
   d. Vaccination programs
6. Which person is more likely to be a source of asymptomatic transmission?
   a. Mary, who was meticulous about handwashing while caring for her husband with food poisoning
   b. Bill, a father caring for his 2-year-old son, who is too young to cover his sneezes
   c. Roberto, whose girlfriend had a cold over the weekend
   d. Lupe, whose mother has an infected foot ulcer that is covered with an occlusive dressing

7. Which individual in the hospital has developed an endogenous infection?
   a. A patient with a urinary catheter who develops a urinary tract infection
   b. A nurse who receives a needlestick injury and develops hepatitis
   c. A patient who develops pertussis from a hospital roommate
   d. A nurse who develops influenza from a co-worker

8. What is a preventative action a surgical nurse can take to protect the portal of entry?
   a. Inserting a urinary catheter
   b. Wearing a face shield
   c. Inserting an intravenous line
   d. Getting a flu vaccination

9. A method of protecting susceptible hosts from infection is:
   a. Implementing vaccination programs for patients and healthcare workers.
   b. Isolating healthcare workers from infected patients.
   c. Providing infected patients with personal protective equipment.
   d. Rotating shifts to minimize healthcare worker exposure to infection.

10. Which is a true statement about Standard Precautions?
    a. The use of Standard Precautions is limited to settings where there is anticipated exposure to blood.
    b. Before implementing Standard Precautions, it is advisable to determine if the patient is contagious.
    c. Standard Precautions are implemented regardless of the perceived status of the source individual.
    d. Engineering and work practice controls are not required if Standard Precautions are implemented.
11. Before administering an intramuscular injection to a patient with HIV, the nurse takes protection against which potential means of HIV transmission?
   a. Touching the patient’s skin
   b. Receiving a needlestick injury
   c. Touching the patient’s blood with a gloved hand
   d. Forgetting to wear a surgical gown

12. Which is a true statement regarding Contact Precautions?
   a. Healthcare workers must wear an N-95 respirator when entering a patient’s room to provide direct patient care.
   b. Healthcare workers must wear a gown and gloves when entering a patient’s room to provide direct patient care.
   c. Contact Precautions are implemented only for patients with active skin infections.
   d. Contact Precautions permit cohorting of patients infected with different microorganisms.

13. What are the unique infection-control measures for a patient on Airborne Precautions?
   a. A single-patient room with the door kept closed and the use of gown and gloves when entering a patient’s room
   b. A negative-pressure airborne infection isolation room with the door kept closed and the use of an N-95 respirator
   c. The correct placement of a powered air-purifying respirator on the patient during his or her transport
   d. The donning of a surgical face mask when entering the patient’s room

14. What is the single most important infection control procedure to prevent the spread of infection?
   a. Hand hygiene
   b. Prompt and thorough reporting
   c. The use of gloves
   d. The isolation of infected patients

15. Which is an engineering control in the healthcare setting designed to reduce the spread of infection?
   a. Vaccination programs for hospital staff
   b. Nursing education programs about infectious disease
   c. Puncture-resistant containers for the disposal of sharps
   d. Wearing gloves to prevent contact with body fluids
16. Which action is required if a needlestick injury occurs in the healthcare setting?
   a. The healthcare worker is placed on probation until medical testing is completed.
   b. The patient involved in the exposure is placed in isolation until medical testing is completed.
   c. A report of the exposure is filed with the local public health department.
   d. The post-exposure management plan is implemented to prevent infection.

17. Spills of blood or other body fluids are decontaminated by using:
   a. An EPA-registered list D or E germicide.
   b. Soap and water, with chemical germicides added.
   c. Strong detergents applied with protective gloves.
   d. A full-strength bleaching agent.

18. Containers used to store, transport, and dispose of regulated waste must be identified with warning labels colored:
   a. Orange, red, or orange-red.
   b. Black, brown, or gray.
   c. Yellow or gold.
   d. Blue or blue-green.

19. Personal protective equipment is specialized clothing or equipment that:
   a. Prevents sharps injuries to healthcare workers.
   b. Assists when physically restraining a patient.
   c. Guards a healthcare worker against a workplace hazard.
   d. Reduces the transmission of sexually transmitted diseases.

20. Which is a true statement about glove use by healthcare workers?
   a. The CDC does not recommend the use of gloves with patient contact.
   b. Use gloves only when providing care to patients with open wounds.
   c. The use of gloves precludes the need for hand hygiene.
   d. Use gloves when contact with mucous membranes is anticipated.

21. According to Standard Precautions, during patient care the use of an isolation gown is:
   a. Rarely indicated.
   b. Indicated for all patient care.
   c. Based on a patient’s infection status.
   d. Based on anticipated exposure to blood or body fluids.
22. A nurse in the surgical unit is treating a patient who begins bleeding a small amount from a wound. The nurse notices that her own gown and clothing underneath has become contaminated by a small area soaked through with blood, but she has not finished redressing the wound. After controlling the bleeding and ensuring patient safety, what is the nurse’s next action?
   a. Continuing care and discarding the soiled gown when finished with patient care
   b. Removing and replacing the blood-soaked gown and clothing as soon as possible
   c. Asking a co-worker to help her place a new gown over the top of the soiled gown
   d. Discarding the soiled gown and continuing to provide care without a new gown

23. Which is a true statement regarding the use of PPE when caring for patients infected with the Ebola virus?
   a. PPE donning/doffing procedures must always be supervised by a trained observer.
   b. PPE donning/doffing procedures are the same as for all other bloodborne pathogens.
   c. PPE guidelines recommend the use of one pair of latex gloves.
   d. PPE guidelines recommend frequent disinfection of gloved hands using soap and water.

24. A nurse in the hospital reports to her supervisor that she has recently developed a skin rash. What is the appropriate action for the supervisor to take with the nurse?
   a. Reminding the nurse to follow both Universal and Standard Precautions while caring for patients
   b. Arranging a medical evaluation to determine the nurse’s ability to work and need for any work restrictions
   c. Recommending the nurse return home and stay there until she feels better
   d. Transferring the nurse to work in a nonclinical area of the hospital for the day

25. Which practice is an occupational health strategy designed to prevent the transmission of infectious disease?
   a. Pre-employment screening for tuberculosis
   b. Annual screening for drug use
   c. Annual chest x-rays for all employees
   d. Pre-employment determination of sexual preference and practices

26. The CDC recommends that all healthcare workers receive vaccination against hepatitis B, measles, mumps, rubella, and chickenpox if they:
   a. Plan to work in epidemic areas.
   b. Do not have laboratory or clinical evidence of immunity.
   c. Have been exposed to a family member with any of these infections.
   d. Have recently traveled outside the United States.
27. Bloodborne pathogens training for healthcare workers must include:
   a. A thorough study of the physiology of pathogens.
   b. Protective measures to minimize risk of occupational exposure.
   c. A focus on the gastrointestinal tract, with its resident organisms.
   d. Vaccination for all identified, vaccine-preventable disease.

28. After accepting a position working on a medical surgical unit of a hospital, a nurse learns that the OSHA Bloodborne Pathogens Exposure Control Plan dictates that he or she will need which vaccine?
   a. The hepatitis A vaccine
   b. The hepatitis B vaccine
   c. The pneumococcal vaccine
   d. The Haemophilus influenzae type b vaccine

29. While disconnecting a patient’s blood transfusion, a nurse accidentally sprays his own face and eyes with blood. What is the nurse’s first action?
   a. Reporting the incident to a supervisor before the end of the shift
   b. Monitoring himself for any signs or symptoms of infection
   c. Arranging for follow-up screening
   d. Washing or irrigating his face and eyes

30. When administering pain medication via intramuscular injection to a patient, the nurse accidentally incurs a needlestick injury. The nurse’s action is to:
   a. Seek medical evaluation if the site becomes red, inflamed, or painful.
   b. Report the exposure incident immediately to his or her supervisor.
   c. Cleanse the injured area using alcohol swabs.
   d. Report the injury only if the patient has tested positive for a bloodborne pathogen.