A NATIONAL EPIDEMIC

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About the Authors

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Purpose and Goals

The goal of this course is to educate nurses and other healthcare professionals in the principles of infection control through a better understanding of epidemiology and pathogen transmission, as well as through federal regulations and recommendations. It is our goal that healthcare professionals will then recognize their responsibility to apply these scientifically based principles to minimize the opportunity for transmission of disease, and therefore be able to make a significant impact on their community.

Learning Outcomes

1. Outline reasons for proper infection control standards as defined by the CDC, and understand how healthcare workers can make a significant impact on reducing the cost of healthcare associated infections (HAIs).
2. Recognize the components of the OSHA Bloodborne Pathogens Standard and know the responsibilities of employers and employees as required by federal law.
3. List some infection control equipment, supplies, and precautions required by law to be provided to the healthcare worker environment.
4. Identify personal protective equipment (PPE) and recognize its effectiveness against various microbes such as bloodborne and airborne pathogens.
5. Identify the role of the healthcare worker in the management of infection control practices.
6. Recognize the importance of hand washing and be able to instruct patients in proper hand washing technique.
7. Develop strategies to improve the handwashing practices of healthcare personnel that will reduce the transmission of infections.
8. List appropriate methods necessary to assure sterilization of instruments and equipment in the hospital and/or clinic.
9. Summarize how PPE is chosen based on design and choice of materials and explain the concept of strikethrough and how it converts to potential amounts of pathogen contamination.
11. Describe antibiotic stewardship and discuss how clinical outcomes can be improved.
12. Discuss the modes of transmission for hepatitis A virus (HAV), hepatitis E virus (HEV) and noroviruses.
13. Identify strategies to prevent the transmission of hepatitis B virus (HBV) and hepatitis C virus (HCV).
14. Identify the risk factors for transmission of hepatitis B, hepatitis C, and HIV.
15. Explain how hepatitis D virus is acquired and why HDV infection leads to chronic liver disease.
16. Compare and discuss the three stages of infection of the Human Immunodeficiency Virus (HIV).
17. Recognize the symptoms of influenza infection and be able to apply specific recommendations for infection control.
18. Understand the modes of transmission for Ebola Virus Disease (EVD) and identify the relevant preventative and treatment measures.
20. Identify the symptoms of MIS-C in children who have been infected or exposed to the SARS-CoV-2 virus.
21. Explain the symptoms and disease progression of influenza viruses and compare influenza to the common cold.
22. Identify the modes of transmission of tuberculosis (TB) and know the TB control recommendations as set forth by the CDC and OSHA.
23. Discuss the etiology of the prion diseases Creutzfeldt-Jakob disease (CJD), Bovine...
TB infection can infect an average of 10 to 15 deaths related to TB. A person with an active infection with tuberculosis worldwide, and there were 1.5 million infections from the World Health Organization, in 2018, 10 million people became ill infected with tuberculosis. According to the World Health Organization, one-fourth of the world's population is infected with tuberculosis. Advances then led to the development of effective vaccines. Although tuberculosis in the United States has declined steadily since 1992, the disease has remained one of particular concern throughout the world. Statistics from the Centers for Disease Control (CDC) and the World Health Organization (WHO) state that one-fourth of the world's population is infected with tuberculosis. According to the WHO, in 2018, 10 million people became ill with TB worldwide, and there were 1.5 million deaths related to TB. A person with an active TB infection can infect an average of 10 to 15 new people each year.

Hepatitis B infection persists as a significant threat to healthcare and public safety workers despite the availability since 1982 of an effective hepatitis B vaccine. Human Immunodeficiency Virus (HIV) infection resulting in Acquired Immunodeficiency Syndrome (AIDS) led to the universal practice of implementing blood and body fluid precautions for every patient, even in the absence of overt illness.

The latest global threats in infection control include the emergence of multiple antibiotic resistant organisms, influenza viruses, avian influenza A viruses, chikungunya, and Zika viruses. Most recently, the global pandemic of the novel coronavirus COVID-19 has emphasized how crucial proper infection control practices are, and how greatly they can affect disease transmission and outcomes.

Antibiotic resistance is one of the biggest challenges faced by healthcare professionals. In 2019, the CDC reported that more than 2.8 million people in the United States become infected with an antibiotic resistant infection each year, and more than 35,000 people die from these infections.

The importance of having a thorough understanding of infection control principles cannot be overemphasized. Patients entering a healthcare setting are at risk of acquiring an infection because of decreased resistance, either as a result of the patient's underlying illness or as a result of a specific course of therapy. Other factors increasing the risk of infection include increased exposure to numbers and types of disease-causing organisms, and the need for invasive procedures to be performed. Infection control techniques are designed to prevent the spread of infection from patients, healthcare providers, or visitors, and are some of the most important functions of the healthcare professional. Healthcare workers are the first line of defense against disease transmission.

Cost of Health Care-Associated Infections (HAIs)

“HAIs are the most common complication of hospital care and one of the top 10 leading causes of death in the United States”


The CDC's National Healthcare Safety Network estimates every day that 1 in 25 patients being treated at a medical facility has an infection associated with his or her care at that facility. CDC also reports that one in every nine patients who gets an infection will die during their hospital stay. The World Health Organization estimates that 7 of every 100 hospitalized patients in high income countries will acquire at least one HAI. For patients in ICUs in high-income countries they estimate the HAI rate is 30%.

In 2015, in the U.S., there was an estimated 687,000 HAIs in people who were hospitalized in acute care hospitals, and HAIs were responsible for the deaths of 72,000 hospitalized patients.

In 2009, a Direct Medical Cost Report released by the CDC showed that overall annual direct medical costs of HAIs to U.S. hospitals ranged from $28.4 to $33.8 billion for urban consumers and $35.7 billion to $45 billion for inpatient hospital services. In spite of the billions of dollars spent, almost 1.7 million hospitalized patients acquire an infection during their inpatient treatment, and approximately 100,000 will die from the infection.

A 2013 study of HAIs in five U.S. hospitals, published by JAMA Internal Medicine, showed

One in every nine patients who gets an infection will die during their hospital stay
The overall direct medical costs associated of HAI in just five U.S. hospitals to be $9.8 billion during 2013, with surgical site infections contributing the most toward the total costs.

The Leapfrog Group, a national non-profit organization that transparently reports hospital performance on nearly 2000 hospitals in 36 states, reported in their 2017 survey that the percentage of hospitals reporting zero infections has declined dramatically since 2015. Their report was based on 5 types of infections:
- **CLABSI** (central line–associated blood stream infections) in ICUs and select wards;
- **CAUTI** (catheter–associated urinary tract infections) in ICUs and select wards;
- **MRSA** (methicillin-resistant *Staphylococcus aureus* infections) that were inpatient hospital onset;
- **C. diff** (Clostridium difficile infections) that were inpatient hospital onset; and
- **SSI: Colon** (surgical site infections) resulting from major colon surgery.

The 2017 Leapfrog Hospital Survey also found that the majority of hospitals reporting had fewer infections than would have been expected. Some facilities had extremely high SIRs (standardized infection ratios) which are ratios developed by the CDC’s National Healthcare Safety Network for tracking HAIs at national, state, and local levels. The SIR compares the actual number of HAIs that are reported to the number that would be predicted in the standard population, adjusting for several risk factors. An SIR greater than 1 means more HAIs were observed than predicted, and an SIR less than 1 means there are fewer HAIs than predicted.

It is estimated that Americans make over one billion doctor and hospital visits each year, more than 4 visits per person, and approximately 5% of these patients will acquire a HAI.

Estimates of HAIs in US hospitals are shown in Table 1 below.

<table>
<thead>
<tr>
<th>Guidelines, Standards, and Enforcement Directives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection control in the healthcare setting is a major focus of a variety of public and private organizations. Among the most important are:</td>
</tr>
<tr>
<td><strong>CDC</strong></td>
</tr>
</tbody>
</table>

The **Centers for Disease Control and Prevention (CDC)** is responsible for the collection of surveillance data on nationally notifiable communicable diseases. Surveillance is used to plan more effective disease control and prevention programs. Each state reports to the CDC through a state department with authority derived from the state legislature. The CDC also gathers data on healthcare associated infections (HAIs) and publishes guidelines for infection prevention and control. The Occupational Safety and Health Act of 1970 created a division of the CDC known as the **National Institute of Occupational Safety and Health (NIOSH)**, and a division of the U.S. Department of Labor known as the **Occupational Safety and Health Administration (OSHA)**. NIOSH is the federal agency that is responsible for conducting research, education and training regarding workplace safety, and is responsible for making necessary recommendations for prevention of work-related injury and illness. In addition to NIOSH, the CDC is also composed of the Office of Public Health Preparedness and Response; the office of State and Local Support; the Office of Surveillance, Epidemiology and Laboratory Services; the Office of Non-communicable Diseases, Injury and Environmental Health; the Office of Infectious Diseases; and the Center for Global Health. Additional information is available at [http://www.cdc.gov](http://www.cdc.gov).

**OSHA**

The **Occupational Safety and Health Administration (OSHA)** was established by Congress in 1970 as a branch of the U.S. Department of Labor to protect the health of American workers. OSHA is responsible for developing and enforcing workplace safety and health standards, and ensuring workplace compliance through inspections. Working in cooperation with the Centers for Disease Control and Prevention (CDC), OSHA implemented the Bloodborne Pathogen Standard in December 1991 to protect healthcare workers from occupational exposure and subsequent infection from bloodborne pathogens, namely from hepatitis B, hepatitis C, and Human Immunodeficiency Virus (HIV). Additional information is available at [http://www.osha.gov](http://www.osha.gov).

**The Joint Commission**

The **Joint Commission** is a nationally recognized organization that accredits healthcare organizations demonstrating significant compliance with published standards. The organization implemented the first formal hospital infection control requirements when it published its infection control standards in 1976 as a requirement for hospital accreditation. Standards are revised periodically to reflect changes in infection control practice, and are published annually in the Comprehensive Accreditation Manual[s] for different healthcare settings.

Although The Joint Commission accreditation is voluntary, it is viewed as critical by most hospitals because many states recognize this accreditation in licensure decisions and some accept accreditation in lieu of state inspection. The standards used for accreditation of a health facility (ambulatory care, behavioral health care, home care and hospitals) are also required for Medicare and Medicaid participation. Facilities accredited by The Joint Commission can qualify for Medicare and Medicaid without undergoing separate quality inspections, thus

### Estimates of Healthcare-Associated Infections (HAIs) in US Hospitals Annually as reported by the CDC for 2011

<table>
<thead>
<tr>
<th>All health care-associated infections</th>
<th>Estimated number of infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>157,500</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>157,500</td>
</tr>
<tr>
<td>Gastrointestinal infection</td>
<td>123,100</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>93,300</td>
</tr>
<tr>
<td>Primary bloodstream infection</td>
<td>71,900</td>
</tr>
<tr>
<td>Other types of infections</td>
<td>118,500</td>
</tr>
<tr>
<td><strong>Estimated total number of infections in hospitals</strong></td>
<td><strong>721,800</strong></td>
</tr>
</tbody>
</table>
easing the burden of duplicate federal and state regulatory agency inspections. Additional information is available at http://www.thejoint-commission.org.

APIC

Hospital Infection Control Committees began to appear in the 1960s, after their use was recommended as a mechanism to monitor and prevent the spread of healthcare-acquired infections. To implement programs developed by these committees, there arose a need for new positions requiring employees with expertise in infection control. The Association for Professionals in Infection Control and Epidemiology (APIC) was organized in 1972 and today is a multi-disciplinary, international organization. APIC strives to prevent disease and infection through education, collaboration, research, practice, and credentialing. Like the CDC and OSHA, APIC publishes guidelines for healthcare practice. Additional information can be found at http://www.apic.org.

DNV GL

DNV GL is an international accreditation company whose hospital standards have been approved by the U.S. Government Centers for Medicare and Medicaid Services (CMS). Their standards are developed for hospitals, primary care providers, and specialist outpatient clinics. Hospitals can receive the DNV GL Healthcare Certification in Infection Prevention (CIP) when meeting guidelines for management of infection risks and reduction of healthcare-associated infections. The CIP requirements are compatible with requirements set forth by the World Health Organization (WHO), CDC, OSHA and CMS. DNV GL survey teams will visit hospitals on an annual basis to maintain their accreditation.

ACHC

The Accreditation Commission for Healthcare (ACHC) is a non-profit accreditation organization whose standards are developed for facilities such as home health, hospice, ambulatory care, renal dialysis, home infusion therapy, and private duty care. ACHC has also partnered with DNV GL to provide single-source accreditation of hospitals and healthcare systems with ancillary services. ACHC conducts on-site accreditation surveys every 3 years using a review process that is compliant with state and federal laws. Additional information is available at https://www.achc.org

Evolution of Substance Precautions Safety

In 1985, the Centers for Disease Control and Prevention (CDC) developed a strategy of "universal blood and body fluid precautions" in an effort to address concerns regarding the transmission of hepatitis B Virus (HBV) and HIV, the causative agent in AIDS.

In 1987, after a 3-year study done by infection control personnel from Seattle's Harborview Medical Center and the University of California at San Diego, a new infection control system was proposed. Body Substance Isolation (BSI) is an infection control method that defines all body fluids and substances (blood, urine, feces, saliva) as infectious and isolates them through the use of gloves. With this method, the fluids and other potentially infectious material (OPIM) covered by the Bloodborne Pathogens Standard (see below) are further expanded to include all body substances. OSHA allows for BSI to be used in place of Universal Precautions if facilities using this method comply with all other aspects of the Bloodborne Pathogens Standard.

In 1991, OSHA issued the Bloodborne Pathogens Standard to protect workers from hepatitis B, hepatitis C, and HIV/AIDS, and this was added to the United States Code of Federal Regulations under 29 CFR 1910.1030. This standard was based on the principle of Universal Precautions, which is defined by OSHA as "a concept of bloodborne disease control which requires that all human blood and other potentially infectious medical materials be treated as if known to be infectious for HIV, HBV, HCV or other bloodborne pathogens regardless of the perceived ‘low’ risk status of a patient or patient population." The term Universal Precautions is also used to refer to the OSHA mandated program that is required to control infection and protect employees from exposure to all human blood and OPIM through engineering controls, orientation, education, and record keeping in healthcare facilities.

In 1996 the CDC published Guidelines for Isolation Precautions in Hospitals to assist healthcare organizations in maintaining up-to-date isolation practices. This guideline established a two-tiered system for precautions: standard and transmission based. Standard Precautions are designed to reduce the risk of transmission of pathogens from both recognized and unrecognized sources of infection. They are used for all patients in any healthcare setting regardless of their confirmed infection status. Standard Precautions apply to:

1. blood,
2. all body fluids, secretions, and excretions except sweat regardless of whether or not they contain visible blood,
3. non-intact skin and,
4. mucous membranes.

It is important to note that Standard Precautions are more stringent than Universal Precautions alone, combining the features of Universal Precautions and Body Substance Isolation. Standard Precautions are now the CDC’s foundation for preventing transmission of infection in all healthcare settings. Transmission Precautions are designed for patients documented or suspected to be infected or colonized with highly transmissible organisms that require additional precautions, above and beyond the Standard Precautions, to interrupt transmission of infections in healthcare facilities. The CDC places utmost importance on the use of Transmission Precautions based on clinical presentation and potential pathogens, until the cause of disease can be determined.

In 2001, the Bloodborne Pathogens Standard was revised to reflect the Needlestick Safety and Prevention Act. Four areas of concern were addressed and changed in this new revision. This included:

1. modifying the definitions related to engineering controls (sharps containers and other personal injury protection devices that remove the bloodborne pathogens from the workplace);
2. revising and updating the Exposure Control Plan;
3. acquiring the solicitation of input from non-managerial employees who have direct patient care for evaluation and selection of effective practices; and
4. recordkeeping of a sharps injury log for identification of high risk areas and evaluation of devices.

The updated Standard became effective on March 6, 2002.

In 2007, the CDC published Guidelines for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. This document expanded and updated the 1996 Guidelines for Isolation Precautions in Hospitals.

Six key areas were addressed in the new update:

1. The need for common principles that could be applied to all healthcare settings and modified for the needs of a particular healthcare institution.
2. The need to address a broader scope of isolation guidelines that could be applied to new pathogens such as SARS-CoV (avian influenza in humans) or evolving pathogens (C. difficile, noroviruses, and community-associated MRSA or CA-MRSA); development of new therapies such as gene therapy; and the possibility of bioweapons attacks.
3. The need to reaffirm the Standard Precautions of the 1996 guideline, adding sections on Respiratory Hygiene/Cough Etiquette, safe injection practices, and
the use of masks for insertion of catheters or injection of material into spinal or epidural spaces when performing high risk spinal procedures.

4. The need to address life threatening fungal infections in severely immunocompromised patients by updating the components of the Protective Environment.

5. The need for administrative involvement in developing and supporting infection control programs because these are key influences in having healthcare personnel adhere to recommended infection control practices.

6. The need for more specific surveillance and control of multi-drug resistant organisms (MDROs) that can be workable and effective in all types of healthcare settings.

In 2014, in response to the spread of the Ebola virus, the CDC restructured previous infection control standards for healthcare professionals. The new guidelines focus on the specific type of personal protective equipment (PPE) that should be used to help control the spread of infection; they also provide detailed instructions regarding how to safely don (put on) and doff (remove) the equipment. The CDC's 2014 infection control guidelines are centered on three principles used during the safe treatment of patients infected with Ebola at the Nebraska Medical Center, National Institutes of Health Clinical Center, and Emory University Hospital. None of the healthcare employees at any of these facilities contracted Ebola by adhering to the following standards:

1. All employees underwent thorough training regarding how to properly wear PPE.
2. All employees were supervised by a trained monitor prior to donning and doffing PPE.
3. At no times was skin exposed while wearing PPE.

The CDC has found that healthcare providers need to conduct routine training on how to properly use PPE. Training programs should focus on simple step-by-step instructions on how to put on and remove PPE. One of the most critical aspects of wearing PPE equipment is to ensure that the skin remains covered at all times.

Facilities must also make sure that their education department is familiar with the 2014 infection control guidelines that include training and use of the following:

- Respirators including either a N95 respirator or a powered air purifying respirator (PAPR)
- Surgical hoods to help ensure complete coverage of the neck and head
- Waterproof aprons
- Single-use fluid resistant gowns that extend to at least mid-calf or coveralls without an integrated hood
- Double gloves
- Waterproof boot covers worn at least mid-calf or full leg covers
- Any unfixed tissue or body organ (other than intact skin) from a human (living or dead)
- HIV-containing cells or tissue cultures, organ cultures, and HIV or HBV-containing culture media or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Bloodborne Pathogen Standard

The OSHA Bloodborne Pathogens Standard applies to all workers with potential occupational exposure to blood. It must include information on engineering controls, work practices, and personal protective equipment (PPE) with its location, use, and decontamination. An explanation regarding why particular PPE was chosen should be given. Employees should be trained concerning what to do if exposure occurs and what should be done for post-exposure evaluation. Information on the hepatitis B vaccine must be given, including safety and efficacy, and all employees must be offered the vaccine free of charge. Explanations on signs, labels and color-coding for infection and biohazard labeling must be discussed. Finally, all employees must be given access to a copy of the Bloodborne Pathogens Standard and the employer’s exposure control plan, and the ability to obtain written copies of each. Throughout the training period, employees must be given an opportunity to ask any questions. Additional training is necessary for employees in HIV and HBV labs and production facilities. Information for this training and the entire Bloodborne Pathogens Standard can be found at https://www.osha.gov/pls/oshaweb/owadisp.showdoc?w_id=100518&part=STANDARDS

An Exposure Control Plan

Every employer with employees who may potentially encounter skin, eye, mucous membrane or parenteral contact (including human bites which may break the skin) with blood or OPIM that can potentially result from the performance of their duties, must have an exposure control plan in place. An exposure
control plan is a written agenda that is worked out by the employer to eliminate or minimize an employee's exposure to blood and OPIM. This document must be accessible to all employees as well as to OSHA and NIOSH, and must contain the following parts:

1. **A documented exposure determination.** This section of the document must have
   - a list of all job classifications in which all employees in those job classifications have occupational exposure. This is determined as if employees were without personal protective equipment.
   - a list of job classifications in which some employees have occupational exposure. This is determined as if employees were without personal protective equipment.
   - a list of tasks and procedures (or those closely related) in which job exposure occurs to either of the groups in a or b above.

2. **The procedures for evaluating the circumstances surrounding an exposure incident.** This evaluation should include:
   - The engineering controls and work practices in place
   - The personal protective equipment or clothing used at the time of the exposure incident
   - An evaluation of the policies and why controls failed at the time of the exposure incident.

3. **The schedule of how and when other provisions of the standard will be implemented.** This includes methods of compliance, a hepatitis B vaccination program and post-exposure follow-up, communication of hazards to employees, and record keeping.

4. **Documented input from non-managerial employees who are responsible for direct patient care and who are potentially exposed to injuries from contaminated sharps.** This input should be for the identification, evaluation and selection of effective engineering control and work practices. During an inspection, OSHA will check for compliance with this by asking employees if and how their input was requested.

   The exposure control plan may be an individual document or may be part of another document such as an employer’s health and safety manual. The plan must be changed and updated as employees, tasks, and procedures change, and it must be reviewed annually. Each update must reflect advances in technology that could eliminate or reduce exposure to bloodborne pathogens. The annual review must reflect consideration and use of any safer commercially available medical devices that are designed to eliminate exposure to bloodborne pathogens. Devices selected by employers should not jeopardize patient or employee safety, and should make an exposure incident less likely to happen.

**Engineering Controls**

Engineering controls refer to methods of isolating or removing a bloodborne pathogen from the workplace. These include sharps disposal containers, sharps with engineered sharps injury protection (SEISP), needleless systems, and other mechanical devices used to reduce the handling of contaminated needles. SEISPs are defined as “a non-needle sharp or a needle device used for withdrawing body fluids, accessing a vein or artery, or administering medications or other fluids, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident.” Needles that are not contaminated by blood do not need to have engineering controls, for example needles used to withdraw medications from vials. However, the needle used to actually administer the medication to the patient must have engineering controls in place. All engineering controls must be examined and maintained or replaced on a regular basis. Sharps containers must be closable, puncture resistant, leak proof on sides and bottom, and properly labeled and color-coded. Sharps containers must be easily accessible and located as close as feasible to the location where the sharps are used. They must remain upright and not allowed to be overfilled. When sharps are moved, the containers must be closed immediately to prevent spills. If leakage occurs or is possible, the primary container must be placed in a secondary container. The secondary container must also be closable, properly labeled and color-coded, and constructed to contain all contents and prevent leakage during handling and transport.

Citations are issued by OSHA to employers who do not review their engineering controls at the very least, on an annual basis. The federal government enforces sanctions to discourage healthcare facilities from continuing to use older conventional devices concerning engineering controls. It is documented that OSHA has levied fines against hospitals for failure to evaluate and consider the adoption of specific engineering controls that reduce the risk of needlestick injury.

**Work Practice Controls**

Work practice controls are techniques that reduce the likelihood of exposure by changing the way a task is performed.

Employers must provide areas for handwashing that are easily accessible to employees. When necessary, hands should be washed with soap and water, and immediately or as soon as possible after removing gloves and other PPE. Antiseptic hand cleaner or antiseptic towelettes should be used when soap and water are not available, but if used, hands must be washed with soap and water as soon as possible. If skin should come into contact with blood or OPIM, affected areas must be washed with soap and water immediately or as soon as possible. If mucous membranes should come into contact with blood or OPIM, they must be flushed with running water immediately or as soon as possible.

Contaminated needles should never be recapped or bent, and contaminated sharps should never be bent or removed unless an employer can show that there is no other feasible way of performing a procedure. If a contaminated sharp or needle must be bent, recapped or removed, it must be done by a mechanical device or in a single-handed manner where the least amount of risk is possible. All used sharps and needles must be placed in appropriate sharps containers immediately after use or as soon as possible.

Employees are prohibited from eating, drinking, applying make-up or contact lenses, or using lip balm in areas of potential exposure. It is prohibited to keep food and drink in areas where blood or OPIM are present, including refrigerators, counters, and cabinets where exposure may occur or specimens are stored.

**Personal Protective Clothing and Equipment (PPE)**

Personal protective clothing and equipment (PPE) must be supplied at the employer expense to all employees at risk for occupational exposure to blood and OPIM. PPE may include gloves, gowns, laboratory coats, face shields, masks, eye protection, and/or other protective items. The PPE must provide appropriate protection for the level of actual or expected exposure. As per OSHA definition, PPE is considered acceptable only if it does not allow blood or OPIM to pass through or reach the employee’s work clothes, street clothes, underwear, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time for which the PPE will be used. PPE must be readily accessible and available in appropriate sizes, and the employee must be instructed in the proper use and care of the PPE provided. It is also the responsibility of the employer to clean or launder all PPE as well as repair or replace it as necessary.

Employer enforced use of PPE by healthcare workers is an OSHA mandate. The only exception is a rare and unusual circumstance when, in the professional judgment of the healthcare worker, use of PPE would prevent delivery of healthcare or public safety services, or would endanger the healthcare worker or fellow em-
The employee who is expected to have hand contact with blood or other potentially contaminated surfaces or materials must wear gloves. If more extensive contact with blood or OPIM is expected, the employee should use more extensive coverings to include gowns or aprons, masks, face shields or goggles, and shoe covers or boots. If gross contamination is likely, such as in situations encountered during orthopedic surgery or an autopsy, surgical caps and hoods may also be required to prevent exposure to blood and OPIM. The key to preventing exposure to bloodborne pathogens is to prevent blood or OPIM from reaching the healthcare worker’s skin, eyes, mouth, or other mucous membranes.

A. Gloves

Gloves are worn for three important reasons:

1. To provide a protective barrier and to prevent gross contamination of the hands when touching blood, body fluids, secretions, excretions, mucous membranes, non-intact skin, and contaminated equipment. Wearing gloves in specified circumstances to reduce exposure to bloodborne pathogens is mandated by the OSHA bloodborne pathogen standard.

2. To reduce the likelihood that microorganisms present on the hands of healthcare personnel will be transmitted to patients during invasive or other patient-care procedures that involve touching mucous membranes and non-intact skin.

3. To reduce the possibility that the hands of personnel contaminated with organisms from a patient or fomite (an inanimate object, such as a pen or a drinking glass, which may be contaminated with an infectious organism and can serve as a vehicle for transmission of that organism) can transmit these organisms to another patient. In this situation, gloves must be changed between patient contacts, and hands should be washed after removal of gloves. Failure to change gloves and wash hands between patient contacts is an infection control hazard.

Gloves must be available and consistently used in situations where hand contact with blood or OPIM is expected. It is the responsibility of the employer to provide hypoallergenic gloves, powderless gloves, glove liners, or an alternative for employees who have allergies to normal gloves. It is prohibited by OSHA law to wash or decontaminate disposable gloves for reuse. Utility-type gloves may be decontaminated for reuse provided the gloves do not lose their ability to function as a barrier and have no cracks, tears, punctures, or signs of deterioration.

The type of gloves selected by the caregiver should be predetermined as appropriate to the task being performed. The following general guidelines are suggested for selecting gloves:

- Sterile gloves should be used for all invasive procedures and procedures involving contact with areas of the body that are normally sterile.
- Examination gloves should be used for procedures that do not require the use of sterile gloves or for procedures involving contact with mucous membranes, unless otherwise indicated.
- General-purpose utility gloves should be used for housekeeping chores or for cleaning and decontaminating instruments and equipment. Gloves should be designed to protect the healthcare worker’s hands from the harsh cleaning chemicals as well as blood and OPIM.

B. Masks and Face Shields

Masks and eye protection devices with various types of face shields must be worn during activities that could generate aerosols, splashes or splatters, and droplets of blood or OPIM. This provides protection of the mucous membranes of the eyes, nose and mouth. Hospital personnel generally wear a surgical mask to provide protection against spread of infectious large particle droplets transmitted by close contact. These large droplets generally travel only short distances (up to 6 ft.) from infected patients who are coughing or sneezing.

C. Gowns, Aprons, and Other Protective Body Clothing

Protective body clothing that is fluid resistant must be worn during activities that could generate aerosols, splashes or splatters. Gowns and various types of protective apparel are worn to prevent contamination of clothing and to protect the skin from exposure to blood and body fluids. Gowns are also worn during the care of patients infected with epidemiologically significant organisms. In addition to functioning as a barrier, gowns also reduce the opportunity to transfer pathogens from patients or various items in a particular environment to other patients or to other environments. When gowns are worn for this purpose, they are removed before leaving the patient’s environment and placed in proper containers for decontamination. By OSHA standards, it is prohibited for employees to launder contaminated PPE at home. Uniforms or scrubs that are worn next to the skin in a manner similar to street clothes are an exception to this since they are not intended to function as PPE. If uniforms or scrubs are not protected and do become contaminated, they must be disinfected in the same manner as other contaminated PPE.

Labels and Signs

The biohazard warning label must be placed on all items containing blood or OPIM: The OSHA biohazard label is an orange or orange-red label with lettering and symbols in a contrasting color, usually black. Labels must be affixed as close as possible to containers using adhesive, wire, or string, or with another method that will prevent loss or unintentional removal. Red bags or red containers may be substituted for labels. Biohazardous waste that has been decontaminated does not need to be labeled or color-coded.

The fluorescent orange or orange-red biohazard label must be affixed to the following items:

- Containers of regulated waste
- Refrigerators and freezers containing blood or other OPIM
- Containers used to store, transport, or ship blood or OPIM

Exemptions from the biohazard labeling include:

- Materials in red biohazard bags or red containers that are substituted for labels
- Blood or blood products that are labeled as to their contents and released for transfusion or clinical use
- Individual containers of blood or OPIM are placed in a labeled container during storage, transport, shipment or disposal

Housekeeping

Employers must ensure that the employee work site is clean and sanitary, and maintain a written schedule for cleaning and decontam-
ination based on location, type of surfaces to be cleaned, and procedures performed in that area. All equipment and surfaces including bins, pails, cans, and receptacles must be decontaminated on a regular basis and decontaminated immediately or as soon as feasible after contact with blood and other OPIM. Products used for decontamination must be effective against mycobacterium tuberculosis (MTB) and HIV. Any protective covering on equipment (example plastic or aluminum) must be decontaminated and removed and replaced if they become overtly contaminated.

Work surface areas must be cleaned on a regular basis. Cleaning must occur after a task is completed, at the end of a shift, or at least weekly. Disposable towels used to clean spills must be disposed of in biohazard labeled bags.

Contaminated broken glassware may not be picked up with the hands directly, but must be handled indirectly with forceps, tongs or a dustpan and brush. Any contaminated reusable sharps must not be handled with hands and must be stored in containers that do not require employees to reach in by hand during processing.

Contaminated laundry should be handled as little as possible. It must be bagged in the area where it was used and may not be sorted or rinsed in the location of use. Bags for soiled laundry must be color-coded and transported according to Universal Precautions. If laundry is wet and leakage of fluids is possible, bags must be leak proof.

Containment of Regulated Waste

Waste that contains blood or OPIM must be placed in closable containers that will prevent leakage of fluid during handling, transport or storage and must be labeled with the fluorescent orange or orange-red biohazard label or in red containers. All contaminated needles and sharps containers must be puncture resistant and closed prior to moving to prevent spilling of contents. If the outside of the container becomes contaminated, the container must be placed in a secondary container that meets all the above biohazard safety criteria for the first container.

Record keeping

A. Medical Records

Employers must maintain records for each employee who has occupational exposure. These records must be kept accurate and up to date with the following:

- The employee's name and social security number
- A copy of the employee's hepatitis B vaccination status with all dates of hepatitis B vaccinations, boosters, pertinent medical records related to vaccination, medical records following report of an exposure incident, or the mandatory statements of declination signed by the employee
- All medical records following the report of an exposure incident, including all medical testing and follow-up

The employer must ensure that all employee medical records are kept confidential and not disclosed or reported to anyone inside or outside the workplace without the employee's written consent, except where required by law. Medical records must be made available to a respective employee, anyone with written consent of the respective employee, or to OSHA for copying or examination if requested.

Records must be maintained for the duration of the employee's employment plus 30 years to be in compliance with 29 CFR 1910.1020. Information on access to and transfer of records may be found at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1020

B. Training Records

Training Records must be maintained for 3 years from the date when training occurred. They must be made available to employees, to employee representatives, or to OSHA for copying or examination if requested. Training records must include the following:

- The date of the training session
- A summary of the training session
- Names and qualifications of the person(s) who is (are) conducting the training
- Names and job titles of all persons attending the training

C. Sharps Injury Log

A Sharps Injury Log must be maintained by employers to record ALL percutaneous injuries from needles or contaminated sharps. This log must be done in a manner that protects the confidentiality of any employee that is injured. Scratches, cuts, lacerations or punctures must be recorded only if they are work-related and involve contamination with another person's blood or OPIM. Injuries must be recorded within 7 calendar days of receipt of information that an injury occurred.

The Sharps Injury log must include the following:

- The type and brand of device involved in the exposure incident
- The department or work area where the exposure occurred
- An explanation of how the injury occurred

OSHA requires that these injuries be recorded on the OSHA Form 300 Log of Work Related Injuries, OSHA Form 300-A Summary of Work-Related Injuries and Illnesses, and OSHA Form 301 Injury and Illness Incident Report or an equivalent (such as an insurance report form) with the same information contained on Form 301. The OSHA Form 300-A Summary of Work-Related Injuries and Illnesses must be posted from February 1 to April 30 of the year following the year covered by the form. The most recent version of these forms can be found at https://www.osha.gov/recordkeeping/RKforms.html

Employee privacy is protected by the OSHA definition of a privacy case. As per 29 CFR 1904, an employee who has any of the following injuries or illnesses is considered a privacy case:

- Illness or injury to an intimate part of the reproductive system
- Illness or injury resulting from sexual assault
- Mental illness
- HIV infection, hepatitis or tuberculosis
- Needlestick injuries and cuts from sharp objects that are contaminated with another person's blood or OPIM
- Other illness, if the employee voluntarily requests that his or her name not be entered on the log

Because all needlestick injuries are considered to be a privacy case, the employee's name is not entered on the OSHA 300 Log and the words “privacy case” are entered in the space where the employee's name is normally entered.

Hepatitis B Vaccination

The hepatitis B vaccine must be offered at no cost to all employees who may be potentially exposed to blood or OPIM within (ten) 10 working days of initial employment unless one of the following applies:

- The employee has already received the complete hepatitis B vaccine series
- Antibody testing shows the employee is immune
- The vaccine is contraindicated for medical reasons

All vaccinations must be performed under the supervision of a physician or other licensed health care professional at a reasonable time and location. Participation in a hepatitis B prescreening program as a prerequisite for receiving the vaccine, is prohibited by law. Employees who decline vaccination must sign the mandatory OSHA form hepatitis B Vaccination Declination (appendix A of 29 CFR 1910.1030). Any employee who has declined the vaccine series may choose to be vaccinated at a later date at no cost to the employee if the employee is still covered by the standard. If routine boosters of the vaccine are recommended by the U.S. Public Health Service at future dates, the vaccine boosters must also be made available to employees at no cost.

Exposure Incidents and Post Exposure Follow-up

Any employee who has had an exposure incident must report the exposure immedi-
ately and begin post-exposure prophylaxis (PEP). A confidential medical evaluation and follow-up must then be made immediately for the exposed employee. On site evaluation is acceptable if there is a method in place to protect employee confidentiality. By OSHA law, it is not appropriate for the medical evaluation and follow-up to be done by a physician who is both the employer and the evaluating healthcare professional. In this case, an independent evaluation with independent testing must be done. All medical procedures and evaluations and post-exposure prophylaxis must be performed by a licensed physician at no cost to the employee. All medical care must be provided according to recommendations made by the U.S. Public Health Service at the time the evaluation occurs. Lab testing must be done by an accredited laboratory at no cost to the employee.

Immediately after an exposure, the confidential medical evaluation must include:

1. Documentation of the route of exposure and circumstances surrounding the exposure incident
2. Identification and documentation of the source individual unless identification is impossible or prohibited by state or local laws

A. The source's blood must be tested for HBV and HIV infectivity as soon as possible after consent is given. If consent is not given or obtained, the employer must establish that legal consent cannot be obtained. If the source's blood is available and legal consent is not required by law, it must be tested and results documented. If the source is known to be infected with HBV or HIV, the testing need not be repeated.

B. Results of the source's blood testing must be made available to the exposed employee as well as all applicable laws and regulations concerning the identity and infectious status of the source.

3. Testing of the exposed employee's blood for HBV and HIV infectivity as soon as possible after consent is given. If the employee consents to baseline blood collection but not to HIV testing, the sample must be preserved for 90 days. If the employee later agrees to HIV testing within 90 days of exposure, the testing must be done as soon as possible. An employer may not accept an employee-signed waiver that waives the right for untested baseline blood to be preserved for the 90 days required by OSHA law. Any baseline sample collected must be kept for the full 90 days.

4. Post-exposure prophylaxis

5. Counseling

6. Evaluation of reported illnesses

Standards regarding HIV, the hepatitis B vaccine, and hepatitis B post-exposure evaluation and follow-up can be found on the OSHA website at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030

**Prevention and Control of Infections**

The healthcare worker plays a major role in the prevention and control of infections in the healthcare environment. Nursing interventions in infection control can be divided into:

1. actions designed to prevent the onset of infection, and
2. actions designed to contain an infection once it has developed.

To prevent an infection from developing, the healthcare worker minimizes the numbers and kinds of organisms within the environment by eliminating reservoirs of infection and avoiding actions that transmit microorganisms. These practices are known as **medical asepsis** and include environmental disinfection, use of appropriately processed supplies and equipment, and handwashing.

To contain an infection, the healthcare worker controls portals of entry and exit and implements additional measures to ensure organisms are not transmitted. These practices include use of **standard and transmission-based precautions**.

Often the same actions are taken to prevent or to contain an infection. Some of these common practices are:

- use of occlusive dressings
- use of PPE
- patient placement away from other susceptible patients
- work practice controls such as policies for specimen collection and transportation
- environmental controls such as appropriately ventilated work areas

A final measure is to strengthen a potential host's defenses against infection. Nutritional support, rest, maintenance of physiological protective mechanisms, emotional and spiritual support, and immunizations all protect the potential host from invasion by pathogens.

**Handwashing**

Handwashing is the single most effective method to prevent the transmission of infection. As healthcare workers, our hands are in constant contact with organisms. Numerous studies continue to illustrate that in practice, handwashing is inadequate despite the constant reinforcement that hands must be washed frequently. APIC guidelines assert that hands are washed in only about fifty percent of the situations that requiring handwashing, and that the duration of handwashing is generally less than recommended. In addition, healthcare workers overestimate the frequency and duration of handwashing. Hospitals continue to submit data stating that their hand hygiene performance rates are above 95%, yet their HAI rates have not dropped.

**CDC reports “On average, healthcare providers clean their hands less than half the times they should”**

The process of handwashing decreases the bioburden (number of organisms) on the hands and minimizes the number of organisms reaching patients, caregivers, equipment, and the healthcare environment. Improper or infrequent handwashing places patients and caregivers at risk for acquiring infections or communicable diseases. The literature abounds with HAI outbreak investigations implicating inadequate handwashing in the transfer of organisms such as staphylococcus, enterobacteriaceae, pseudomonas, and klebsiella. At the same time, inadequate handwashing places the healthcare worker at risk for viral diseases such as hepatitis A, B, C, and D; HIV; chickenpox; and multiple bacterial infections such as staphylococcus and streptococcus.

To receive accreditation through The Joint Commission, they require healthcare organizations to have the following 4 hand hygiene practices in place:

1. Implement a hand hygiene program
2. Set goals for improving compliance of that program
3. Monitor the success of plans for that program
4. Improve results of that program with suitable actions

In January of 2018, the Joint Commission began issuing citations of Requirement For Improvement (RFI) to healthcare facilities for any observation of even one single failure to perform hand hygiene. Receiving RFIs can result in revisits by commission surveyors and put a hospital's accreditation at risk.

It has been determined that any method to monitor the hand hygiene performance of healthcare workers does not ultimately improve or change the results of their hand hygiene. When workers know they are being watched, they are 3 times more likely to clean their hands. After times of observation, however, handwashing will return to the previous status quo. Direct observation of handwashing practices was used more frequently at one time, but it was difficult to obtain a meaningful sample size with direct observation.

Healthcare facilities have begun relying more
on data derived from the Internet of Things (IoT) with cloud connected hand hygiene stations that capture data without bias. Sensors are placed strategically in places to monitor traffic flow, as well as on soap and hand sanitizer dispensers. A cloud-based platform can then collect the data and interpret it. The sensors can also track employee badges via Bluetooth and employees can be monitored by staff administrators, and can be reminded to wash their hands. This technology is surprisingly affordable and the cost to implement these systems is becoming less each year.

Real-time interventions are also being used to improve handwashing practices. These can be in the form of vibrations, beeps, lights, text messages, or a human voice that can serve to alert workers to wash their hands. It has been found that real-time intervention is very effective in improving handwashing and in changing hand hygiene behavior.

**Resident and Transient Flora**

Microorganisms found on the skin are classified as either resident flora (normal flora) or transient flora. **Resident flora** are also known as colonizing flora. **Colonization** is the presence of microorganisms in or on a host with growth and multiplication, but without tissue invasion or damage. Resident organisms grow and multiply on the individual’s skin. Resident organisms rarely cause infections unless they are introduced into deep tissues through invasive procedures, or if the patient is severely immunocompromised. Resident organisms can be repeatedly cultured from the skin and are usually aerobic, gram-positive organisms. These organisms are NOT easily removed by hand-washing. *Staphylococcus epidermidis* is a good example of resident flora.

**Transient flora** is the opposite of resident flora. Transient organisms are recent contaminants that survive only a short time and are usually anaerobic, gram-negative organisms. They survive less than 24 hours on the skin and are easily removed with handwashing. Transient organisms readily cause infection and are most frequently associated with healthcare acquired infections (HAIs). *Escherichia coli* is a good example of a transient organism. Handwashing is used to remove dirt, organic material, and transient organisms.

The wearing of rings or acrylic fingernails has been shown to increase the contamination of pathogenic organisms on hands and has been implicated in the spread of HAIs. For these reasons, healthcare workers with direct contact with high risk patients should not wear artificial nails, tips, wraps, gels, acrylics, any nail jewels, etc. Patients at high risk include every patient in an operating room, neonatal units and intensive care units. Natural nails should be kept less than ¼ inch in length and must be kept neatly manicured. Rings should not be worn or kept to a minimum.

**Types of Handwashing Agents**

Various handwashing agents, plain or antimicrobial, are available in the healthcare setting. **Plain soaps** physically remove dirt and transient organisms through the use of mechanical friction. **Antimicrobial agents** not only remove dirt and transient organisms but also kill or inhibit the growth of organisms to further reduce microbial levels. **Antimicrobial alcohol-based hand sanitizers or rubs** are designed for use without water. Although they have no effect on dirt, they inhibit microbial flora, and can be used in areas where running water is not readily available. Reports from the CDC show that alcohol-based hand rubs (ABHR) with 60% or 70% ethanol or isopropylol are more effective at killing pathogens and are the least damaging to skin when compared to soap and water. They require less time to use and can easily be placed in areas where needed most. Because of evidence of better compliance among healthcare workers compared to soap and water, ABHRs are the preferred and recommended method of hand decontamination unless the hands are visibly soiled. CDC suggests handwashing with soap and water for at least 20 seconds when visibly soiled, before eating, and after using the restroom.

Handwashing agents are available in various forms such as bars, granules, liquids, leaflets and powders. It should be noted that when bar soap is used, it should be in the form of small bars that are changed frequently and placed on antimicrobial soap racks that promote drainage. Bar soap that is not drained properly on antimicrobial soap racks that promote drainage. Bar soap that is not drained properly and is allowed to remain moist can become contaminated. Therefore, bar soap is generally recommended for patient hygiene but not routine handwashing of healthcare workers’ hands. Soap should be selected based on the type and degree of hand contamination and the need to either reduce or maintain minimal counts of resident organisms.

**Indications for Handwashing and Hand Decontamination**

Based on Standard Precautions, The CDC outlines the following guidelines for hand hygiene during the delivery of healthcare:

1. Hands should be washed with either a non-antimicrobial soap and water or an antimicrobial soap and water when hands are:
   - visibly dirty
   - contaminated with blood or body fluids
   - contaminated with protein-based substances
2. When hands are not visibly soiled, or after visible soil is removed with soap and water as stated in 1 above, the preferred method of handwashing, or more specifically hand decontamination, is with an alcohol-based hand rub. Hand decontamination with antimicrobial agents (hand asepsis) is indicated for removing or destroying transient microorganisms. Antibacterial soap and water can also be used. Hands should be decontaminated at the following times:
   - Before direct contact with all patients, and before donning gloves and performing invasive procedures
   - After contact with blood, body fluids, excretions, mucus membranes, non-intact skin, or wound dressings
   - After contact with patient intact skin (for example when taking blood pressure)
   - During patient care, if hands are moving from a contaminated body site to a clean body site
   - After contact with inanimate objects and medical equipment near the patient (such as bedrails, IV pumps, computer keyboards)
   - After removing gloves and other PPE
   - Before preparing or eating food
   - After personal contact such as nose blowing, sneezing, using the bathroom, etc.

3. Hands should be washed with soap and water when there has been contact with spore-forming bacteria (example *Clostridium Difficile* or *Bacillus anthracis*) because the physical action of handwashing using friction and running water is more likely to remove the spores. Alcohols, chlorhexidine, and other antimicrobial agents used in antiseptic hand rubs have virtually no activity against spores.

4. Healthcare workers should be provided with hand lotions or creams to minimize irritation of hands and to prevent contact dermatitis from handwashing. Lotions or creams should be used at least daily.

The World Health Organization has outlined their recommendations for hand hygiene to simplify the number of times handwashing is necessary in the healthcare setting. This method, known as My Five Moments for Hand Hygiene, promotes handwashing at the times within a sequence of patient care that will yield the maximum opportunity for patient safety. The theory behind this approach is that if handwashing occurs at the precise time it is needed, transmission of microbes will be halted and patient harm will thus be prevented. Proponents of this approach hope that the methods taught will “stick” to the healthcare worker and compliance will be high enough to reach a point that it will become an unconscious habit.
YOUR 5 MOMENTS FOR HAND HYGIENE

**My Five Moments for Hand Hygiene:**
1. Before touching a patient
2. Before a clean/aseptic procedure
3. After exposure risk to a body fluid
4. After touching a patient
5. After touching patient surroundings

CDC offers the following guidance for healthcare personnel.

Healthcare personnel should use an alcohol-based hand rub or wash with soap and water for the following clinical indications:
- Immediately before touching a patient
- Before performing an aseptic task (e.g., placing an indwelling device) or handling invasive medical devices
- Before moving from work on a soiled body site to a clean body site on the same patient
- After touching a patient or the patient’s immediate environment
- After contact with blood, body fluids, or contaminated surfaces
- Immediately after glove removal

From: https://www.cdc.gov/handhygiene/providers/guideline.html

**Handwashing Technique**

Studies done on handwashing have shown greater microbial reduction with a longer handwashing time (for example 30 sec vs. 5 sec) and sufficient enough soap (for example 3ml of soap vs. 1ml of soap.) Using a sufficient amount of alcohol-based hand sanitizer has also been shown to affect the number of bacteria remaining on hands after washing. Handwashing studies have shown that using a quick rinsing technique with water alone resulted in no reduction in hand contamination. The bottom line is that hands must be washed with a sufficient amount of product, with the correct technique, and for a sufficient length of time in order to reduce the number of transient organisms.

Per CDC guidelines, the proper handwashing technique for using soap and water is as follows:
- Wet hands and apply a sufficient amount of soap as recommended by the manufacturer
- Rub hands vigorously to create a lather, scrubbing all surfaces of both hands including backs of hands, wrists, between fingers, and especially thumbs and under fingernails. Continue for at least 20 seconds. The important thing is washing hands at the right times.
- Rinse hands well under running water.
- Dry hands with a disposable paper towel, and use the paper towel to turn off the faucet.

on sinks that do not have foot controls or automatic shut off.
- Avoid using hot water because hot water will dry out the skin.

Per CDC guidelines, the proper handwashing technique for using an alcohol-based hand rub is as follows:
- Apply the amount of rub recommended by the manufacturer to the palm of one hand.
- Rub hands together, wetting all surfaces and focusing on fingernails and fingertips. Continue until hands are dry.

Per CDC guidelines for surgical hand hygiene, the proper handwashing technique is as follows:
- Hands can be washed with either an antimicrobial soap or an alcohol-based hand rub with persistent activity.
- Remove all jewelry and watches.
- Use a nail cleaner and running water to remove any debris from under fingernails.
- Using an antimicrobial soap, hands and forearms should be scrubbed according to the manufacturer’s recommendations. This is generally 2-6 minutes.
- Using an alcohol-based hand rub with persistent activity, hands and forearms should first be washed with a non-antimicrobial soap and allowed to completely dry. The hand rub should be applied according to manufacturer’s recommendations. Hands and forearms should be allowed to dry thoroughly before donning sterile gloves.

**Patient Education**

Teaching patients correct handwashing techniques is of utmost importance. Patients can transmit microbes from one environment to another, from one patient to another, or from a contaminated body site on their own body to a clean body site.

Teaching pediatric patients correct handwashing will promote habits that may last a lifetime. Kids can be taught that the correct amount of time for handwashing is the time it takes to sing the "Happy Birthday" song two times, or about the time it takes to sing the "ABCs" song. Terrific resources for educating pediatric and adult patients are available through the non-profit, Henry the Hand Foundation, developed by Dr. William Sawyer. The website offers tailored programs and tools targeted to different groups such as pre-K programs and businesses.

Henry, a cute little hand-shaped character, teaches patients to properly wash hands and keep hands away from eyes, nose, and mouth by the saying "Do Not Touch the T-Zone!" More information can be found at http://www.henrythehand.com

For community settings, CDC recommends
to follow these five steps every time.

1. **Wet** your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
2. **Lather** your hands by rubbing them together with the soap. Lather the backs of your hands, between your fingers, and under your nails.
3. **Scrub** your hands for at least 20 seconds.

Need a timer? Hum the “Happy Birthday” song from beginning to end twice.

4. **Rinse** your hands well under clean, running water.
5. **Dry** your hands using a clean towel or air dry them.

Key times to wash hands are when you are likely to get and spread germs:
- Before eating food
- Before and after caring for someone at home who is sick with vomiting or diarrhea
- Before and after treating a cut or wound
- After using the toilet
- After changing diapers or cleaning up a child who has used the toilet
- After blowing your nose, coughing, or sneezing

### Levels of disinfection by type of microorganism

<table>
<thead>
<tr>
<th>Disinfection level</th>
<th>Bacteria (vegetative)</th>
<th>Bacteria (Tubercle bacillus)</th>
<th>Bacteria (spores)</th>
<th>Fungi†</th>
<th>Viruses (lipid and medium size)</th>
<th>Viruses (nonlipid and small size)</th>
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<tbody>
<tr>
<td>High</td>
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<td>Low</td>
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<td>−</td>
<td>−</td>
<td>Variable killing effect</td>
<td>+</td>
<td>± Variable killing effect</td>
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</tbody>
</table>

* + indicates that a killing effect can be expected when the normal use-concentrations of chemical disinfectants or pasteurization are properly employed
  − indicates little or no killing effect

* Material in this table compiled from references 2, 951.

† This class of microorganisms includes asexual spores but not necessarily chlamydospores or sexual spores.

Source: https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf
• After touching an animal, animal feed, or animal waste
• After handling pet food or pet treats
• After touching garbage
• During the COVID pandemic, CDC added:
  • After you have been in a public place and touched an item or surface that may be frequently touched by other people, such as door handles, tables, gas pumps, shopping carts, or electronic cashier registers/screens, etc.
• Before touching your eyes, nose, or mouth because that’s how germs enter our bodies.

Source: www.cdc.gov/handwashing/when-how-handwashing.html

Environmental Cleaning

Just as handwashing decreases the bioburden on the hands, cleaning decreases the bioburden in the environment. Both practices are designed to minimize the number of organisms in contact with clients, visitors or healthcare workers. A clean healthcare environment is crucial to infection control because patients colonized with pathogenic, disease-producing organisms contaminate their environment with these same organisms. Some organisms survive long enough to be transmitted to a susceptible host. *Staphylococcus aureus* and *Enterococcus* have been shown to survive for days on improperly disinfected environmental surfaces. Hepatitis B is another example of an infective agent that can be readily transferred from person to person by way of the contaminated environment. Countless articles have described the transmission of infection from contact with contaminated supplies or improperly cleaned equipment. It is impossible to prevent the transmission of infections if environmental cleaning and proper handling of supplies and equipment are absent or ineffective. Environmental cleaning services are generally provided by a dedicated sanitation staff. However, in some institutions or in certain situations, the healthcare worker might be called upon to perform some types of cleaning activity. In keeping with the principles of medical asepsis, cleaning schedules should progress from the least soiled areas to the most soiled areas to prevent the inadvertent transfer of dirt and organisms from dirty areas onto clean areas. Cleaning activities should also minimize turbulence to prevent the aerosolization of organisms. Each healthcare institution has unique cleaning requirements and schedules. Healthcare workers should become familiar with their responsibilities to maintain a clean environment as set forth by their respective institution.

Patient Care Equipment and Environmental Surfaces

Cleaning of patient care equipment can be divided into sterilization and disinfection. Sterilization is defined as a procedure that destroys all forms of microbial life, including high numbers of resistant bacterial spores, through the use of chemical or physical methods. Chemical agents that are able to destroy all microbes and high numbers of microbial spores are called chemical sterilants. Disinfection is defined as a procedure that destroys all or most of the microbes that cause infection, except bacterial spores, on inanimate objects.

All patient care equipment must be cleaned and disinfected or sterilized between patient uses. Numerous articles, new and old, illustrate the need for proper reprocessing and clearly illustrate the infection consequences when equipment is not properly processed. However, not all patient care equipment needs to be sterilized between uses. Earle H. Spaulding devised a clear and simple classification system more than 50 years ago to assist healthcare workers in determining the level of reprocessing required for patient care items and equipment. This approach was so logical that it is still used today and the CDC retains the Spaulding classification for medical and surgical instruments.

Spaulding divided disinfection into high-level disinfection, intermediate level disinfection, and low-level disinfection. High-level disinfection is defined as complete elimination of all microbiorganisms in or on an inanimate object, except for a high number of bacterial spores. Intermediate level disinfection is a process that kills mycobacteria, vegetative bacteria, most viruses, and most fungi, but not bacterial spores. Low Level disinfection is a process that kills most vegetative bacteria, some viruses, and some fungi, but not mycobacteria or bacterial spores within a practical period of time.

Spaulding divided patient care items and equipment into three categories based on the risk of infection associated with their use. These three categories are critical, semi-critical, and non-critical.

1. **Critical items** have a high infection potential if any organisms including bacterial spores are present. These items must be sterile because they will enter normally sterile areas such as sterile tissue or the vascular system, or they will have blood flow through them. Critical items include needles, surgical instruments, implants, cardiac and urinary catheters, and ultrasound probes used in body cavities. Items can be purchased as sterile, or sterilized by either steam under pressure or dry heat. If items cannot tolerate heat, sterilization with ethylene oxide gas, hydrogen peroxide gas plasma or chemical sterilants may be suitable. Chemical sterilants include >2.4% glutaraldehyde-based formulations and 7.5% stabilized hydrogen peroxide.

2. **Semi-critical items** are items that come in contact with mucous membranes or non-intact skin. These items must be free of all organisms except small numbers of bacterial spores. Semi-critical items include respiratory therapy and anesthesia equipment, endoscopes, and diaphragm fitting rings. Semi-critical items require high-level disinfection with wet pasteurization or chemical germicides. Reliable chemical germicides include glutaraldehyde, and stabilized hydrogen peroxide. Some semi-critical items such as hydrotherapy tanks require only intermediate level disinfection. Intermediate level disinfectants include phenolics, chlorine, iodophors and hospital disinfectants with a claim for tuberculocidal activity. Chlorine use is also recommended for hydrotherapy tanks because they have been linked to the spread of infection.

3. **Non-critical items** come in contact with intact skin but not mucous membranes. Since the skin acts as an effective barrier to organisms, sterility is not critical. Non-critical items require only low-level disinfection. Non-critical items include bedpans, blood pressure cuffs, bed rails, computers, and patient furniture. Low-level disinfectants include phenolics, iodophors, weak household bleach (100 parts per million available chlorine), and quaternary ammonium compounds. Non-critical items are generally cleaned where they are used and do not need to be sent to a central processing area. Under certain circumstances, however, it is necessary to dedicate non-critical items to a specific patient or ensure adequate disinfection of the item before it is used on another patient. These specific circumstances include: patients infected or colonized with resistant or highly virulent organisms such as vancomycin resistant enterococci (VRE), or patients on contact precautions.

All equipment that requires reprocessing must be thoroughly cleaned before being disinfected or sterilized. Cleaning removes organic matter, salts, and visible soils that can all interfere with microbial activation. Large numbers of microbes are removed by the physical action of scrubbing with detergents and rinsing with water. The success of sterilization or disinfection depends on proper cleaning. Each institution must establish equipment

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pre-cleaning procedures and protocols for returning contaminated equipment for reprocessing. Manufacturer’s instructions must be closely followed to prevent inadvertent damage to the item and provide sufficient contact time to ensure adequate disinfection or sterilization.

In 1991, the CDC proposed adding an additional category to Spaulding’s classifications and called it “environmental surfaces.” These surfaces do not come into direct contact with patients during patient care and have the least risk of disease transmission. The CDC further divided environmental surfaces into medical equipment surfaces (such as knobs or handles on hemodialysis machines, x-ray machines, instrument carts, and dental units) and housekeeping surfaces (floors, walls, and tabletops).

**Advancements in Environmental Disinfection**

In addition to their routine cleaning procedures, healthcare facilities have added the use of mobile disinfection robots that use ultraviolet light to kill organisms known to cause HAIs. These robots can kill more microorganisms than human disinfection alone can kill. The UV light emitted is able to bounce off walls and objects to kill pathogens in many areas. The light that is used causes damage to microbial cellular DNA thus causing fatal mutations. Rooms are evacuated while the robots are at work cleaning. The UV light used is relatively harmless for humans passing outside of a room because the UV cannot penetrate glass. Studies have shown 50-100% decreases in MRSA, C. difficile, and surgical site infection (SSI) rates after use of the robots. This technology can also be used to sanitize EMS vehicles, medvac helicopters, and senior living facilities, etc., giving these robots great importance in the future of infection control.

**Detergents, Disinfectants and Cleaning Agents**

Any detergent/disinfectant registered with the Environmental Protection Agency (EPA) may be used for routine environmental cleaning. However, agents designated as hospital grade detergents/disinfectants must be able to inactivate specific organisms such as salmonella, staphylococcus, and streptococcus. In the healthcare setting, detergents/disinfectants must be chosen carefully to determine which agent is appropriate for the task to be performed.

High-level disinfectants and liquid sterilants for use on medical and dental devices and instruments are regulated exclusively by the FDA. Intermediate and low-level disinfectants are regulated by the EPA and are labeled with an EPA registration number. Labels on the disinfectants will show indications for product use range of antimicrobial activity. Germicides must undergo product testing required by the EPA to support their label claims of microbial inactivation. Germicides labeled “hospital disinfectant” are low-level disinfectants that lack the ability to inactivate mycobacteria. Germicides labeled “tuberculocidal” are able to inactivate mycobacteria and are considered to be intermediate-level disinfectants. The ability of a product to be tuberculocidal is a benchmark by which germicidal potency is measured. This is because mycobacteria have the highest intrinsic level of resistance of the vegetative bacteria, viruses, and fungi. It is important to note that use of tuberculocidal disinfectants will NOT interrupt or prevent the transmission of TB in healthcare settings because TB is NOT acquired from environmental surfaces.

Products designed for use on patients’ skin are known as antisepsics and are not suitable for environmental cleaning. The only exceptions are isopropyl and ethyl alcohol. Both can be effective as antisepsics and environmental disinfectants. It should be noted that alcohol is inactivated by organic debris; therefore, if alcohol is used as an environmental disinfectant, any organic contamination such as pus or blood should be wiped up before attempting to disinfect the area.

Cleaning procedures and products designed for environmental cleaning should not be applied to patient care equipment. Environmental cleaning agents may be too harsh for delicate patient equipment or so weak that the cleaning is ineffective. Dilution formulas and surface contact time must be exact according to the manufacturer’s recommendations to ensure adequate destruction of organisms. Healthcare workers must be aware that detergents and disinfectants could also affect the well being of patients. For example, there is a strong association between the use of phenolic disinfectants and hyperbilirubinemia in newborns when improper dilutions are used or environmental surfaces are inadequately rinsed.

Specific agents are required in certain situations. OSHA requires a tuberculocidal agent or properly diluted household bleach to decontaminate blood spills and OPIM. The prion that is associated with the development of Creutzfeldt-Jakob disease (CJD) and related conditions is very resistant to routine methods of sterilization; therefore, disinfection of instruments exposed to CJD require special procedures.

Personal protective equipment (PPE) must be used while performing cleaning activities. Gloves should be designed to withstand the chemical effects of the detergent/disinfectant and be thick enough to protect against percutaneous injury to the hands. Face protection must be adequate to protect the face and eyes if splashing or splattering is anticipated, and gowns must cover and protect the skin from harsh chemicals.

**Storage of Supplies**

Proper care and storage of supplies is just as important in the prevention of infection as maintaining a clean environment or appropriately reprocessing patient care equipment. Holes, tears, and breaks in package integrity permit the direct entry of organisms. Excessive or improper handling, improper storage techniques, heat, moisture, dust, and dirt can also compromise the integrity of supply packaging. Dropping supplies onto the floor can cause enough force to push bacteria and dust into a package without creating any visible indications that the package has been compromised. The standards for proper storage of supplies have been established to minimize contamination from these environmental factors.

Supplies should be stored in a closed or covered cabinet or closet that is free from dust, moisture and insects, and allows adequate circulation of air. Storage shelves should be eight to ten inches up from the floor to permit routine cleaning; 5 inches from ceilings not near a sprinkler head and 18 inches from any sprinkler heads to ensure adequate functioning of fire sprinklers; and two inches in from an outside walls to eliminate moisture damage created by changes in inside and outside temperatures. Supplies must also be stored away from pipes, windows, and air vents. If open shelving is used for storage, the bottom shelf should be solid or closed to prevent the contamination of supplies on the bottom shelf from floor dust and the cleaning process.

Sterile supplies should be separated from non-sterile supplies by a functional barrier such as a drawer, bin, or shelf. This practice prevents the excessive handling of sterile supplies in order to reach non-sterile supplies and minimizes the chances that a non-sterile item will be selected for use when a sterile item is needed. Access to storage areas should be restricted to minimize traffic. If supplies are located in a large storage room, sterile supplies should be located away from doorways and high traffic lanes.

Supplies should be inspected prior to use to ensure that the package is free from tears, dampness, dried water marks, excessive dust or dirt, and that the expiration date has not been reached (if expiration dates are used.) Items in packaging that has been wet, torn, or punctured must not be used and must be either discarded or re-sterilized. Any item dropped on the floor must be inspected for packaging and found to be free from contamination before it is used.
damage and breakage to the contents. Undamaged items in heat-sealed impervious plastic with intact seals do not need to be reprocessed.

Each institution will establish their own storage times and specific storage conditions. Although some hospitals still use expiration dates to ensure sterility, many hospitals have switched to event-related practices for sterility. **Event-related sterility** recognizes that a product will remain sterile until some event causes the item to become contaminated, such as a tear in packaging or if the package becomes wet. Factors that can affect the contamination of items include traffic in the area, insects, vermin, air movement, humidity, temperature, and the overall bioburden (the amount of contamination) of the environment. Studies done on event-related sterility have shown that there is no trend of increasing contamination over time if packages are placed in covered storage. Studies have also shown that contamination is event-related and that contamination increases with increased package handling.

**Waste Management**

The policies for defining, collecting, storing, decontaminating, and disposing of infective waste are determined by the healthcare institution in accordance with federal, state, and local regulations. In addition to OSHA mandated laws, policies and procedures for waste management can be obtained by contacting the local and state health departments or agencies responsible for waste management.

**A Review of Isolation Precautions**

**Standard Precautions**

**Definition**

Standard Precautions are the **minimum** infection practices that apply to all patient care in any setting where health care is delivered. These precautions are used for all patients in any healthcare setting regardless of their confirmed infection status.

Standard Precautions describe specific infection practices including hand hygiene and safe injection practices as well as the use of PPE that includes gowns, gloves, masks, eye protection, and face shields. Standard Precautions, as defined by the CDC, incorporate the principles from OSHA as outlined above.

Standard Precautions apply to:

1. Blood
2. All body fluids, secretions, and excretions except sweat regardless of whether or not they contain visible blood
3. Non-intact skin
4. Mucous membranes.

Although it has not been specifically implicated in the transmission of HIV (HIV is not spread through saliva) or other bloodborne diseases, saliva has not been removed from the list of body fluids that require the caregiver to exercise Standard Precautions. In all clinical settings, the CDC and the American Dental Association’s Council on Dental Therapeutics suggest assuming that saliva can be contaminated with blood and can therefore potentially carry HIV and other diseases.

**Personal Protective Equipment**

Gloves must be used for any contact with blood, body fluids, secretions, excretions, mucous membranes, non-intact skin, and any potentially contaminated items. Gowns or coveralls must be worn during any procedure or patient care activity where skin or clothing might come into contact with blood, body fluids, secretions, excretions, or potentially contaminated items.

Bloodborne pathogen strikethrough (penetration) conversion chart (This chart converts the amount of strikethrough to the amount of potential bloodborne pathogen contamination). The four spots at the top were formed from premeasured droplets of synthetic blood and marked in microliters (µL) ranging from 100 µL to 0.1 µL. Adapted with permission from AAMI TIR 11:2005, “Selection and use of protective apparel and surgical drapes in health care facilities.”

Bloodborne pathogen strikethrough (penetration) conversion chart. (This chart converts the amount of strikethrough to the amount of potential bloodborne pathogen contamination). The four spots at the top were formed from premeasured droplets of synthetic blood and marked in microliters (µL) ranging from 100 µL to 0.1 µL. Adapted with permission from AAMI TIR 11:2005, “Selection and use of protective apparel and surgical drapes in health care facilities.”

Taken from CDC Considerations for Selecting Protective Clothing Used in Healthcare for Protection Against Microorganisms in Blood and Body Fluids. Selecting Protective Clothing. Avail at: [https://www.cdc.gov/niosh/npptl/topics/protectiveclothing](https://www.cdc.gov/niosh/npptl/topics/protectiveclothing)
taminated items. When choosing the protective clothing to be worn, employers must consider the material the clothing is made from as well as the design of the clothing including locations of seams and ties. Microorganisms can be transported onto clothing by body fluids, respiratory droplets, shed skin cells, dust, and lint. Studies identified by the CDC have shown that microorganisms can penetrate a material via a liquid carrier without the liquid being visible. Therefore, the only way to determine if microorganisms can potentially penetrate any part of a garment is to have standardized testing methods sensitive enough to detect microbe penetration. Testing methods used by the American Society of Testing and Materials International (ASTM) are used in the United States. Testing methods used by the International Organization for Standardization (ISO) are used in Europe. More detailed information on testing of clothing using these methods can be found on the CDC website at https://www.cdc.gov/niosh/nptl/topics/protectiveclothing/

A very small volume of blood or body fluids can transport an extremely large number of microbes and yet be invisible to the naked eye. The chart below shows how strikethrough (liquid penetration) can be converted to potential amount of bloodborne pathogen contamination for HBV, HCV, and HIV.

Masks, face shields and eye protection must be worn during any patient care activity that could generate blood sprays or splashes of body fluids, secretions, and excretions, and during procedures such as suctioning or intubation. For all patient resuscitation, mouthpieces, ventilation bags, or other ventilation devices must be used to prevent contact with the patient’s mouth and saliva.

**Needles, Sharps, and Exposure to Patient Fluids**

The number of needlestick injuries have decreased greatly since universal precautions were adopted by the CDC in 1985 in response to the HIV virus. The greatest threat today from a needlestick injury is acquiring either hepatitis B or hepatitis C. Needlestick injuries are largely preventable and usually occur because of a healthcare worker’s unsafe practices or negligence.

![Safe Injection Practices Coalition](https://www.cdc.gov/injectionsafety/one-and-only.html)

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**For occupational post-exposure prophylaxis for HIV, HBV and HCV consultation call (888) 448-4911 (Open every day from 11AM-8PM Eastern)**

**Safe Injection Practices**

Safe injection practices are vital to infection control. Each year, unsafe injection practices in the U.S. are the cause of outbreaks of bacterial and bloodborne pathogens, putting both healthcare professionals and patients at risk for disease.

In an effort to eliminate unsafe injection practices, the CDC and the Safe Injection Practices Coalition (SIPC) collaborated to form the One and Only Campaign. The purpose of this campaign is to raise awareness among health care workers and patients about safe injection practices. “One Needle, One Syringe, Only One Time” is the campaign’s good rule to remember.

Safe injection practices as outlined by the CDC include the following:

1. Proper hand hygiene using an alcohol based hand rub or soap and water should be performed prior to administering any medication.
2. Aseptic technique must be maintained during preparation and administration of injected medications. Injection preparation should be done in a clean area where there is no contact with blood, body fluids, or contaminated equipment. Rubber septums on medication vials must be disinfected with alcohol prior to piercing.

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**Of reported possible exposure to HIV among US healthcare workers from 1981-2010, percutaneous needlestick injury was the known cause in 48 cases.**

It is estimated that there are as many as 600,000 needlestick injuries to health care workers in the U.S. annually, of which about half are reported. Approximately 25% of all needlestick injuries occur in operating rooms. Surgical residents are at greatest risk. In a small survey of EMS workers, over 80% self-reported having no occurrences ever, while 18% had a needlestick injury within the previous 12 months. There is the potential for exposure any time a puncture wound occurs from a contaminated needle, lancet, or surgical instrument. Special care should be taken when using, caring for, disinfecting, or cleaning these items. Needles should NEVER be recapped with both hands, purposely bent, broken, manipulated, or removed from disposable syringes by hand.

After use, disposable syringes and needles, scalpel blades, and all other sharps that are to be disposed of should be placed in a puncture-resistant container that is placed as close as possible to the area where used. Large bore reusable needles should be placed in a puncture-resistant container and then transported to the nearest reprocessing area.

It is important to note that many needle stick injuries have involved IV therapy equipment. Injuries can occur during IV disassembly, and can also occur during any of the steps of the assembly/use/discard process, including insertion into drip chambers, injection ports, and IV bags. Healthcare workers should be aware that needles attached to discontinued IV lines might also present a problem.

If a needlestick or sharps injury does occur, or if exposure to blood or any body fluids of a patient occurs, the CDC recommends that the following steps should be immediately taken:

1. Wash needlesticks and cuts with soap and water
2. Flush splashes to the nose, mouth, or skin with water
3. Irrigate eyes with clean water, saline, or sterile irrigants
4. Report the incident to a supervisor following your facility’s protocol
5. Seek immediate medical treatment

Assistance to clinicians for medical treatment for occupational exposures is available from the National Clinician Consultation Center’s Post Exposure Prophylaxis (PEP) Line at 1-888-448-4911.
3. Needles and syringes are to be used for only one patient and this includes manufactured pre-filled syringes and cartridge devices such as insulin pens.

4. Tubing and connectors for medication administration should be used for only one patient.

5. Never administer medication from the same syringe to more than one patient, even if the needle is changed.

6. Never re-use a previously used needle or syringe to enter a vial. Medication vials should always be entered with a new needle and new syringe even when obtaining additional doses for the same patient.

7. Do not use bags or bottles of IV solution and single-dose or single-use medication vials or ampules for more than one patient.

8. Limit the use of multi-dose vials and dedicate them to a single patient whenever possible. Multi-dose vials for more than one patient should be kept in a centralized medication area and should not enter the immediate patient treatment area. If a multi-dose vial enters the immediate patient treatment area, it should be dedicated for single patient use and discarded immediately after use.

9. Multi-dose vials should be dated when first opened and discarded within 28 days unless the manufacturer specifies a shorter or longer date for that opened vial. (The date the vial was opened should not be confused with the printed drug expiration date on the vial.)

10. Always use a facemask when injecting material or inserting a catheter into an epidural or subdural space.

Patient Placement and Transportation of Infected Patients

Patients who have illnesses with the potential for increased risk of disease transmission should be given priority for placement in single patient rooms. A private room is important to prevent direct or indirect contact transmission when the source patient has poor hygienic habits, is likely to contaminate the environment, or cannot be expected to assist in maintaining infection control precautions to limit the transmission of organisms. When a private room is not available, an infected patient is placed with an appropriate roommate.

A private room with appropriate air handling and ventilation is important for reducing the risk of transmission of organisms from a source patient and other persons in the hospital when the organism is spread by airborne transmission. Limiting the movement and transportation of patients infected or colonized with virulent or epidemiologically important organisms reduces opportunities for transmission of organisms. Such patients should be transported only when essential for care.

Respiratory Hygiene and Cough Etiquette

Patients with any symptoms of respiratory infection should be instructed to cover their mouth and nose with a tissue when coughing or sneezing. When a tissue is not available, patients should cough or sneeze into their elbow or sleeve and not into their hands. Used tissues should be disposed of in the nearest hands-free waste container. Hands should be washed with soap and water for at least 20 seconds or with alcohol-based hand gel if soap and water are unavailable. If possible, patients should wear surgical masks (N95 respirators are not necessary) or be separated from well individuals by a distance greater than six feet.

Healthcare facilities should provide tissues and hands-free waste containers for tissue disposal. Dispensers of alcohol-based hand gel should be conveniently located and readily available. Hand washing supplies such as soap and disposable towels where sinks are located should be frequently checked and restocked and ready for use.

Housekeeping

Routine cleaning and disinfection of surfaces, instruments, and patient care equipment should be practiced. Laundry and other contaminated items must be properly handled. Disposable equipment should never be reused. All biohazardous materials must be properly labeled and disinfected. All specimens should be placed in leak-proof containers or bags with a biohazard warning label.

Transmission-Based Precautions

Transmission-based precautions were designed for patients with suspected or documented infection with highly transmissible or epidemiologically important pathogens requiring additional practices beyond Standard Precautions. When a new patient is admitted to a healthcare facility, transmission-based precautions are used, based on clinical presentation and likely etiology. After the pathogen is identified and modes of transmission are known, necessary isolation precautions can be re-evaluated. The three types of transmission-based precautions are Contact Precautions, Droplet Precautions, and Airborne Precautions. These precautions are used when Standard Precautions alone are not enough to interrupt the transmission of certain diseases. They are always used in conjunction with Standard Precautions. Some diseases/infections with multiple routes of transmission may require a combination of transmission-based precautions: for example, chickenpox (Varicella) requires airborne and contact precautions, in addition to Standard Precautions.

Contact Precautions

Contact precautions are designed to reduce the risk of transmission of organisms by direct or indirect contact with the patient or the patient’s environment. Direct contact involves skin-to-skin contact and physical transfer of organisms from an infected/colonized source to a susceptible host. The hands of healthcare workers are most often implicated when direct contact transmission is discussed, but direct contact transmission can also occur between two patients. Indirect contact involves contact of a susceptible host with a contaminated intermediate object, usually some inanimate object in the environment. Contact precautions apply to specified patients known or suspected to be infected or colonized with significant organisms that can be transmitted by direct contact, such as methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus (VRE), Clostridium difficile colitis, and respiratory syncytial virus (RSV). Contact precautions are also used for patients with fecal incontinence, excessive wound drainage, or other bodily discharge that could potentially cause transmission of infectious microbes.

Gowns and gloves must be worn for all patient contact or contact with potentially contaminated areas of the patient’s environment such as bedsrails, furniture or medical equipment. PPE must be put on before entering the patient’s room and removed before leaving the room to contain any potential microbes.

Private rooms are the preferred choice for patients who are on Contact Precautions. When private rooms are not available, infection control personnel should be consulted for risk assessment before cohorting patients. Patients should be transported only when necessary for diagnosis or treatment, and the risk of infection transmission must be weighed against the need for transport. Patients should wear a clean long-sleeved gown if transport is necessary.

Contact Precautions

Ensure appropriate patient placement in a single patient space or room if available in acute care hospitals. In long-term and other residential settings, make room placement decisions balancing risks to other patients. In ambulatory settings, place patients requiring contact precautions in an exam room or cubicle as soon as possible.

Use personal protective equipment (PPE) appropriately, including gloves and gown. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient’s environment. Donning PPE upon room entry
and properly discarding before exiting the patient room is done to contain pathogens.

Limit transport and movement of patients outside of the room to medically-necessary purposes. When transport or movement is necessary, cover or contain the infected or colonized areas of the patient's body. Remove and dispose of contaminated PPE and perform hand hygiene prior to transporting patients on Contact Precautions. Don clean PPE to handle the patient at the transport location.

Use disposable or dedicated patient-care equipment (e.g., blood pressure cuffs). If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient.

Prioritize cleaning and disinfection of the rooms of patients on contact precautions ensuring rooms are frequently cleaned and disinfected (e.g., at least daily or prior to use by another patient in outpatient setting) focusing on frequently-touched surfaces and equipment in the immediate vicinity of the patient.

Source: https://www.cdc.gov/infectioncontrol/basics/transmission-based-precautions.html

**Droplet Precautions**

Droplet precautions are designed to reduce the risk of droplet transmission of infective agents when patients are infected with pathogens such as influenza and coronavirus. Droplet transmission involves contact of the conjunctiva or the mucous membranes of the nose or mouth of a susceptible person with large particle droplets. Droplets are generated from the source patient primarily during coughing, sneezing or talking, or during procedures such as suctioning or bronchoscopy. Transmission of infection by large particle droplets requires close contact between the source patient and the susceptible host. Droplets do not remain suspended in the air and generally travel only short distances of approximately three to six feet or less. For these reasons, special ventilation systems and air handling are not required to prevent droplet transmission.

Surgical masks must be worn by healthcare professionals for close contact within six feet of patients who are on Droplet Precautions. Respirators are not necessary. Private rooms are the preferred choice for patients. When private rooms are not available, infection control personnel should be consulted for risk assessment before cohorting patients. Patients must wear a surgical mask during transport and observe respiratory/cough etiquette.

**Airborne Precautions**

Airborne Precautions are designed to prevent transmission of microbes that can remain infectious over long distances if they become suspended in the air. Airborne transmission occurs by dissemination of either airborne droplet nuclei (small particle residue of evaporated droplets that can remain suspended in the air for long periods of time) or dust particles containing the infectious agent. Organisms transmitted in this manner can be widely dispersed by air currents and may be inhaled or deposited on a susceptible host within the same room or a long distance from the source patient. Therefore, special air handling and ventilation systems are required to prevent airborne transmission. Patients requiring airborne precautions MUST be admitted into an **airborne infection isolation room (AIIR)** with negative airflow relative to the hallways or surrounding areas and 12 air exchanges per hour in buildings with new construction and renovation, and six air exchanges per hour in existing facilities. Air from AIIRs must be directly exhausted to the outside or put through a HEPA filtration system before returning to the building. Examples of diseases requiring Airborne Precautions include rubeola virus (measles), varicella virus (chicken pox), M. tuberculosis, and anthrax.

All personnel entering an isolation room must wear gowns, gloves and an N95 NIOSH rated respirator. The term “N95” refers to a filter class and not the respirator itself. An N95 respirator is one that filters out at least 95% of airborne particles when tested to meet particular standards as set forth by NIOSH. A typical surgical mask is **NOT** an N95 respirator. Surgical masks are not able to filter small particles from the air and do not prevent leakage around the mask edges when the user inhales. All NIOSH-approved particulate filtering facepiece respirators will have the manufacturer's name, the part number (P/N), the protection provided by the filter (example N95 or P100) and “NIOSH” in block letters or the NIOSH logo written on the outside front, the exhalation valve, or the straps.

**NIOSH maintains an updated list of approved N95 Particulate Filtering Facepiece Respirators at** https://www.cdc.gov/niOSH/npptl/topics/respirators/disp_part/n95list1.html

If a respirator does not have these markings or does not appear on the NIOSH approved list, it cannot be certified for occupational use. All facilities that have AIIRs must have a facility-wide respiratory protection program that includes education on respirator use, and appropriate fit testing with user seal checks before caring for anyone requiring airborne precautions. Patient transport should be limited to medically necessary purposes only.

**Empiric Use of Transmission-Based Precautions**

Many diseases are the most contagious when a patient first arrives at a healthcare facility with an unknown diagnosis. Since some laboratory tests that confirm a suspected illness could take several days for results, transmission-based precautions are used in addition to Standard Precautions to prevent further potential spread of disease. Certain diseases and syndromes are associated with a high enough risk to necessitate the empiric use of transmission-based precautions. In other words, based on experience and observation, the benefits of also using transmission-based precautions will outweigh the cost until laboratory tests yield a definitive diagnosis. CDC Category A diseases that could possibly result from a bioterrorist threat or attack also warrant the empiric use of transmission-based precautions. See the following tables:
**Clinical Syndromes or Conditions Warranting Empiric Transmission-Based Precautions in Addition to Standard Precautions**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Clinical Syndrome or Condition†</th>
<th>Potential Pathogens‡</th>
<th>Empiric Precautions (Always Includes Standard Precautions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>Acute diarrhea with a likely infectious cause in an incontinent or diapered patient</td>
<td>Enteric pathogens§</td>
<td>Contact Precautions (pediatrics and adult)</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Meningitis</td>
<td>Neisseria meningitidis</td>
<td>Droplet Precautions for first 24 hours of antimicrobial therapy; mask and face protection for intubation</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Meningitis</td>
<td>Enteroviruses</td>
<td>Contact Precautions for infants and children</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Meningitis</td>
<td>M. tuberculosis</td>
<td>Airborne Precautions if pulmonary infiltrate Airborne Precautions plus Contact Precautions if potentially infectious draining body fluid present</td>
</tr>
<tr>
<td>Rash or Exanthems, Generalized, Etiology Unknown</td>
<td>Petechial/echymotic with fever (general)</td>
<td>Neisseria meningitides</td>
<td>Droplet Precautions for first 24 hours of antimicrobial therapy</td>
</tr>
<tr>
<td>Rash or Exanthems, Generalized, Etiology Unknown</td>
<td>Petechial/echymotic with fever (general) If positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever</td>
<td>Ebola, Lassa, Marburg viruses</td>
<td>Droplet Precautions plus Contact Precautions, with face/eye protection, emphasizing safety sharps and barrier precautions when blood exposure likely. Use N95 or higher respiratory protection when aerosolgenerating procedure performed. Ebola Virus Disease Update [2014]: Updated recommendations for healthcare workers can be found at Ebola: for Clinicians (<a href="https://www.cdc.gov/vhf/ebola/clinicians/index.html">https://www.cdc.gov/vhf/ebola/clinicians/index.html</a> accessed September 2018).</td>
</tr>
<tr>
<td>Rash or Exanthems, Generalized, Etiology Unknown</td>
<td>Vesicular</td>
<td>Varicella-zoster, herpes simplex, variola (smallpox), vaccinia viruses</td>
<td>Airborne plus Contact Precautions; Contact Precautions only if Herpes simplex, localized zoster in an immunocompetent host or vaccinia viruses most likely</td>
</tr>
<tr>
<td>Rash or Exanthems, Generalized, Etiology Unknown</td>
<td>Maculopapular with cough, coryza and fever</td>
<td>Rubeola (measles) virus</td>
<td>Airborne Precautions</td>
</tr>
<tr>
<td>Respiratory Infections</td>
<td>Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for human immunodeficiency virus (HIV) infection</td>
<td>M. tuberculosis, Respiratory viruses, S. pneumoniae, S. aureus (MSSA or MRSA)</td>
<td>Airborne Precautions plus Contact precautions</td>
</tr>
</tbody>
</table>

Continued next page...
### Clinical Syndromes or Conditions Warranting Empiric Transmission-Based Precautions in Addition to Standard Precautions

*continued...*

<table>
<thead>
<tr>
<th>Disease</th>
<th>Clinical Syndrome or Condition †</th>
<th>Potential Pathogens ‡</th>
<th>Empiric Precautions (Always Includes Standard Precautions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Infections</td>
<td>Cough/fever/pulmonary infiltrate in any lung location in an HIV infected patient or a patient at high risk for HIV infection</td>
<td>M. tuberculosis, Respiratory viruses, S. pneumoniae, S. aureus (MSSA or MRSA)</td>
<td>Airborne Precautions plus Contact Precautions Use eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated. If tuberculosis is unlikely and there are no AIIRs and/or respirators available, use Droplet Precautions instead of Airborne Precautions. Tuberculosis more likely in HIV-infected individual than in HIV negative individual</td>
</tr>
<tr>
<td>Respiratory Infections</td>
<td>Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10–21 days) to countries with active outbreaks of SARS, avian influenza</td>
<td>M. tuberculosis, severe acute respiratory syndrome virus (SARS-CoV), avian influenza</td>
<td>Airborne plus Contact Precautions plus eye protection. If SARS and tuberculosis unlikely, use Droplet Precautions instead of Airborne Precautions.</td>
</tr>
<tr>
<td>Respiratory Infections</td>
<td>Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children</td>
<td>Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, Human metapneumovirus</td>
<td>Contact plus Droplet Precautions; Droplet Precautions may be discontinued when adenovirus and influenza have been ruled out</td>
</tr>
<tr>
<td>Skin or Wound Infection</td>
<td>Abscess or draining wound that cannot be covered</td>
<td>Staphylococcus aureus (MSSA or MRSA), group A streptococcus</td>
<td>Contact Precautions Add Droplet Precautions for the first 24 hours of appropriate antimicrobial therapy if invasive Group A streptococcal disease is suspected</td>
</tr>
</tbody>
</table>

* Infection control professionals should modify or adapt this table according to local conditions. To ensure that appropriate empiric precautions are implemented always, hospitals must have systems in place to evaluate patients routinely according to these criteria as part of their preadmission and admission care.

† Patients with the syndromes or conditions listed below may present with atypical signs or symptoms (e.g. neonates and adults with pertussis may not have paroxysmal or severe cough). The clinician’s index of suspicion should be guided by the prevalence of specific conditions in the community, as well as clinical judgment.

‡ The organisms listed under the column “Potential Pathogens” are not intended to represent the complete, or even most likely, diagnoses, but rather possible etiologic agents that require additional precautions beyond Standard Precautions until they can be ruled out.

§ These pathogens include enterohemorrhagic Escherichia coli O157:H7, Shigella spp, hepatitis A virus, noroviruses, rotavirus, C. difficile.

### Table 3A. Anthrax

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site(s) of Infection; Transmission Mode</strong></td>
<td>Cutaneous (contact with spores); Respiratory Tract: (inhalation of spores); Gastrointestinal Tract: (ingestion of spores - rare)</td>
</tr>
<tr>
<td>Cutaneous and inhalation disease have occurred in past bioterrorist incidents</td>
<td><strong>Comment</strong>: Spores can be inhaled into the lower respiratory tract. The infectious dose of <em>B. anthracis</em> in humans by any route is not precisely known. In primates, the LD50 (i.e., the dose required to kill 50% of animals) for an aerosol challenge with <em>B. anthracis</em> is estimated to be 8,000–50,000 spores; the infectious dose may be as low as 1-3 spores</td>
</tr>
<tr>
<td><strong>Incubation Period</strong></td>
<td><strong>Incubation Period Cutaneous</strong>: 1 to 12 days; <strong>Respiratory Tract</strong>: Usually 1 to 7 days but up to 43 days reported; <strong>Gastrointestinal Tract</strong>: 15-72 hours</td>
</tr>
<tr>
<td><strong>Clinical Features</strong></td>
<td>Cutaneous: Painless, reddish papule, which develops a central vesicle or bulla in 1-2 days; over next 3-7 days lesion becomes pustular, and then necrotic, with black eschar; extensive surrounding edema. <strong>Respiratory Tract</strong>: initial flu-like illness for 1-3 days with headache, fever, malaise, cough; by day 4 severe dyspnea and shock, and is usually fatal (85%-90% if untreated; meningitis in 50% of Respiratory Tract cases. <strong>Gastrointestinal Tract</strong>: if intestinal form, necrotic, ulcerated edematous lesions develop in intestines with fever, nausea and vomiting, progression to hematemesis and bloody diarrhea; 25-60% fatal</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Cutaneous: Swabs of lesion (under eschar) for immunohistochemistry, polymerase chain reaction and culture; punch biopsy for immunohistochemistry, polymerase chain reaction and culture; vesicular fluid aspirate for Gram stain and culture; blood culture if systemic symptoms; acute and convalescent sera for ELISA serology <strong>Respiratory Tract</strong>: Chest X-ray or CT scan demonstrating wide mediastinal widening and/or pleural effusion, hilar abnormalities; blood for culture and polymerase chain reaction; pleural effusion for culture, polymerase chain reaction and immunohistochemistry; cerebrospinal fluid if meningeal signs present for immunohistochemistry, polymerase chain reaction and culture; acute and convalescent sera for ELISA serology; pleural and/or bronchial biopsies immunohistochemistry. <strong>Gastrointestinal Tract</strong>: blood and ascites fluid, stool samples, rectal swabs, and swabs of oropharyngeal lesions if present for culture, polymerase chain reaction and immunohistochemistry.</td>
</tr>
<tr>
<td><strong>Infectivity</strong></td>
<td>Cutaneous: Person-to-person transmission from contact with lesion of untreated patient possible, but extremely rare. <strong>Respiratory Tract and Gastrointestinal Tract</strong>: Person-to-person transmission does not occur. <strong>Aerosolized powder, environmental exposures</strong>: Highly infectious if aerosolized</td>
</tr>
<tr>
<td><strong>Recommended Precautions</strong></td>
<td>Cutaneous: Standard Precautions; Contact Precautions if uncontained copious drainage. <strong>Respiratory Tract and Gastrointestinal Tract</strong>: Standard Precautions. <strong>Aerosolized powder, environmental exposures</strong>: Respirator (N95 mask or Powered Air Purifying Respirators), protective clothing; decontamination of persons with powder on them.(Notice to Readers: Occupational Health Guidelines for Remediation Workers at Bacillus anthracis-Contaminated Sites — United States, 2001–2002 (<a href="https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm">https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm</a> accessed September 2018). <strong>Hand hygiene</strong>: Handwashing for 30-60 seconds with soap and water or 2% chlorhexidine gluconate after spore contact (alcohol handrubs inactive against spores [Weber DJ JAMA 2003; 289:1274]). Postexposure prophylaxis following environmental exposure: 60 days of antimicrobials (either doxycycline, ciprofloxacin, or levofloxacin) and Postexposure vaccine under IND</td>
</tr>
</tbody>
</table>
### Table 3B. Botulism

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site(s) of Infection; Transmission Mode</strong></td>
<td><strong>Gastrointestinal Tract:</strong> Ingestion of toxin-containing food, <strong>Respiratory Tract:</strong> Inhalation of toxin containing aerosol cause disease. <strong>Comment:</strong> Toxin ingested or potentially delivered by aerosol in bioterrorist incidents. LD50 (lethal dose for 50% of experimental animals) for type A is 0.001 μg/ml/kg.</td>
</tr>
<tr>
<td><strong>Incubation Period</strong></td>
<td>1-5 days.</td>
</tr>
<tr>
<td><strong>Clinical Features</strong></td>
<td>Ptosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia followed by symmetrical descending paralysis and respiratory failure.</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Clinical diagnosis; identification of toxin in stool, serology unless toxin-containing material available for toxin neutralization bioassays.</td>
</tr>
<tr>
<td><strong>Infectivity</strong></td>
<td>Not transmitted from person to person. Exposure to toxin necessary for disease.</td>
</tr>
<tr>
<td><strong>Recommended Precautions</strong></td>
<td>Standard Precautions.</td>
</tr>
</tbody>
</table>

### Table 3C. Ebola Hemorrhagic Fever

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site(s) of Infection; Transmission Mode</strong></td>
<td>As a rule infection develops after exposure of mucous membranes or respiratory tract, or through broken skin or percutaneous injury.</td>
</tr>
<tr>
<td><strong>Incubation Period</strong></td>
<td>2-19 days, usually 5-10 days.</td>
</tr>
<tr>
<td><strong>Clinical Features</strong></td>
<td>Febrile illnesses with malaise, myalgias, headache, vomiting and diarrhea that are rapidly complicated by hypotension, shock, and hemorrhagic features. Massive hemorrhage in &lt; 50% pts.</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Etiologic diagnosis can be made using respiratory tract-polymerase chain reaction, serologic detection of antibody and antigen, pathologic assessment with immunohistochemistry and viral culture with EM confirmation of morphology.</td>
</tr>
<tr>
<td><strong>Infectivity</strong></td>
<td>Person-to-person transmission primarily occurs through unprotected contact with blood and body fluids; percutaneous injuries (e.g., needlestick) associated with a high rate of transmission; transmission in healthcare settings has been reported but is prevented by use of barrier precautions.</td>
</tr>
<tr>
<td><strong>Recommended Precautions</strong></td>
<td>Hemorrhagic fever specific barrier precautions: If disease is believed to be related to intentional release of a bioweapon, epidemiology of transmission is unpredictable pending observation of disease transmission. Until the nature of the pathogen is understood and its transmission pattern confirmed, Standard, Contact and Airborne Precautions should be used. Once the pathogen is characterized, if the epidemiology of transmission is consistent with natural disease, Droplet Precautions can be substituted for Airborne Precautions. Emphasize: 1. use of sharps safety devices and safe work practices, 2. hand hygiene; 3. barrier protection against blood and body fluids upon entry into room (single gloves and fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields); and 4. appropriate waste handling. Use N95 or higher respirators when performing aerosol-generating procedures. In settings where AIIRs are unavailable or the large numbers of patients cannot be accommodated by existing AIIRs, observe Droplet Precautions (plus Standard Precautions and Contact Precautions) and segregate patients from those not suspected of VHF infection. Limit blooddraws to those essential to care. See text for discussion and Appendix A for recommendations for naturally occurring VHFs.</td>
</tr>
</tbody>
</table>
### Table 3D. Plague

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site(s) of Infection;</strong></td>
<td><strong>Respiratory Tract:</strong> Inhalation of respiratory droplets.</td>
</tr>
<tr>
<td>Transmission Mode</td>
<td><strong>Comment:</strong> Pneumonic plague most likely to occur if used as a biological weapon, but some cases of bubonic and primary septicemia may also occur. Infective dose 100 to 500 bacteria.</td>
</tr>
<tr>
<td><strong>Incubation Period</strong></td>
<td>1 to 6, usually 2 to 3 days.</td>
</tr>
<tr>
<td><strong>Clinical Features</strong></td>
<td>Pneumonic: fever, chills, headache, cough, dyspnea, rapid progression of weakness, and in a later stage hemoptysis, circulatory collapse, and bleeding diathesis.</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Presumptive diagnosis from Gram stain or Wayson stain of sputum, blood, or lymph node aspirate; definitive diagnosis from cultures of same material, or paired acute/convalescent serology.</td>
</tr>
<tr>
<td><strong>Infectivity</strong></td>
<td>Person-to-person transmission occurs via respiratory droplets risk of transmission is low during first 20-24 hours of illness and requires close contact. Respiratory secretions probably are not infectious within a few hours after initiation of appropriate therapy.</td>
</tr>
<tr>
<td><strong>Recommended Precautions</strong></td>
<td>Standard Precautions, Droplet Precautions until patients have received 48 hours of appropriate therapy. Chemoprophylaxis: Consider antibiotic prophylaxis for HCWs with close contact exposure.</td>
</tr>
</tbody>
</table>

### Table 3E. Smallpox

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site(s) of Infection;</strong></td>
<td><strong>Respiratory Tract Inhalation</strong> of droplet or, rarely, aerosols; and skin lesions (contact with virus).</td>
</tr>
<tr>
<td>Transmission Mode</td>
<td><strong>Comment:</strong> If used as a biological weapon, natural disease, which has not occurred since 1977, will likely result.</td>
</tr>
<tr>
<td><strong>Incubation Period</strong></td>
<td>7 to 19 days (mean 12 days).</td>
</tr>
<tr>
<td><strong>Clinical Features</strong></td>
<td>Fever, malaise, backache, headache, and often vomiting for 2-3 days; then generalized papular or maculopapular rash (more on face and extremities), which becomes vesicular (on day 4 or 5) and then pustular; lesions all in same stage.</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Electron microscopy of vesicular fluid or culture of vesicular fluid by WHO approved laboratory (CDC); detection by polymerase chain reaction available only in select LRN labs, CDC and USAMRID.</td>
</tr>
<tr>
<td><strong>Infectivity</strong></td>
<td>Secondary attack rates up to 50% in unvaccinated persons; infected persons may transmit disease from time rash appears until all lesions have crusted over (about 3 weeks); greatest infectivity during first 10 days of rash.</td>
</tr>
<tr>
<td><strong>Recommended Precautions</strong></td>
<td>Combined use of Standard, Contact, and Airborne Precautions until all scabs have separated (3-4 weeks). Transmission by the airborne route is a rare event; Airborne Precautions is recommended when possible, but in the event of mass exposures, barrier precautions and containment within a designated area are most important. Only immune HCWs to care for pts; Postexposure vaccine within 4 days. <strong>Vaccinia:</strong> HCWs cover vaccination site with gauze and semi-permeable dressing until scab separates (≥21 days). Observe hand hygiene. <strong>Adverse events with virus-containing lesions:</strong> Standard plus Contact Precautions until all lesions crusted. Vaccinia adverse events with lesions containing infectious virus include inadvertent autoinoculation, ocular lesions (blepharitis, conjunctivitis), generalized vaccinia, progressive vaccinia, eczema vaccinatum; bacterial superinfection also requires addition of contact precautions if exudates cannot be contained.</td>
</tr>
</tbody>
</table>
Infectivity Person-to-person spread is rare. Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed.

Clinical Features
Pneumonic: malaise, cough, sputum production, dyspnea; Typhoidal: fever, prostration, weight loss and frequently an associated pneumonia.

Diagnosis
Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by polymerase chain reaction (LRN) or isolated from blood and other body fluids on cysteine-enriched media or mouse inoculation.

Infectivity
Infectivity Person-to-person spread is rare. Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed.

Recommended Precautions
Standard Precautions.

Table 3F. Tularemia

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site(s) of Infection; Transmission Mode</td>
<td><strong>Respiratory Tract:</strong> Inhalation of aerosolized bacteria.</td>
</tr>
<tr>
<td></td>
<td><strong>Gastrointestinal Tract:</strong> Ingestion of food or drink contaminated with aerosolized bacteria.</td>
</tr>
<tr>
<td></td>
<td><strong>Comment:</strong> Pneumonic or typhoidal disease likely to occur after bioterrorist event using aerosol delivery. Infective dose 10-50 bacteria.</td>
</tr>
<tr>
<td>Incubation Period</td>
<td>2 to 10 days, usually 3 to 5 days.</td>
</tr>
<tr>
<td>Clinical Features</td>
<td>Pneumonic: malaise, cough, sputum production, dyspnea; Typhoidal: fever, prostration, weight loss and frequently an associated pneumonia.</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by polymerase chain reaction (LRN) or isolated from blood and other body fluids on cysteine-enriched media or mouse inoculation.</td>
</tr>
<tr>
<td>Infectivity</td>
<td>Infectivity Person-to-person spread is rare. Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed.</td>
</tr>
<tr>
<td>Recommended Precautions</td>
<td>Standard Precautions.</td>
</tr>
</tbody>
</table>

Antibiotic Stewardship

Each year in the U.S., at least 2.8 million people are infected with antibiotic-resistant organisms and more than 35,000 people die as a result. Antibiotic resistance is one of the world’s most critical problems because it affects so many people and so many aspects of life and healthcare from patients undergoing treatment in hospitals, to animals being raised in agriculture, to daily veterinary medicine. Good antibiotics that function to properly kill pathogens are crucial for patients receiving dialysis, cancer treatment, organ transplantation, surgeries, sepsis treatment, and patients being treated for chronic conditions. Conversely, misuse of antibiotics can expose patients to potential adverse effects and can even affect the health of persons who have not even used antibiotics through the spread of resistant organisms, such as MRSA and C. difficile. For C. difficile in 2017, there were 223,900 cases and at least 12,800 deaths.

In 2014, the CDC released *The Core Elements of Hospital Antibiotic Stewardship Programs* (known as Core Elements) to help all U.S. hospitals begin antibiotic stewardship programs in their facilities. Antibiotic Stewardship refers to a set of commitments and activities designed to “optimize the treatment of infections while reducing the adverse events associated with antibiotic uses.” The Core Elements are the basis for antibiotic stewardship accreditation standards from the Joint Commission and DNV GL. In 2015, The United States National Action Plan for Combating Antibiotic Resistant Bacteria, a five year action plan, was set forth by the White House to make implementation of the Core Elements a part of all hospitals that receive federal funding. A second National Action Plan is expected in the latter half of 2020.

An antibiotic stewardship program requires flexibility due to the complex nature of prescribing antibiotics and medical decision-making on each case-by-case basis. There is no single program template that fits all. Goals of antibiotic stewardship programs include:

- Improving clinical outcomes
- Improving antibiotic prescribing and thus minimizing harm to patients
- Increasing infection cure rates
- Reducing treatment failures
- Reducing adverse effects
- Reducing antibiotic resistance
- Reducing hospital costs and length of stay
- Reducing resistant infections such as *C. difficile*

In both hospitals and nursing homes, antibiotic stewardship is composed of 7 Core Elements:

1. **Leadership commitment.** Leaders commit to improving antibiotic use.
2. **Accountability.** Identify individuals accountable for antibiotic stewardship who have the support of faculty leadership.
3. **Drug Expertise.** Establish access to individuals with antibiotic expertise to implement antibiotic stewardship activities. Receive support from infectious disease consultants and consultant pharmacists with training in antibiotic stewardship.
4. **Action.** Implement prescribing policies and change practices to improve antibiotic use.
5. **Tracking.** Monitor both antibiotic use practices and outcomes related to antibiotics in order to guide practice changes and track the impact of new interventions. Track how and why antibiotics are prescribed, and track how often and how many antibiotics are prescribed.
6. **Reporting.** Share data on adherence with clinicians and nurses to maintain awareness about the progress being made.
made in antibiotic stewardship. Gather feedback for use regarding potential changes in prescribing behaviors.

7. Education. Provide antibiotic stewardship education to clinicians, nursing staff, residents, and families.

Specific Infections

Oral Fecal Infections

Hepatitis A

Hepatitis A (HAV) is transmitted primarily via the fecal-oral route, by consumption of contaminated food or water, and by close person-to-person contact with an infected person. It is not a bloodborne infection. Those considered at increased risk for HAV include those with occupational risk for exposure, people experiencing homelessness, international travelers, men who have sex with men, those who have close contact with an infected international adoptee, users of non-injection illegal drugs.

Symptoms of HAV infection include fatigue, decreased appetite, nausea, stomach pain, diarrhea, malaise, dark urine, clay-colored stools, joint pain, and jaundice. The average incubation period is 28 days with a range of 15-50 days. The disease is self-limited, usually resolves in about 2 months, and chronic infection does not occur. Seventy percent of children under the age of six do not show symptoms, and if symptoms are present, they do not have jaundice. Antibodies produced as a result of infection will result in lifetime immunity.

The hepatitis A vaccine was first made available in 1995, and vaccination of the public greatly reduced rates of infection. Data from the CDC has shown that outbreaks have been linked to imported food, or have occurred among non-immune persons. In 2017, large outbreaks were linked to persons using drugs and persons who were homeless. Data from the CDC in 2017 showed 3,366 cases of HAV in the U.S. were reported, but about 6,700 cases was more likely the total number of cases due to underreporting.

HAV can survive outside of the body for months. In contaminated food, it is not deactivated by freezing, but rather by heating above 185°F (85°C) for one minute.

Standard Precautions are recommended for HAV, with added Contact Precautions when working with diaphoretic or incontinent patients. When working with infants or children under 3 years of age, contact precautions should be used through duration of hospitalization; when working with children 3-14 years of age, maintain Contact Precautions for 2 weeks after onset of symptoms; when working with patients greater than 14 years of age, maintain Contact Precautions for 1 week after onset of symptoms.

Hepatitis E

Hepatitis E virus (HEV) is another viral hepatitis that is transmitted by ingestion of fecal matter, even if only ingested in microscopic amounts. Although rarely found in the U.S., it is common in other parts of the world, primarily where there is poor sanitation and water supplies have become contaminated. Recent outbreaks have occurred in South Asia and Africa. In the U.S., most cases of HEV have originated from travel to a country where HEV is endemic, or from the consumption of uncooked or undercooked pork, venison, or boar meat.

Symptoms of HEV include nausea, vomiting, abdominal pain, loss of appetite, fever, fatigue, joint pain, dark urine, clay-colored stools, and jaundice. Symptom onset can occur between 15-60 days post-exposure, with an average of 40 days. Most people recover completely from illness. Pregnant women are at a greater risk for severe illness, and mortality rates can reach 10-30% in women who are in the third trimester of pregnancy. Persons with pre-existing liver disease and persons who have had an organ transplant and are on immunosuppressive therapy are at great risk for liver disease or death with HEV infection.

Patients with symptoms of viral hepatitis that have tested negative for hepatitis A, hepatitis B, and hepatitis C should be tested for HEV. Serologic and nucleic acid tests for HEV have not been approved by the FDA for use in the U.S., but tests from other countries are commercially available and used in certain labs, and also used for research.

Treatment for HEV is supportive therapy including good nutrition, adequate rest and fluid intake, and avoidance of medications that can cause liver damage such as acetaminophen. There is no antiviral therapy for acute HEV infection. A recombinant vaccine is approved for use in China, but no vaccine has been approved by the FDA for use in the United States. Immune globulin does not prevent infection with hepatitis E. HEV infection can be prevented by not drinking unpurified water in developing countries, and by not eating uncooked or undercooked pork, venison, or boar meat.

Standard Precautions are recommended for HEV, with added Contact Precautions when working with diaphoretic or incontinent patients to be continued for the duration of illness.

Noroviruses

Noroviruses are highly contagious capsid-enclosed RNA viruses that cause acute gastrointestinal illness. Although sometimes referred to as the “stomach flu,” the “stomach bug,” or the “cruise ship virus,” norovirus is not related to the influenza virus and it affects only a small portion of cruise ship passengers.

According to the CDC, between 2008-2014, 74 million passengers sailed on cruise ships and of those 129,678 became ill with an acute gastrointestinal illness. Of those cases, 1 in 10 were part of a norovirus outbreak. Norovirus is spread by direct contact from infected persons, by consuming contaminated food or water, and by contact with contaminated surfaces. An infected person can shed billions of viral particles, but only a few viral particles are necessary for infection to occur. Previous infection can confer some degree of immunity, but it is unknown how long lasting that immunity will be. There are many types of norovirus, and they are highly prone to mutation, thereby creating the potential for a person to become infected many times during their life.

Symptoms of norovirus infection include fever, nausea, vomiting, diarrhea, stomach pain, headache, and body aches. Dehydration can occur due to fluid loss from vomiting and diarrhea. Symptoms develop 12-48 hours post exposure, and symptoms can resolve in 1-3 days. After symptoms have resolved, infected persons can continue to spread norovirus for two weeks or more.

Norovirus is the leading cause of illness and outbreaks from contaminated food in the US. A few particles can create infection.

You can spread norovirus for two weeks or more after symptoms have resolved.

Standard Precautions with added Contact Precautions are recommended for working with cases of norovirus. Contact Precautions should be used for a minimum of 48 hours post resolution of illness to control further outbreaks. Masks are recommended for cleaning areas contaminated with feces and vomitus because the viruses can be aerosolized from these body substances. Sodium hypochlorite solutions (chlorine bleach) with concentrations of 1000 to 5000 ppm (5 to 25 tablespoons of household bleach, or 5-8%, per gallon of water) should be used to break transmission; alcohol is unable to break through the capsid enclosure of the virus. Disinfectants registered by the EPA as effective against norovirus are also recommended. Meticulous handwashing is essential. Since the viruses can also withstand temperatures as high as 145°F, laundry, clothing, and dishes that are not washed in very hot water will still have infectious viral particles. During outbreaks, infected patients should be cohorted to separate airspaces and separate bathrooms and toilets to help break transmission.
### Hepatitis B

Hepatitis B (HBV), formerly known as serum hepatitis, is more contagious and more deadly than HIV. Hepatitis B is a widespread inflammatory condition of the liver usually manifested by jaundice and often, liver enlargement. Other signs and symptoms include fever, fatigue, vague abdominal pain, loss of appetite, intermittent nausea and vomiting, dark urine, clay-colored stools, and joint pain. Symptoms usually begin an average of 90 days after exposure, with a range of 60-150 days post-exposure. HBV infection can become chronic, with patients showing elevated levels of AST/ALT, cirrhosis, and potential hepato-cellular carcinoma.

Although the rate of acute hepatitis B cases in the U.S. has remained stable over the past decade, based on statistics reported to the CDC, the CDC estimates 22,200 new cases of acute hepatitis B in the U.S. in 2017. CDC estimates that 862,000 people in the U.S. are living with chronic HBV. Chronic hepatitis B infection is found primarily among persons born outside the U.S. where HBV is prevalent at intermediate or high rates. Chronic infection is under diagnosed because it can go for many years without signs or symptoms, during which time it causes damage to the liver and other organs. Chronic HBV infection cannot be cured, but it can be managed clinically with antiviral medications and close monitoring. Up to 40% of infected people do not know how or when they were exposed to the virus.

Hepatitis B is transmitted by sexual exposure, perinatal exposure, occupational contact with infected blood and body fluids, sharing contaminated items, and unregulated tattooing. Injection drug use remains a major risk factor for transmission of acute hepatitis B infection. The virus can live up to two weeks on inadequately cleaned environmental surfaces, therefore transmission is possible from objects such as razors, toothbrushes, ear-piercing needles and other items contaminated by blood or infectious body fluids. Standard Precautions are used when working with patients infected with HBV.

Vaccination against hepatitis B is a safe and effective method to prevent infection. The HBV vaccine has been available since 1981. The CDC recommends that the following persons should be vaccinated against hepatitis B:
- All infants
- Unvaccinated children aged <19 years
- Persons at risk for infection by sexual exposure
  - Sex partners of hepatitis B surface antigen (HBsAg)-positive persons
  - Sexually active persons who are not in a long-term, mutually monogamous relationship (such as persons with more than 1 sex partner during the previous 6 months)
- Persons seeking evaluation or treatment for a sexually transmitted infection
- Men who have sex with men
- Persons at risk for infection by percutaneous or mucosal exposure to blood
- Current or recent injection drug users
- Household contacts of HBsAg-positive persons
- Residents and staff of facilities for developmentally disabled persons
- Persons with diabetes aged 19-59 years, persons with diabetes aged ≥ 60 years at the discretion of the treating clinician
- Others
  - International travelers to countries with high or intermediate levels of endemic HBV infection (HBsAg prevalence of ≥ 2%)
  - Persons with HCV infection
  - Persons with chronic liver disease (including, but not limited to, persons with cirrhosis, fatty liver disease, alcoholic liver disease, autoimmune hepatitis, and an alanine aminotransferase [ALT] or aspartate aminotransferase [AST] level greater than twice the upper limit of normal)
  - Persons with HIV infection
  - Incarcerated persons
  - All other persons seeking protection from HBV infection

In addition to the hepatitis B vaccine, hepatitis B immune globulin (HBIG) is available to provide temporary passive protection following a documented HBV exposure in an unvaccinated person within 24 hours of exposure. HBIG is a preparation of immunoglobulin containing high levels of HBV antibody. When given as a combination treatment with the hepatitis B vaccine, it is over 90% effective in preventing the disease.

The aforementioned National Clinician Consultation Center that offers post-exposure consultation from 11:00 am to 8:00 pm EST at (888) 448-4911 also has the PEP Quick Guide for Occupational Exposures can be found at: https://nccc.ucsf.edu/clinical-resources/pep-resources/pep-quick-guide-for-occupational-exposures/

### Hepatitis C

Hepatitis C (HCV), formerly known as hepatitis Non A-Non B (NANB), is the most common chronic bloodborne infection and the most common type of viral hepatitis in the United States. Most people with hepatitis C are chronically infected but are not aware they are infected because they have no outward symptoms. HCV infection is on the rise in the United States at an alarming rate, and it is estimated that 4 in 10 people do not know they are infected. The highest rates of new infections are currently found in younger adults ages 20-39, as shown in the chart below. The CDC has now recommended that every adult be tested at least once for HCV, that pregnant women be tested during every pregnancy, and that persons with ongoing risk factors be tested regularly.

Symptoms of clinical illness with HCV are similar to other types of hepatitis. Patients may present with jaundice and flu-like symptoms, fatigue, joint pain, vague abdominal pain, loss of appetite, dark urine, clay-colored stools, and intermittent nausea and vomiting. Symptoms may begin from 2-12 weeks after exposure, with a range of 2-26 weeks. For unknown reasons, about 15%-25% of people with HCV can clear the virus from their bodies without treatment and do not develop chronic infection. Conversely, 75%-85% of infected persons will become chronically infected. Prior infection with HCV does not confer immunity against later infection with the same or different genotype of the virus.

In 2017, the CDC estimated that there were 44,700 cases of acute HCV in the U.S. Currently in the United States, there are an estimated 2.4 million people living with chronic HCV infection. Drugs to cure hepatitis C have been available since 2013. After undergoing 8-12 weeks of oral therapy, approximately 90% of patients can be cured of HCV infection, regardless of the infecting genotype.

Hepatitis C is transmitted in the same manner as hepatitis B, although sexual contact is a less likely method of transmission. Most people who are infected with HCV today have acquired it from behaviors associated with injection drug use. Screening blood, organ and tissue donors, counseling to reduce and/or modify high-risk practices, and compliance with the procedures outlined in Standard Precautions will offer the best protection against hepatitis C. There is no vaccine available for the hepatitis C virus, but research is currently being done to find a vaccine. There is no post-exposure prophylaxis for exposure to HCV available or approved.

### Hepatitis D

Hepatitis D infection (HDV), also known as “delta hepatitis,” can be acquired either as a
co-infection with HBV or as a superinfection of persons with chronic HBV infection. HDV only occurs in persons infected with HBV because it is an incomplete RNA virus that requires HBV to replicate, and for this reason, it is known as a "satellite" virus. The modes of HDV transmission are similar to those for HBV, with percutaneous or mucosal exposure with infectious blood being the primary routes of transmission. Sexual transmission of HDV is less efficient than for HBV; perinatal HDV transmission is rare. Clinical symptoms of HDV are not distinguishable from other types of viral hepatitis and diagnosis can only be confirmed by serologic testing. Persons with who are positive for HBV surface antigen (HBsAg) and are experiencing severe symptoms or acute exacerbations should be tested for HDV. Standard Precautions are used when working with patients who are HBV-HDV positive.

Since HDV is not a nationally notifiable condition, the number of cases in the U.S. is not known. HDV is not common in the U.S.

It is most common in Southern and Eastern Europe, the Mediterranean region, Central and Western Africa, the Middle East, Eastern Asia, and the Amazon Basin.

Persons with HBV-HDV co-infection may have more severe acute disease and a higher risk of fulminant hepatitis (2%-20%) compared with those infected with HBV alone. However, chronic HBV infection appears to occur less frequently in persons with HBV-HDV co-infection. Chronic HBV carriers who acquire HDV superinfection usually develop chronic HDV infection. In long-term studies of chronic HBV carriers with HDV superinfection, 70%-80% have developed evidence of chronic liver diseases with cirrhosis because HDV accelerates the progression of chronic HBV. In comparison, 15%-30% of patients with chronic HBV infection alone have gone on to develop chronic liver disease. Because HDV is dependent on HBV for replication, HBV-HDV co-infection can be prevented with either pre- or post-exposure prophylaxis for HBV. Prevention of HDV superinfection depends primarily on education to reduce risk behaviors. There is no vaccine for hepatitis D.

### Human Immunodeficiency Virus (HIV) Infection

Human Immunodeficiency Virus (HIV) is the virus responsible for acquired immunodeficiency syndrome (AIDS). The virus was first identified in 1981, and is likely to have been in the US since the middle to late 1970s. It is believed the virus originated in Central Africa in chimpanzees that were infected with simian immunodeficiency virus (SIV). It is theorized that when humans hunted the chimpanzees for meat, SIV was transmitted to humans and mutated into HIV in the late 1800s.

According to the CDC, 37,832 people in the United States and its dependent areas were diagnosed with HIV in 2018. Of those diagnosed, 69% were among gay, bisexual, and other men who have sex with men, 24% were among heterosexuals, and 7% were among people who inject drugs (PWID). It is estimated that at the end of 2018, 1.2 million people in the US were living with HIV.

Fortunately, persons with HIV who take HIV antiretroviral therapy (ART) medications as prescribed and stay virally suppressed can remain healthy and can become severely damaged. There are 3 stages of clinical infection with the HIV virus:

**Stage 1: Acute HIV infection.** The acute stage of infection can begin within 2-4 weeks after initial exposure to the virus. Sexual exposure, perinatal exposure, and occupational contact with infected blood and body fluids all transmit HIV. Patients may experience a flu-like illness that can last several weeks. Body rash and lymphadenopathy can also be present. Positive confirmation of HIV infection can only be determined by either an antigen/antibody test or a nucleic acid test (NAT). During this time, patients are highly contagious.

**Stage 2: Clinical latency (asymptomatic HIV infection or chronic HIV infection).** Infected persons may be without physical symptoms for years or months before clinical symptoms begin. During this time, viral replication proceeds at very low levels. Areas of HIV infected cells become established in the lymph nodes, gut, and spleen. Patients who do not take medication to treat their HIV infection during this stage may remain in this stage for a decade or longer, but may progress to stage 3 more quickly. It is the goal of ART to keep patients at an undetectable viral load and remain at this stage in a virally suppressed state. In doing so, patients can have effectively no risk of transmitting HIV to their partners through sex. If a patient’s viral load goes up, CD4 levels will decrease and symptoms of
Stage 3: Acquired immune deficiency syndrome AIDS. An AIDS diagnosis is made when CD4 cell counts fall below 200 cells/ml of blood. Symptoms of AIDS include fever, chills, sweats, lymphadenopathy, anorexia, weight loss, chronic diarrhea, fatigue, joint, muscle and bone pain, and weakness. Opportunistic infections such as pneumocystis pneumonia and candidiasis may also be present. The severity of HIV-related opportunistic infections is generally related to the degree of immune dysfunction. Without medications to slow viral replication, patients survive only about 3 years on average in this stage. Persons with poorly controlled HIV or AIDS are considered to be at greater risk for severe illness with COVID-19 and should strictly follow CDC guidelines for social distancing, handwashing, and disinfection.

The CDC recommends pre-exposure prophylaxis (PrEP) to persons at risk from getting HIV through sex or injection drug use. Medications such as Truvada® (emtricitabine 200 mg tenofovir disoproxil fumarate 300 mg) and Descovy® (emtricitabine 200 mg and tenofovir alafenamide 25 mg) have been approved by the FDA for daily use and must be taken consistently to be effective.

The primary method of preventing occupational exposure to HIV is to follow Standard infection control practices. Safety devices have also been developed to help prevent needle-stick injuries if used properly. Further strategies are continually being developed to reduce the risk of injury associated with sharps disposal. Although the most important approach toward reducing the risk of occupational exposure to HIV transmission is to prevent occupational exposures altogether, plans for post exposure management for healthcare workers should be in place at every healthcare facility. The CDC has issued guidelines for the management of these exposures to HIV and recommendations for Post-Exposure Prophylaxis (PEP). All healthcare employees should be trained and familiar with policies for PEP at their facility.

Transmission of HIV through occupational exposure is very rare. If a healthcare worker has a possible exposure, they should immediately be seen by a physician familiar with PEP or go to an emergency room. PEP must be started within 72 hours post exposure, the sooner the better, because EVERY hour counts.

Ebola Virus Disease (EVD)

Ebola Virus Disease (EVD), previously known as Ebola hemorrhagic fever, is an acute viral zoonotic illness that can be fatal if left untreated. EVD affects humans and non-human primates including chimpanzees, gorillas, and monkeys.

The Ebola virus initially appeared in 1976 during two simultaneous outbreaks in the Democratic Republic of Congo (DRC), formerly Zaire, and approximately 500 miles away in what is now the area of South Sudan. The outbreak in the Congo occurred in a village near the Ebola River, from which the disease takes its name. It was later discovered that these two separate outbreaks were caused by two genetically distinct viruses: Ebola virus (Zaire ebolavirus), and Sudan virus (Sudan ebolavirus). Although research has shown that three types of African fruit bats are a natural host of Ebola virus, the zoonotic source has not been discovered. Scientists continue to study the fruit bat to find conclusive evidence as to their role in the transmission of EVD.

EVD has previously occurred as a series of outbreaks in the Sub-Saharan regions of Africa. The most extensive recent outbreak occurred from 2014 to 2016. This outbreak affected Sierra Leone, Liberia, Nigeria, and Guinea; however, confirmed cases have been identified in other parts of the world including the U.S. The World Health Organization (WHO) has reported that about 28,000 people were infected and 11,000 deaths occurred with that outbreak. During the recent 10th Ebola outbreak in the DRC from August 1, 2018 to June 25, 2020, the WHO reported a total of 3,470 cases of EVD with a total of 2,287 deaths and 1,171 survivors. Although the 10th outbreak was officially declared to be over, on June 1, 2020 an 11th outbreak was declared after 7 cases of Ebola were reported in Mbandaka city and the neighboring Bikoro Health Zone in the Equateur Province.

Symptoms of EVD begin 8-12 days after exposure to the virus and have an abrupt onset that can include fever, severe headache, weakness, chills and malaise. After about 5 days, gastrointestinal symptoms develop such as nausea, vomiting, diarrhea, and abdominal pain. Other symptoms reported include chest pain, shortness of breath, confusion, hiccups, seizures, conjunctival infection, and muscle pain. Advanced stages may progress to severe bleeding, coma, organ failure, and ultimately death. If death occurs from EVD, it is usually due to low blood pressure from fluid loss. The virus lives in animal hosts, and humans can
contract it from infected animals. After initial transmission, the virus is spread from person to person. EVD is spread by direct contact with blood, secretions, or other bodily fluids from an infected person and from contact with contaminated surfaces. It is also spread through sexual contact. The virus enters the body through the nose, mouth, or eyes, and through breaks in the skin.

**Diagnosis and Treatment of Ebola Virus Disease**

During the early phase of infection, it is often difficult to distinguish the EVD from other infectious diseases such as malaria, meningitis, or typhoid fever. Clinicians generally rely on a series of examinations to confirm diagnosis. These include complete blood count (CBC) with differential, liver enzymes, bilirubin, creatinine, and blood urea nitrogen (BUN) tests, tissue cultures, reverse-transcription polymerase chain reaction assay, enzyme-linked immunosorbent assay (ELISA), and electron microscopy examinations.

Currently, there is no anti-viral drug that is licensed or approved by the FDA for treatment of EVD. Investigational treatments in clinical trials have shown that patients who receive either REGN-EB3 (a three monoclonal antibody cocktail that is indicated for use in all patients), or mAb-114 (a monoclonal antibody that flags Zaire ebolavirus for action by the immune system that is indicated for use in adults and children who are at the early stages of infection symptoms) have a greater chance of survival than patients receiving other available treatments.

Survival rates for persons infected with EVD may be greatly improved through early supportive care. This includes hydration with oral fluids if tolerated or large volumes of intravenous fluids, oxygen therapy, treatment of concomitant infections, and medications administered for support of blood pressure, reduction of vomiting and diarrhea, and pain management. Blood products such as platelets or frozen plasma may also be used to assist with blood loss. For many patients especially those with evidence of septic shock, the addition of broad-spectrum antimicrobials is also recommended.

**Prevention of Ebola**

In December 2019, the FDA approved the rVSV-ZEBOV vaccine (trade name Ervebo®) for prevention of Ebola virus. This single dose vaccine is only effective against the Zaire ebolavirus species of EVD. This dual component vaccine is not approved by the FDA for current use.

Ebola is classified as a Category A agent of bioterrorism. Proper infection prevention technique is vital in controlling outbreaks of EVD. For this reason, any healthcare workers who are caring for Ebola patients must have received comprehensive training and must demonstrate competency in performing infection control practices and procedures for EVD. Droplet + Contact + Standard Precautions are recommended for the entire duration of illness. Recommended infection control measures include the use of sterilizing equipment, barrier isolation, and protective clothing including gloves, gowns, and masks. PPE that covers the clothing and skin and completely protects the mucous membranes is absolutely required. Use of N95 or higher respirators are recommended when performing any aerosol generating procedures. A trained observer must supervise every step of PPE donning and doffing to ensure that strict PPE protocol is enforced. An onsite nurse must at all times supervise any healthcare workers caring for patients known or suspected EVD. Direct contact with the body of an Ebola patient should also be avoided.

Quarantining infected patients can decrease the spread of the disease, and contact tracing plays a role in helping to isolate the disease.

**Contact tracing** involves locating anyone who may have had close contact with the infected individual and then observing them for signs of illness for at least 21 days. If any of these contacts contract the disease, they should then be isolated, tested, and treated.

The use of the Go.Data smartphone app, developed by the Global Outbreak Alert and Response Network (GOARN) in conjunction with the WHO, is being used to speed detection of Ebola in hotspots of the DRC. The app enables field data collection such as symptoms of contacts, as well as contact tracing, and visualization of chains of transmission. Epidemiologists are able to access data in near real time, enabling prompt action in cases where Ebola cases are identified.

In 2014, the CDC issued an advisory to all healthcare workers concerning EVD. The advisory recommended that Ebola should be considered for any patient who shows symptoms of fever, severe headache, abdominal pain, vomiting, diarrhea, or unexplained bleeding. For these patients, inquiries should be made as to whether they traveled to an Ebola-affected country within the past 21 days.

Patients who have traveled to an Ebola-affected country and are symptomatic should be isolated in a private room. Any patients under investigation (PUI) and patients with confirmed EVD must be isolated. All body fluids, such as blood, urine, saliva, stool, vomit, and sweat are considered infectious and should be handled with strict Standard, Contact and Droplet Precautions. It is also important to note that the WHO has stated that Ebola virus can persist in some body fluids (including semen) of survivors for several months, and in rare cases could potentially trigger secondary transmission or relapse.

- **Disposal medical equipment should be used whenever possible, and if possible only dedicated equipment should be used for patient care.**
- **If equipment is not dedicated and not disposable, it should be cleaned according to manufacturer’s instructions and hospital policy.**
- **Use of needles and sharps should be limited as much as possible and handled with extreme care.**
- **Hand hygiene should be performed before and after patient contact, contact with infectious material, and before putting on and after removing PPE, including gloves.**
- **Any healthcare worker with percutaneous or mucocutaneous exposure to blood, body fluids, or secretions of a PUI should immediately wash skin surfaces with soap and water or irrigate mucous membranes or eyes with copious amounts of water or eye wash and immediately notify a supervisor for post-exposure management.**

Key infection control precautions as recommended by the CDC for preventing Ebola transmission in U.S. hospitals can be found at [https://www.cdc.gov/vhf/ebola/clinicians/evd/infection-control.html](https://www.cdc.gov/vhf/ebola/clinicians/evd/infection-control.html)

**Environmental Disinfection of Ebola Virus**

One laboratory study has shown that under favorable conditions, Ebola can remain viable on solid surfaces for up to 6 days. In an African hospital study, however, evidence of the virus was only obtained (via nucleic acid amplification) from objects that were blood stained, but the virus could not be cultured for live infectious virus. According to the CDC, at this time, there is no evidence that Ebola virus can be transmitted from either the environment or fomites that could become contaminated during patient care such as doorknobs, bedrails, and laundry. However, out of an abundance of precaution due to high virus titers in blood, disease severity, etc., higher levels of precaution are warranted to reduce any potential risk. The CDC recommends the use of a U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant with a label claim for NON-ENVELOPED virus (such as norovirus, rotavirus, and poliovirus) for environmental disinfection of Ebola. Al-
though Ebola is an enveloped virus, selection of the higher potency disinfectant with labeling for non-enveloped virus is recommended at this time. For more specific instructions on environmental cleaning and disinfection of Ebola, please see the CDC website.

**Respiratory Infections**

**COVID-19 Coronavirus**

Coronavirus Disease 2019 or COVID-19 was first named on February 11, 2020 by the WHO (CO for Corona, VI for virus, D for disease, 19 for 2019). COVID-19 is the disease. The virus responsible for the disease is the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This virus was first identified in Wuhan China and was reported to the WHO Country Office in China on December 31, 2019 as a "pneumonia of unknown cause."

By January 30, 2020, the WHO declared the outbreak as a "Public Health Emergency of International Concern." Then on March 11, 2020, the WHO officially declared the novel coronavirus COVID-19 outbreak to be a global pandemic. This was the first pandemic ever to be caused by a coronavirus. A pandemic is defined by the CDC as "an epidemic that has spread over several counties or continents, usually affecting a large number of people."

Coronaviruses are a family of single-stranded RNA viruses with crown-like spikes on their surface that can infect humans, pigs, cats, cattle, minks, camels, and bats. COVID-19 is also known to infect dogs, and large cats such as tigers, and lions. Viruses are generally species specific, but these viruses are highly capable of mutating, which accounts for their ability to infect different species of animals and humans. Other human coronaviruses include SARS-CoV responsible for Severe Acute Respiratory Syndrome (SARS) and MERS-CoV responsible for Middle East Respiratory Syndrome (MERS).

COVID-19 is primarily spread through respiratory droplets and aerosols, and more easily spread through close contact. Current evidence suggests it spreads through direct contact and indirect contact (with contaminated surfaces). At the time of this writing, there is no evidence of transmission of the virus to humans directly through food (either handling food or consuming food), and the virus has not been found in drinking water. The risk of the virus spreading through food packaging, shopping bags, postal packaging, or domestic or international mail is considered to be very low. At the time of this writing, there is also no evidence of the virus spreading from workers who have been ill with COVID-19 to consumers through the food or packaging that those workers may have handled.

Incubation time for COVID-19 is 2 to 14 days. Symptoms vary over the course of the disease and can range from patients being asymptomatic to having life threatening pneumonia. When present, symptoms can include fatigue, fever, chills, shaking with chills, cough, shortness of breath or difficulty breathing, headache, sore throat, muscle pain or body aches, loss of smell or taste, runny nose, nausea and diarrhea. Patients should seek immediate medical attention if they experience trouble breathing, persistent chest pain or pressure, bluish lips or face, confusion, inability to arouse, or any other symptom that is severe or concerning. Most persons recover from the virus within two weeks if they have had a mild case, or in 5 weeks or more if they have had a more severe or critical case. It is unknown if illness will confer any significant degree of lasting immunity.

Persons at greatest risk for severe illness include people aged 65 and older and anyone with serious underlying medical conditions such as moderate to severe asthma, chronic kidney disease, COPD, diabetes, hemoglobin disorders, immunocompromised individuals, liver disease, nursing or long-term care residents, serious heart conditions, and severe obesity. Statistics have shown that adults comprise most of the cases of COVID-19, and children are less likely to show symptoms or to have severe symptoms.

A condition known as Multisystem Inflammatory Syndrome in Children (MIS-C), however, has been associated with children who have had the virus themselves or were exposed to someone with COVID-19. MIS-C causes inflammation in various organs such as the heart, lungs, kidneys, brain, gastrointestinal tract, eyes, and skin. Symptoms of MIS-C include:

- Fever, or prolonged fever of 5 or more days
- Severe abdominal pain, diarrhea, vomiting
- Conjunctivitis, bloodshot, red, or pink eyes
- Skin rash
- Neck pain
- Changes in skin color such as pale or patchy blue skin
- Bluish lips or face
- Red cracked lips
- Bumps on tongue resembling a strawberry
- Difficulty in feeding and drinking in infants
- Chest pain
- Lethargy
- Confusion
- Trouble breathing
- Irritability
- Tachycardia
- Swelling of hands and feet

At the time of this writing, it is not known why some children have become sick with MIS-C while other children have not. It is also not known if this syndrome can occur in adults or if this syndrome is specific to children.

Although SARS-CoV-2 is known to be a virus transmitted via respiratory routes, viral nucleic acids of both the patient’s respiratory specimen and the stool specimen have tested positive for SARS-CoV-2. Research has shown that viral RNA from COVID-19 patients can be shed into the stool and can continue to be detectable in stool samples even after samples from the respiratory tract test negative. At the time of this writing it is unclear if SARS-CoV-2...
from feces can spread to another person. CDC has stated the risk of transmission is low based on data from previous outbreaks for related coronaviruses.

Many patients show symptoms of nausea, vomiting, diarrhea, and abdominal discomfort prior to the onset of the respiratory symptoms characteristic of COVID-19. The first case of COVID-19 in the U.S. reported symptoms of vomiting and nausia for 2 days at the time of hospital admission, and had a loose stool on the day after admission.

Healthcare precautions for COVID-19 disease are strict adherence to Standard Precautions with added Transmission-Based Precautions: Contact, Droplet, and Airborne. PPE including masks, gloves, gowns and face shields should be worn according to the CDC’s Infection Control Guidance.

The CDC guidance is available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control.html The CDC actively updates this guidance and summarizes any changes as new findings for COVID-19 become available.

Cloth face coverings are NOT PPE and should NOT be worn for the care of patients with suspected or confirmed COVID-19.

Key concepts for infection control as put forth by the CDC include reducing facility risk, isolation of symptomatic patients as quickly as possible, and protection of health-care personnel. Source control via the use of cloth face coverings or facemasks that cover the nose and mouth to prevent the spread of respiratory secretions are vital and should be worn by all adults and patients 2 years of age and over. Face coverings should not be worn by children under the age of 2, anyone who has trouble breathing, anyone who is unconscious or incapacitated, or anyone unable to remove a mask without assistance. Contact tracing involves locating anyone who may have had close contact with an infected individual (or probable COVID-19 patient) and who was within 6 feet of that infected person for at least 15 minutes starting from 2 days before illness onset (or for asymptomatic patients 2 days prior to positive specimen collection) until the time the patient is isolated. Testing is recommended for those close contacts. Those testing positive are managed as a confirmed COVID-19 case. Asymptomatic contacts who test negative should self-quarantine for 14 days from their last exposure. If no testing is available, symptomatic close contacts should self-isolate and be managed as a probable COVID-19 case. If no testing is available, asymptomatic close contacts should self-quarantine and be monitored for 14 days after their last exposure, with linkage to clinical care if symptoms develop.

Administrative controls, engineering controls, and social distancing of at least 6 feet as directed by the CDC will all contribute to reducing infection. As this disease is further studied and more becomes known, please see the latest recommendations put in place by the CDC and OSHA.

CDC Interim Infection Prevention and Control Recommendations are available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html

OSHA directives and Enforcement Memoranda are available at: https://www.osha.gov/SLTC/covid-19/news_updates.html

Influenza

Each year, millions of people become infected with flu virus. The CDC has estimated that between 5% to 20% of U.S. residents will acquire flu infection each year; 3% to 11% of the population will have symptomatic flu illness; and more than 200,000 will be hospitalized for flu-related complications. Different strains of influenza viruses may be responsible for outbreaks and this will vary from year to year. The predominant influenza virus for most of the U.S. for the 2018-2019 season was influenza A(H1N1)pdm09, with low levels of influenza B and influenza A(H3N2) also observed. For the 2019-2020 flu season, influenza B/Victoria was the predominant strain. This was the first time an influenza B strain was predominant since the 1992-1993 flu season.

Pigs are susceptible to avian, human, and swine influenza viruses, and can be infected with viruses from different species at the same time. In 2009, a major change in the influenza A virus occurred when pigs were simultaneously infected with swine, avian, and human viruses, creating a new virus that was called influenza H1N1. This occurrence is known as antigenic shift. This new H1N1 “Swine Flu” virus was very contagious and caused the first influenza pandemic in over 40 years. It was estimated by the CDC that H1N1 influenza infected between 41 million to 84 million persons in the United States between April 2009 and January 2010 with a mid-level range of about 57 million people infected. Of those persons infected during this time frame, the CDC estimated that between 8,330 and 17,160 deaths related to H1N1 occurred, with a mid-level range of 11,690 deaths. Swine influenza virus infections in humans are now called variant virus infections in humans.

The influenza virus is primarily spread through large- and small-particle respiratory droplet transmission when coughing, sneezing or talking. Transmission requires close contact of approximately 8 feet or less because the
These include minimizing outpatient visits for mild influenza-like illness in patients who do not have risk factors for complications, postponing elective visits in patients with confirmed influenza, and denying entry to any visitors who are ill.

- **Engineering controls.** These include installing partitions in triage areas or public areas, and using closed suctioning systems for airway suctioning in intubated patients.

- **Administrative controls.** These include promoting and providing vaccination, enforcing that ill healthcare workers stay home, implementing respiratory hygiene/cough etiquette strategies, setting up triage stations and separate areas for emergency room patients that present with influenza symptoms, management of patient flow, and assigning dedicated staff to treat potential flu patients so that not all healthcare staff are exposed.

- **Personal Protective Equipment.** This is the lowest ranking and last line of defense for exposure that cannot be controlled. PPE must be used throughout the potential exposure period with complete adherence to be effective.

**Specific Recommendations for Infection Control of Influenza**

- **Employers should provide vaccination for healthcare professionals with incentives if necessary.**
- **Unless contraindicated, all persons greater than 6 months should be vaccinated, including healthcare professionals, patients, and residents of long-term care facilities.**
- **Respiratory hygiene/cough etiquette should be enforced for all persons including patients, visitors and healthcare professionals.**
- **Supplies and instructions for hand hygiene should be provided for all patients upon arrival to the facility.**
- **Facility access and procedures for triage of symptomatic patients should be established and controlled.**
- **Symptomatic patients should wear facemasks provided by the facility upon facility entry.**
- **Visitor access and movement in the facility should be managed.**
- **The number of healthcare workers entering isolation rooms should be limited.**
- **Healthcare workers who show signs of respiratory illness should be instructed not to report to work or stop patient care activities if already at work.**
- **Workers who have been ill and return to work to care for patients in a protective environment, (such as hematopoietic stem cell transplant patients), should be reassigned or excluded from work for 7 days from symptom onset or until resolution of symptoms, whichever is longer.**

**Prevention of Influenza**

Although the effectiveness of the flu vaccine will vary by season, vaccination is still the best way to protect against influenza, either by preventing infection and its serious complications, or by reducing symptom severity and duration. Based on the November 2018 to February 2019 flu season, the CDC has estimated that the seasonal influenza vaccine was 47% effective in preventing medically attended and laboratory confirmed influenza infection. Vaccination is recommended for all persons who are ≥ 6 months of age.

Preventing the transmission of influenza in healthcare facilities can be approached through a hierarchy of controls. Healthcare facilities can take the following CDC recommended steps (listed in order from highest to lowest ranking in the hierarchy) using this approach:

- **Elimination of potential exposures.** These include minimizing outpatient visits for mild influenza-like illness in patients who do not have risk factors for complications, postponing elective visits in patients with confirmed influenza, and denying entry to any visitors who are ill.

- **Engineering controls.** These include installing partitions in triage areas or public areas, and using closed suctioning systems for airway suctioning in intubated patients.

- **Administrative controls.** These include
workers should be promptly alerted when there is increased activity. During periods of increased community flu activity, facilities should consider setting up triage stations that facilitate rapid screening of patients for influenza and allow for separation from other patients.

- Engineering controls such as installing physical barriers for partitions in triage areas or installing curtains in shared patient areas should be considered. Appropriate air handling systems should be installed and maintained.
- Standard cleaning and disinfection procedures are adequate for influenza management when properly performed.
- Antiviral treatment and chemoprophylaxis should be administered to patients and healthcare personnel when appropriate. Healthcare workers and persons at higher risk for complications from influenza include pregnant women and women who are up to 2 weeks postpartum, persons 65 years old and older, and persons with chronic diseases such as asthma, heart disease, diabetes, morbid obesity, suppressed immune systems, and chronic medical conditions. For these individuals, vaccination and early treatment with antiviral medications can decrease the risk of hospitalizations and death.

**Tuberculosis**

Tuberculosis remains one of the world’s deadliest diseases. As stated in the introduction to this course, statistics from the CDC and the WHO showed that one-fourth of the world population (nearly 2 billion people in 2018) were infected with tuberculosis, and there were 1.5 million deaths related to TB. In spite of the high numbers of people infected worldwide, CDC surveillance data from 2018 showed tuberculosis incidence in the U.S. to be the lowest ever reported with a total of 9,025 new cases or 2.8 cases per 100,000 persons. Preliminary reported cases for 2019 are 8,920. Tuberculosis incidence rates for healthcare workers are also similar to those of the general population, suggesting that workers are not at an increased risk for TB disease or latent TB infection as once thought. Elimination of TB in the U.S., however, will require great investment in the detection and treatment of latent TB infection. An estimated 13 million people living in the United States have latent TB infection.

**Mycobacterium tuberculosis Infection**

Tuberculosis is caused by *Mycobacterium tuberculosis* (*M. tuberculosis*), a slow growing, acid-fast, aerobic bacillus. It is spread through airborne particles, or droplet nuclei generated when persons infected with pulmonary or laryngeal TB sneeze, cough, speak, or sing. Droplet nuclei are very small particles (1-5 microns in diameter) that can remain suspended in the air for several hours. This means that TB can move very quickly through crowded communities where persons share the same air space such as in hospitals, prisons, or other living quarters. TB is generally not transmitted through contact with environmental surfaces or through contact with the personal items of an infected person.

Infection occurs when a susceptible person inhales droplet nuclei containing *M. tuberculosis*. These inhaled droplet nuclei are small enough to reach the alveoli of the lungs where the bacteria are taken up by alveolar macrophages and spread throughout the body. *M. tuberculosis* usually attacks the lungs, but can also attack other parts of the body such as the kidneys, the spine, or the brain. The immune system limits multiplication and spread of the tubercle bacilli; however, some bacilli can remain dormant and viable for many years. This condition is referred to as latent tuberculosis infection (LTBI). Persons with LTBI usually have a positive TB skin test but do not have symptoms of active TB, do not feel sick, and are not infectious to others. The risk for a person with LTBI to progress to having active TB disease is the highest during the first several years after initial infection. TB can remain inactive for a person’s lifetime or can become active when the immune system is weakened.

The probability that a person will become initially infected with tuberculosis depends on the concentration of infectious droplet nuclei in the environment and the duration of exposure. An important note is that most persons who inhale the bacteria do not become infected; of those who do, many do not develop active disease. It should also be noted that a person with an active TB infection can infect an average of 10 to 15 new people each year if infection control precautions are not taken.

Persons who do develop active disease usually do so in the first two years following...
infection. In general, there is a 10% risk of developing active disease over the course of a lifetime. Persons with LTBI that become infected with HIV have approximately an 8%-10% risk of developing active infection each year. HIV-infected people who are already immunocompromised when they become newly infected with M. tuberculosis have an even greater risk of developing active TB.

If latent infection progresses to active disease, signs and symptoms of TB illness may appear including coughing, lethargy, fever, chest pain, night sweats, loss of appetite, and weight loss. Weight loss is the primary reason the disease was once called “consumption.” Persons with active infection often develop a productive cough with blood-tinged sputum as the disease advances. Chest pains and shortness of breath are common as the lungs become ravaged. If a lung cavity erodes into an artery, the person may experience massive hemorrhage.

For more than 25 years, there has been a decrease in TB cases in the US. Increases in the incidence of TB have been observed in certain geographic areas; these increases are related partially to the high risk for TB among immunosuppressed persons, particularly those infected with HIV. Transmission of M. tuberculosis to HIV-infected persons is of particular concern because these persons are at high risk for developing active TB if they become infected with the bacteria. Thus, healthcare facilities should be particularly alert to the need for preventing transmission of M. tuberculosis in settings in which HIV-infected persons work or receive care.

**Treatment of Tuberculosis**

Treatment of drug-susceptible TB is done over the course of 6-9 months with drugs such as isoniazid (INH), rifampin (RIF), ethambutol (EMB), and pyrazinamide (PZA). The dosing regimen consists of a two month intensive phase followed by either a 4 or 7 month continuation phase. Most patients can be treated with the four month continuation phase. Treatment of drug-resistant TB infection can be complicated and life-threatening and requires close management of patients by an expert in the disease. Bedaquiline is approved by the FDA for treatment of multi-drug resistant TB when other regimens have failed. It is not recommended for all multi-drug resistant patients due to its many side effects including potential hepatic and renal impairment, QT interval prolongation, and interactions with many other drugs.

Currently there is no vaccine that shows sufficient research for preventing TB lung disease. Although the BCG (Bacillus Calmette-Guérin) vaccine is used in most countries in the world, it is not recommended for use in the U.S. because of insufficient data showing efficacy in preventing adult pulmonary TB. It has also been associated with a low risk of infection with M. tuberculosis and is therefore not suitable for HIV positive patients and anyone with a weakened immune system. In addition, it can produce false positive test results on the tuberculin skin test, making TB diagnosis and population monitoring difficult.

**Tuberculosis Resistance and Healthcare Costs**

Transmission of M. tuberculosis is a recognized risk to patients and workers in healthcare facilities. Transmission is most likely to occur from patients who have unrecognized pulmonary or laryngeal TB, who are not on effective anti-TB therapy, and who have not been placed in TB isolation. TB outbreaks in healthcare facilities, including outbreaks of Multi-drug-Resistant Tuberculosis (MDR-TB) and Extensively-Drug Resistant Tuberculosis (XDR-TB), have heightened concern about healthcare acquired transmission. MDR-TB is defined as TB that is resistant to the two most effective first-line therapeutic drugs isoniazid and rifampin. XDR-TB is defined as TB that is first MDR and also resistant to the most effective second-line therapeutic drugs, the fluoroquinolones, and at least one of the three injectable drugs: amikacin, kanamycin or capreomycin. XDR TB has been found in the United States and throughout the world. Patients who have MDR-TB or XDR-TB can remain infectious for prolonged periods, and this increases the risk for healthcare acquired and/or occupational transmission of M. tuberculosis. TB, MDR-TB, and XDR-TB are classified as Category C agents of Bioterrorism by the Biodefense branch of the National Institute of Allergy and Infectious Diseases.

According to the CDC, the average cost of treating a patient with TB increases with higher resistance. In 2018, direct costs averaged $175,000 per MDR TB and $544,000 per XDR TB patient; in comparison, estimated cost per non-MDR TB patient is $19,000. Costs are even greater when including loss in productivity experienced by patients receiving ongoing treatments.

**Regulatory Agencies involved with TB Control**

The CDC is the Public Health Service agency responsible for providing direction and leadership in the prevention and control of communicable diseases and other preventable conditions. The CDC periodically updates its infection control strategies to prevent the transmission of TB in healthcare facilities. Although the CDC cannot enforce regulations related to infection control practice, its guidelines and recommendations have become standards for governmental regulations and legislation. In 1994, OSHA mandated TB protection using...
CDC guidelines. OSHA currently enforces TB standards using 29 CFR 1910 Subparts I and J. OSHA conducts inspections and issues citations for hazards associated with occupational exposure to TB.

Healthcare acquired TB outbreaks have demonstrated the substantial morbidity and mortality among patients and healthcare workers that have been associated with incomplete implementation of CDC and OSHA recommendations. The prevention of TB infection in all healthcare settings requires healthcare workers to use appropriate infection control and isolation procedures. Although completely eliminating the risk for transmission of *M. tuberculosis* in all healthcare facilities is not possible, adherence to these guidelines should reduce the risk to persons in these settings.

**Tuberculosis Safety for Healthcare Workers**

Main points for OSHA mandated standards for tuberculosis are summarized below; the OSHA website should be consulted for more detailed information:

1. Use of personal protective equipment 29 CFR 1910.132
2. Use of respirator protection 29 CFR 1910.134

   Employers must establish and implement a written respiratory protection program with work site specific procedures. The program must be updated as necessary to reflect changes in workplace conditions that affect respirator use. The program must be administered by a suitably trained program administrator.

   Respirators must be provided to each employee by the employer and must include:
   - mandatory training of employees in respirator use including use in routine and emergency situations
   - mandatory fit-testing procedures
   - mandatory user seal-check procedures
   - respiratory cleaning, disinfecting, and storing procedures
   - mandatory information for employees using respirators when not required under the standard.

3. General environmental controls
4. Recording criteria for work-related tuberculosis cases

### OSHA Enforcement Procedures for Tuberculosis

Deficiencies identified by OSHA in any of the categories listed below can result in a serious hazard that may be the basis for a citation under 5(a)(1) or a notice under 29 CFR 1960.8(a). Main points are summarized below; the OSHA website should be consulted for more detailed information.

1. Employers should develop a written **TB Infection Control Program** as recommended by the CDC that outlines a protocol for the early identification of individuals with suspected or confirmed TB. The plan should be updated annually and should be supervised by appropriate personnel with expertise in TB and LTBI disease.
2. Employers should conduct a **TB Risk Assessment** as recommended by the CDC with initial and ongoing evaluations of the risk for TB transmission regardless of whether patients with suspected or confirmed TB disease are expected to be encountered in the setting. The three TB screening risk classifications are:
   - low risk—settings in which workers are not expected to encounter persons with TB or clinical specimens that might contain *M. Tuberculosis*.
   - medium risk—settings in which workers will or will possibly be exposed to persons with TB disease or to clinical specimens that might contain *M. tuberculosi*
   - potential ongoing transmission risk—any setting where there is evidence suggestive of person-to-person transmission of *M. tuberculosis* during the preceding year.

3. Employers should conduct **medical surveillance** of workers who perform duties involving patients with suspected or confirmed TB disease. This includes initial exams for workers with baseline TB screening offered at no cost to the workers, and periodic evaluations based on up to date risk assessments. If low risk, annual screening is not necessary but any exposure will warrant screening; if medium risk, screening should be provided every year; if potential for ongoing transmission risk, workers should be tested every 8-10 weeks until a determination that there is no further ongoing transmission, and then risk should remain at that classification for at minimum 1 year.

4. Employers should **conduct case management** of infected employees including prompt evaluation of potentially infected employees, and work restrictions for infected employees. Workers with confirmed TB should be excluded from the workplace and not allowed to return until he or she can provide 3 consecutive negative sputum samples, has responded well to TB treatment, and has been determined to be non-infectious by a knowledgeable physician. Workers with LTBI and workers with extra-pulmonary TB disease that does not affect the respiratory tract can continue to work.

5. Employers should provide **education and training** to ensure their workers receive TB training relevant to their work. Training must be documented and repeated as necessary. Guidance for training is available on the CDC website.

6. Employers should provide **engineering controls** to protect workers from occupational exposure to TB.

   - Patients with confirmed or suspected

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**THE OUTSIZED FINANCIAL TOLL OF MDR AND XDR TB DISEASE**

**COST INCREASES WITH GREATER RESISTANCE**

<table>
<thead>
<tr>
<th></th>
<th>Average treatment costs, per case (2018 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TB Treatment: 6–9 months</td>
</tr>
<tr>
<td></td>
<td>$49,000</td>
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<tr>
<td></td>
<td>$19,000</td>
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<tr>
<td></td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td>MDR TB Treatment: 20–26 months</td>
</tr>
<tr>
<td></td>
<td>$393,000</td>
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<tr>
<td></td>
<td>$175,000</td>
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<tr>
<td></td>
<td>$218,000</td>
</tr>
<tr>
<td></td>
<td>XDR TB Treatment: 32 months</td>
</tr>
<tr>
<td></td>
<td>$758,000</td>
</tr>
<tr>
<td></td>
<td>$544,000</td>
</tr>
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<td></td>
<td>$214,000</td>
</tr>
</tbody>
</table>

**SERIOUS SIDE EFFECTS** experienced by many patients treated for drug-resistant TB:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression/Psychosis</td>
<td>19%</td>
</tr>
<tr>
<td>Loss of Mobility</td>
<td>8%</td>
</tr>
<tr>
<td>Hearing Impairment</td>
<td>13%</td>
</tr>
<tr>
<td>Vision Impairment</td>
<td>7%</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>13%</td>
</tr>
<tr>
<td>Seizures</td>
<td>1%</td>
</tr>
<tr>
<td>Kidney Impairment</td>
<td>11%</td>
</tr>
</tbody>
</table>

**A MAJOR HUMAN COST** of those treated for drug-resistant TB:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalization</td>
<td>73%</td>
</tr>
<tr>
<td>Require Home Isolation</td>
<td>37%</td>
</tr>
<tr>
<td>Stop Working</td>
<td>27%</td>
</tr>
<tr>
<td>Die During Treatment</td>
<td>9%</td>
</tr>
</tbody>
</table>

**Productivity loss during treatment, including deaths**

TB disease should be isolated in an AIIR and any cough-inducing or aerosol-generating procedures performed on patients should be done in an AIIR or with the use of local exhaust ventilation. An AIIR is an Airborne Infection Isolation Room that is a single occupancy patient care room used to isolate persons with suspected or confirmed airborne infectious disease. These rooms are a specialized portion of the healthcare facility’s HVAC system where airflow into the room is balanced with exhaust airflow so that no airborne particles can escape the room into other areas of the facility where workers, other patients, or persons in public areas can be exposed. Exhaust air from AIIRs is moved through specific ductwork to the outside of the building where it can be safely diluted with atmospheric air, or it is re-circulated through a high efficiency particulate air (HEPA) filter.

- AIIRs should have an air exchange rate of ≥ 6 mechanical air changes per hour and the goal when feasible or when renovating or designing new AIIRs should be ≥ 12 mechanical air changes per hour.
- Provisions should be made for emergency power during power outages. If no emergency power is available, dampers should be used to isolate the AIIR or treatment room to prevent backflow of contaminated air.

Additional specific information regarding any of OSHA’s mandated TB guidelines may be found at: https://www.osha.gov/sites/default/files/enforcement/directives/CPL_02-02-078.pdf

Or at: https://www.osha.gov/

**Tuberculosis Testing for Healthcare Workers**

The CDC guidelines for testing healthcare workers for TB were updated in May 2019 from the previous 2005 guidelines. The new 2019 guidelines include:

1. **All U.S. healthcare personnel should have baseline TB screening, symptom evaluation, and an individual risk assessment that is needed to interpret any test results.**
   - **Temporary or permanent residence for 1 month or more in a country with a high TB rate (any country other than the U.S., Australia, Canada, New Zealand, and countries of western or northern Europe)**
   - **Current or planned immunosuppression, including HIV infection, receipt of a transplanted organ, treatment with a tumor necrosis factor TNF-alpha antagonist such as infliximab or etanercept, chronic steroid use equivalent to ≥ 15mg/day for ≥ 1 month, or use of another immunosuppressive medication.**
   - **Close contact with an individual who has had infectious TB disease since the last TB test.**

2. **TB testing with an interferon-gamma release assay (IGRA) or a tuberculin skin test (TST) for persons without documented prior TB disease or latent TB infection (LTBI).**

3. **No routine serial TB testing at any interval after baseline in the absence of a known exposure or ongoing transmission.**

4. **Encouragement of treatment for all healthcare personnel with untreated LTBI, unless treatment is contraindicated.**

5. **Annual symptom screening for healthcare personnel with untreated LTBI.**

6. **Annual TB education of all healthcare personnel.**

**Tuberculosis Control Recommendations for the Healthcare Facility**

An effective TB infection control program requires early identification, isolation, and treatment of persons who have active TB. The CDC has stated that one of the most critical risks for healthcare acquired transmission of TB is from patients with unrecognized TB who are not placed under appropriate airborne precautions or who are moved from AIIRs too soon. The primary emphasis of TB infection control plans in healthcare facilities should be
achieving the following goals by the application of a hierarchy of control measures, including:

1. The use of administrative controls to reduce the risk for exposure to persons who have infectious TB;
2. The use of environmental controls to prevent the spread and reduce the concentration of infectious droplet nuclei;
3. The use of personal respiratory protection in areas where there is still a risk for exposure to *M. tuberculosis* such as in AIIRs.

The table below illustrates the CDC recommendations for an infection control program for settings expecting to encounter TB patients.

**Administrative controls** are the first and most important level of *M. Tuberculosis* TB control. Administrative controls reduce the risk of exposing uninfected persons to persons who may transmit TB. These measures include:
- development and implementation of effective policies and procedures to ensure rapid identification, isolation, diagnosis and treatment of persons likely to have TB;
- implementation of effective work practice controls such as wearing appropriate respiratory protection and keeping the doors to isolation rooms closed;
- educating and training personnel about TB; and
- screening healthcare workers for TB infection and active disease.

**Environmental controls** are the second most important level of TB control. Environmental controls prevent the spread or reduce the concentration of infectious droplet nuclei in the environment. Primary environmental controls are those that control the source of infection through local exhaust ventilation and removal or dilution of contaminated air via general ventilation. Secondary environmental controls are those that control airflow to areas near source rooms of infection (AIIRs) using HEPA filtration or ultraviolet germicidal irradiation (UVGI). UVGI is an air cleaning technology for rooms or corridors that irradiates the air in the upper portion of the room. It can also be used in air ducts to irradiate the air passing through the duct. UVGI is used in ducts that exhaust air to the outside and ducts that recirculate air back to the same room. UV irradiance levels must be properly monitored to ensure safety to workers and patients and to ensure levels are adequate enough to be effective in inactivating the organisms that are in the droplet nuclei.

**Respiratory protection controls** are the third most important level of protection for TB control and are intended for use in situations where there is high risk of infection with *M. tuberculosis*. Risk of infection can be reduced by the implementation and training of a respiratory protection program, and by teaching patients respiratory hygiene and cough etiquette.

**Use of Personal Respiratory Protection for Tuberculosis**

Personal respiratory protection should be used by:
- a) persons entering rooms in which patients with known or suspected infectious TB are being isolated;
- b) persons present where cough-inducing or aerosol-generating procedures are being performed on patients; and
- c) persons in other settings where administrative and engineering controls are not likely to protect them from inhaling infectious airborne droplet nuclei. These other settings include transporting patients who may have infectious TB in emergency transport vehicles and providing urgent surgical or dental care to patients who may have infectious TB before a determination has been made that the patient is noninfectious.

The CDC recommends that employees wear N95 or greater NIOSH approved respirators. All healthcare workers must be fit-tested prior to using respirators. In some settings, workers may be at risk for two types of exposure: inhalation of *M. tuberculosis*, and mucous membrane exposure to fluids that may contain bloodborne pathogens. In these settings, protection against both types of exposure should be used.

**Environmental Disinfection and Sterilization Requirements for Tuberculosis**

Environmental surfaces are seldom associated with the transmission of TB infection. Therefore, it is not necessary to make extraordinary attempts to sterilize or disinfect surfaces. There is no requirement for food trays or utensils of TB-infected persons to be handled differently than those from other patients.

**Patient Equipment**

The CDC recommends high-level disinfection of TB-contaminated devices because high-level disinfectants have been proven to inactivate TB and other pathogens that might contaminate endoscopes and other semicritical devices. Standard Precautions must always be used.

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**Infection Control Program for Settings in Which Patients With Confirmed or Suspected TB Disease Are Expected to be Encountered**

- Assign and train a TB Infection Control Manager or group with expertise in LTBI and TB disease.
- Develop a written infection control plan to promptly recognize and initiate airborne precautions with persons who have suspected or confirmed TB disease and update this annually.
- Develop a problem evaluation if a person with suspected or confirmed TB disease is not promptly recognized and airborne precautions are not initiated, or if administrative, environmental or respiratory controls fail.
- Perform a contact investigation in collaboration with the local or state health department if healthcare associated transmission of *M. tuberculosis* is suspected, then implement and monitor corrective action.
- Collaborate with the local or state health department to develop administrative controls including:
  1. A risk assessment
  2. A written TB infection control plan
  3. Management of patients with suspected or confirmed TB disease
  4. Training and education of healthcare workers
  5. Screening and evaluation of healthcare workers
  6. Problem evaluation
  7. Coordination
- Implement and maintain environmental controls including AIIRs
- Implement a respiratory protection program
- Provide ongoing training and education of all healthcare workers
- Develop a plan for accepting patients with suspected or confirmed TB disease if they are transferred from another healthcare setting

Taken from CDC Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Healthcare Settings, 2005. Avail at: https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm?s_cid=rr5417a1_e
Transmissible Spongiform Encephalopathies (TSEs): Prion Diseases

Creutzfeldt-Jakob Disease

Creutzfeldt-Jakob Disease (CJD) is a rapidly progressive, always fatal neurodegenerative disorder believed to be caused by an abnormal isoform of a cellular glycoprotein known as the prion protein. CJD is classified as a transmissible spongiform encephalopathy (TSE) along with other prion diseases that can affect both humans and animals. TSEs are characterized by deposits of amyloid protein (prions) and microscopic vacuoles in the grey matter of the brain. Microscopic examination of brain tissue shows numerous holes that create a characteristic spongiform appearance. CJD occurs worldwide and the estimated annual incidence in the United States has been reported to be about one to 1.5 cases per million population per year.

The incubation period for CJD can be as short as two years or as long as many decades, but the vast majority of CJD patients die within one year of illness onset. In about 85% of patients, CJD occurs as sporadic CJD disease with no recognizable pattern of transmission. A smaller proportion of patients (5 to 15%) develop a second type of CJD known as hereditary CJD because of inherited mutations of the prion protein gene. Other inherited TSE diseases include Gerstmann-Sträussler-Scheinker Syndrome and fatal familial insomnia. Both are extremely rare. A third type of CJD disease is acquired CJD where transmission of the disease has been linked to use of contaminated neurosurgical equipment, contaminated growth hormone or gonadotropin taken from the pituitary glands of human cadavers, contaminated human dura mater grafts, or contaminated corneas used in transplantation. However, no further cases of acquired CJD have been reported in the U.S. since 1976 because of the implementation of routine sterilization currently used in medical facilities. Kuru is another acquired prion disease that was identified in the isolated Fore tribe of Papua, New Guinea. Kuru was acquired because of practiced ritualistic cannibalism when tribe members ate the tissues and brains of deceased relatives at their funerals. Kuru has now nearly disappeared due to government discouragement of cannibalism.

Bovine Spongiform Encephalopathy (BSE) and Variant CJD (vCJD)

Bovine spongiform encephalopathy (BSE) or "mad cow disease" is a progressive neurological disorder in cattle that is caused by a prion. BSE probably first originated in the 1970s in the UK after cattle were fed meat and bone-meal from either spontaneously occurring BSE or from sheep infected with scrapie (a prion disease of sheep). Strong scientific evidence now exists that the prion responsible for BSE in cattle is the same agent responsible for a disease in humans known as variant Creutzfeldt-Jakob disease (vCJD) in humans. Classic CJD and vCJD are distinctly different diseases with different clinical and pathological characteristics.

Most patients with vCJD may have consumed cattle products from infected animals while they lived in or visited the United Kingdom during a large outbreak of BSE that occurred between 1980 and 1996. There has also been vCJD associated with contaminated cattle products in Saudi Arabia. It should be noted here that cases of vCJD are ascribed to the country of initial symptom onset, regardless of where the exposure occurred. Per CDC data, as of March 6, 2017, variant CJD cases have been reported from the following countries: 178 from the United Kingdom, 27 from France, 5 from Spain, 4 from Ireland, 4 from the United States, 3 in the Netherlands, 3 in Italy, 2 in Portugal, 2 in Canada and one each from Japan, Saudi Arabia, and Taiwan.

Both classic CJD and vCJD are invariably fatal brain diseases with unusually long incubation periods measured in years. There is no known treatment. To date, there have been no cases of vCJD acquired independently in the U.S., but sporadic cases of BSE have been documented in cattle from North America. There have also been no reported cases of vCJD caused by direct human to human transmission in the U.S. In the United Kingdom, however, it is believed that two cases of vCJD were acquired through blood-borne transmission.

Infection Control for Prion Diseases

Persons infected with CJD can have prion accumulation in the tonsils, lymph nodes, appendix, spleen, brain or spinal cord. Healthcare workers should use Standard Precautions when caring for a patient diagnosed or suspected of having CJD or vCJD. Private rooms are not necessary and no special precautions are needed for feeding tubes or feeding utensils, suctioning tubes, bedding, or items related to the care of bed sores. To date, no CJD cases from healthcare facilities have been associated with exposure to the CJD agent from surfaces such as floors, walls, or countertops.

Special precautions are recommended for lab workers handling potentially infected tissue samples, and for autopsy, for handling of a body following autopsy, and for embalming. Although destruction of all heat-resistant surgical instruments that come in contact with high infectivity tissues (brain, spinal cord, and eyes) is the safest and most unambiguous method of infection control, it may not be practical or cost effective. The WHO has developed infection control guidelines for TSEs that address specific sterilization practices for reprocessing medical instruments that come into contact with high infectivity tissues of patients diagnosed with CJD or vCJD. These guidelines can be found on the WHO website at: https://www.who.int/csr/resources/publications/bse/WHO_CDS_CSR_APH_2000_3/en/

Multiple Drug Resistant Organisms (MDROs)

Multiple drug resistant organisms (MDROs) are microorganisms that are resistant to one or more classes of antibiotics. Although MDROs are named according to their resistance to one antimicrobial agent, many of these pathogens have shown resistance to most of the antimicrobial agents that are currently available. Infections caused by MDROs are associated with increased length of hospital stay, increased healthcare costs, increased admissions to the ICU, additional surgical procedures, and increased mortality. According to data from the CDC’s 2019 Antibiotic Resistance Threats Report, there are more than 2.8 million antibiotic-resistant infections occurring in the U.S. each year, and of these, more than 35,000 people die as a result. In 2017, infections caused by Clostridium difficile alone resulted in 223,900 people requiring hospitalization and at least 12,800 deaths.

Drug resistance affects everyone and can affect persons at any stage of life. Antibiotics that are reliable are absolutely necessary for procedures such as organ transplantation, cancer therapy, and joint replacement. Drug resistance has become a global crisis as resistance is spread across borders through people, animals, and goods. Data from the CDC has shown that each year, one billion people cross through international borders, including 350 million travelers arriving in the United States at more than 300 points of entry.

As shown below, the CDC has divided 18 antibiotic-resistant bacteria and fungi into 3 categories: Urgent, Serious, and Concerning, based on the level of concern to human health. There are also 3 pathogens on their “Watch List” due to concern over increasing drug resistance.

MDROs consist primarily of bacteria that can adapt to their environment like most other living organisms. It is this ability to adapt
Antimicrobial Resistance Threats as Classified by the CDC

Urgent Threats
- Carbapenem-resistant Acinetobacter
- Candida auris
- Clostridioides difficile
- Carbapenem-resistant Enterobacteriaceae
- Drug-resistant Neisseria gonorrhoeae

Serious Threats
- Drug-resistant Campylobacter
- Drug-resistant Candida
- ESBL-producing Enterobacteriaceae
- Vancomycin-resistant Enterococci (VRE)
- Multidrug-resistant Pseudomonas aeruginosa
- Drug-resistant nontyphoidal Salmonella
- Drug-resistant Salmonella serotype Typhi
- Drug-resistant Shigella
- Methicillin-resistant Staphylococcus aureus (MRSA)
- Drug-resistant Streptococcus pneumoniae
- Drug-resistant Tuberculosis

Concerning Threats
- Erythromycin-Resistant Group A Streptococcus
- Clindamycin-resistant Group B Streptococcus

Watch List
- Azole-resistant Aspergillus fumigatus
- Drug-resistant Mycoplasma genitalium
- Drug-resistant Bordetella pertussis

Taken from CDC’s Antibiotic Resistance Threats in the United States 2019 (2019 AR Threats Report) available at: https://www.cdc.gov/drugresistance/biggest-threats.html#extend

that has led to the development of antibiotic resistance. As antibiotics were introduced into medicine, antibiotic resistance soon followed. A penicillinase-producing *Staphylococcus aureus* (*S. aureus*) first appeared in the 1950s, methicillin-resistant *S. aureus* (MRSA) appeared in the 1960s, gram-negative bacilli resistant to aminoglycosides (gentamicin, tobramycin) appeared in the 1970s, MRSA resistance to fluoroquinolones appeared in the 1980s, and vancomycin resistance among enterococci appeared in the 1990s. Unfortunately, resistant organisms continue to appear with antibiotic use over time. In the 1990s and early 2000s, three classes of vancomycin-resistant *S. aureus* were identified. They are classified as: vancomycin intermediate-resistant *S. aureus* (VISA), heterogenous vancomycin intermediate-resistant *S. aureus* (hVISA); and high-level vancomycin-resistant *S. aureus* (VRSA). All three differ in their degree of susceptibility to vancomycin, and can no longer be treated with this drug. However, all isolates to date have been susceptible to other Food and Drug Administration (FDA) approved drugs. Staph bacteria are present everywhere on human skin and are especially prevalent in the nose and mucous membranes. In the environment, *Staphylococcus* are relatively heat-resistant and can survive harsh environmental conditions.

There are several different types of MRSA and there are a variety of different strains of *S. aureus* bacteria. Each strain has unique ways of infecting patients and different means of protection from antibiotic treatments. An antibiotic that may be effective for one strain may be useless against another. Some strains of MRSA can cause deadly and aggressively spreading infections, but most types of MRSA are milder and easier to treat.

The following types of infections caused by *Staphylococcus* are the most common:

- **Vancomycin-Resistant* S. aureus (VRSA)** - This type of Staph is resistant to the antibiotic vancomycin and has also become immune to a many other types of antibiotics.
- **Vancomycin-Intermediate* S. aureus (VISA)** - These Staph are similar to VRSA, but they are only partially resistant to the vancomycin.
- **Oxacillin-Resistant* S. aureus (ORSA)** - This variation of Staph is resistant to Oxacillin, an antibiotic of the same class as methicillin.
- **Methicillin-Sensitive* S. aureus (MSSA)** - This is a common type of Staph that is vulnerable to the methicillin class of antibiotics and therefore easier to treat. This type can often be identified on bacterial culture tests.
- **CA-MRSA**. These are strains of MRSA that are frequently found in public places. These strains tend to cause skin infections and are often easier to treat with antibiotics.
- **HA-MRSA**. These are strains of MRSA that are frequently found in hospitals and other healthcare settings.
- **LA-MRSA**. There are strains of MRSA associated with livestock and feed animals. These strains have also been found on caretakers of livestock.

Also of importance are the ESBL-producing *Enterobacteriaceae*. *Enterobacteriaceae* are a large family of gram-negative bacteria (GNB) that are capable of causing infection in both healthcare and community settings. Examples of *Enterobacteriaceae* include *Escherichia coli* (*E. coli*), *Klebsiella pneumonia*, *Salmonella*, *Shigella*, and *Citrobacter*. These organisms have adapted to environments where antibiotics are present by producing enzymes such as broad-spectrum beta-lactamases that break down the antibiotics.

Bacteria possess the ability to develop resistance to antibiotics in various ways. They can mutate, express a latent gene, or acquire new resistance material through direct exchange of DNA with other bacteria. The three major mechanisms of resistance include:

1. production of an enzyme that will inactivate or destroy the antibiotic;
2. alteration of the antibiotic target site to prevent action of the antibiotic; or
3. prevention of the antibiotic’s access to the target site.

An important example of this is the CDC’s posting of an official health advisory regarding isolates of *Neisseria meningitides* from 11 meningococcal disease cases during 2019-2020 that contained a gene associated with both penicillin resistance and mutations associated with ciprofloxacin resistance.

Antibiotic resistance in hospitals may be...
higher than in the community because hospitalized patients may have more severe illness, may be severely immunocompromised, or may be exposed to newer devices and procedures that increase their risk of infection or colonization with resistant organisms. Introduction of resistant organisms from the community and/or ineffective infection control and isolation practices may result in a large number of resistant organisms present in the environment. Finally, the use of broad-spectrum antibiotics and high antibiotic usage within a relatively small geographic area can also force the development of resistant organisms.

Current evidence, based on the following observations, suggests that there is a causal relationship in some hospitals between antibiotic usage and antibiotic resistance:

- Changes in microbial resistance parallel antibiotic usage.
- Antibiotic resistance is more common in hospital-acquired bacterial strains.
- Patients infected with resistant organisms are more likely to have received antibiotics.
- Areas that have the highest rates of antibiotic resistance also have the highest rates of antibiotic usage.

The likelihood that a patient will become colonized with resistant organisms increases with the duration of exposure to antibiotics. For some pathogens, the development of resistance during treatment or prophylaxis is considered a more important risk factor for acquiring resistant organisms than patient-to-patient transmission.

Transmission of Drug-Resistant Organisms

Resistant organisms gain entry into a healthcare facility through an infected or colonized patient or healthcare worker. Resistant organisms are transmitted from patient to patient in the same ways susceptible bacteria are transmitted. Resistant bacteria appear just as potent as the susceptible pathogen in animal models. Both enterococci and staphylococci are part of the body’s normal flora and are spread through direct contact between the patient and caregiver or patient-to-patient. Although MRSA has been recovered from environmental surfaces, it is transmitted primarily by the hands of healthcare workers. Stringent hand hygiene practices are absolutely essential in preventing infection of resistant organisms.

Colonization can last indefinitely, and there is no single standard for the length of time a patient should remain in isolation. Many institutions require three sets of negative cultures from multiple body sites, obtained at one or more weekly intervals, before removing a patient from isolation precautions. Healthcare workers are generally not cultured for resistant organisms unless implicated in an outbreak. Once identified, however, there are no firm guidelines on treatment or work restrictions for healthcare workers infected or colonized with resistant organisms. Each institution will have its own employee guidelines. The following control recommendations are currently in use to prevent the spread of MRSA or VRE. These same techniques can be used to prevent the rise of vancomycin-resistant bacteria and other antibiotic-resistant organisms.

Control Recommendations for Drug-Resistant Organisms

A good prevention program includes an active surveillance system to identify resistant organisms, effective infection control practices to minimize transmission within the institution, and an effective antibiotic-use monitoring program. Healthcare workers should care for all patients using Standard Precautions.

Contact precautions should be used for all patients colonized or infected with resistant microorganisms.

- Hands should be washed with an antimicrobial agent such as an alcohol-based hand gel.
- Gowns should be worn when entering the room if the healthcare worker anticipates his/her clothing will have substantial contact with the patient, the patient’s clothing, environmental surfaces, or items in the patient’s room. Gowns should also be worn if the patient is incontinent or has diarrhea, an ileostomy, a colostomy, or wound drainage not contained in a dressing. This is especially important with VRE patients.
- Gloves should be worn as previously outlined in Standard Precautions. If a patient is incontinent or has diarrhea, gloves should be changed when moving from a “dirty” area of the body to a clean one, especially with VRE patients. Healthcare workers must be careful not to touch any potentially contaminated surface such as a bed or bed stand after removing the protective gown and gloves. Again, this is especially important when caring for patients colonized or infected with VRE.
- Family and friends should be taught that they need to wear protective clothing when they visit the patient, and should be taught how to put on, remove, and dispose of protective clothing properly.
- It is important to avoid the sharing of equipment. If equipment is brought into the room, it should not be placed on the bed or bed stand. Equipment must be cleaned with an appropriate disinfectant before leaving the room. Care should be taken not to touch any potentially contaminated surfaces such as a bed or bed stand after the equipment has been cleaned.

- Medical and ancillary staff responsible for pharmacy decisions should review and ensure that the use of antibiotics is appropriate, and should restrict use of specific antibiotics as needed.

Contact precautions are also recommended for settings with evidence of ongoing transmission, acute care settings with increased risk for transmission, or wounds that cannot be contained by dressings. If private rooms are not available, cohorting patients (having patients with the same diagnosis share a room) should be considered.

It is important for healthcare workers to know their institution’s policies and procedures for antibiotic use. Patients should be instructed to take their antibiotics for the full prescription period, even if they begin to feel better. Patients must also understand that not all diseases can be treated with antibiotics and that antibiotics do not kill viruses. In cases of new or emerging MDROs, local state health departments should be contacted for guidance.

Environmental Disinfection and Sterilization Requirements for Drug-Resistant Organisms

Clearly the environment can be an important reservoir of resistant microorganisms. There is no evidence, however, that multi-drug resistant organisms including VRE are more resistant to routinely used hospital disinfectants than are susceptible organisms. It is important to ensure that routine procedures for cleaning and disinfection of medical devices and environmental surfaces are followed carefully and according to each healthcare facility’s protocol.

Sepsis

Sepsis is a life-threatening condition that is the immune system’s extreme systemic inflammatory response to an infection, and this response can lead to tissue damage, organ failure, and sudden death. Although sepsis has been called “blood poisoning,” it is not an infection alone; it is the toxic response of the body to the infection. The most frequently associated infections leading to sepsis were lung infections (35%), urinary tract/kidney infections (25%), gut infections (11%) and skin infections (11%). Common pathogens involved with sepsis are Staphylococcus aureus, Escherichia coli (E. coli), and certain species of Streptococcus. Sepsis occurs most often in patients 65 years and older, infants younger than 1 year, or persons with weakened immune systems or chronic medical
Sepsis can be difficult to diagnose and early symptoms can resemble symptoms of flu and other viral infections. Left untreated, sepsis can progress to severe sepsis (sepsis with end organ damage), then septic shock (sepsis with severe hypotension) and death.

Symptoms of sepsis include:
1. Fever with chills and shivering, rigors.
2. Extreme pain or discomfort
3. Extreme malaise
4. Clammy and sweaty skin
5. Pale or mottled skin
6. Confusion or disorientation
7. Difficulty arousing
8. Shortness of breath
9. Increased respirations
10. Tachycardia
11. Low blood pressure
12. Decreased or absent urine output

Patients with sepsis are critically ill, making it vital to begin empiric treatment during the time when a diagnosis is still being made.

Healthcare providers can do the following to prevent, recognize, or treat sepsis:
1. Follow infection control guidelines including following good hand hygiene. Ensure patients receive recommended vaccines such as flu and pneumococcal vaccines.
2. Educate patients and their families in infection prevention and in knowing the signs and symptoms of sepsis.
3. Think sepsis by knowing the signs and symptoms of sepsis so that sepsis patients can be quickly identified. Remember that every minute counts toward saving lives.
4. Act quickly if sepsis is suspected, ensuring that tests are ordered quickly to determine if infection is present, where it is located, and what caused the infection. Begin antibiotic administration and medical care immediately. Document antibiotic dose, duration and purpose.
5. Reassess patient management. Check patient progress frequently. Reassess antibiotic therapy 24-48 hours or sooner, and change therapy if needed. Ensure that antibiotic type, dose, and duration are correct.

In 2012, 12-year-old Rory Staunton of New York died of an undiagnosed sepsis infection, only 3 days after getting an abrasion from falling while playing basketball on a school gym basketball court. In response to his parents’ persistent efforts to enact legislation, the New York State Department of Health issued Rory’s Regulations, a mandated clinical protocol for NY hospitals that includes protocols for early recognition and treatment of sepsis and requires administration of antibiotics and IV fluids within an hour of diagnosis, as well as staff training and reporting of clinical outcomes to state authorities.

After the adoption of Rory’s Regulations, mortality rates due to sepsis dropped significantly in N.Y. hospitals. Other states have now adopted similar clinical protocols for sepsis prevention and early recognition. Grassroots efforts of surviving family members of patients who have died from sepsis have been aimed at education of both the public and the healthcare professional. They encourage patients to speak up and be both persistent and respectfully insistent with healthcare workers to consider sepsis as a possible diagnosis, and to begin sepsis protocols immediately when sepsis is suspected.

Rory’s parents went on to found a non-profit that is now named for its mission: END SEPSIS, The Legacy of Rory Staunton

Agents of Bioterrorism

Bioterrorism is defined as the use of a biological agent to intentionally cause disease against civilian populations for the purpose of creating terror. An epidemic is the end result. In an effort to protect the United States from potential terrorist attacks, medical countermeasures against weapons of mass destruction were issued by President George Bush to the Department of Homeland Security. In these directives, biological agents that could potentially pose human threat are classified as follows:

Traditional bioterrorism agents. These are the known naturally occurring microbes or toxin products that have the potential ability to be used as weapons and can easily be disseminated to result in mass casualties. Examples include anthrax and plague.

Enhanced bioterrorism agents. These are microbes that are modified in order to elude and baffle biohazard countermeasures and complicate public health protocols following an attack, such as a microbe that is purposely altered to be resistant to multiple antibiotics.

Emerging bioterrorism agents. These are microbes that are naturally occurring but are recently recognized as having the potential to be a public health threat that could cause a pandemic, such as a highly lethal flu virus, Nipah virus, and hantavirus. Means of detection and treatment of these agents may or may not exist or be readily available.

Advanced bioterrorism agents. These are microbes or biological materials that are newly created in the laboratory and could be formulated to produce a more severe or enhanced spectrum of disease.

Category A Agents of Bioterrorism

There are literally thousands of microbes that could potentially be used in an attack of bioterrorism. Of particular concern, as established by the CDC, are the agents classified as Category “A” agents of Bioterrorism. These microbes are given the highest priority because:
1. they are easily transmitted from person to person or easily dispersed;
2. they result in high morbidity and mortality rates;
3. they have the potential to cause widespread panic and social disruption of the public; and
4. they require special preparedness to deal with should an outbreak occur.

The category “A” agents and their respective isolation precautions are listed in the following table.

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Each year, at least 1.7 million adults in America develop sepsis.

Nearly 270,000 Americans die as a result of sepsis.

1 in 3 patients who die in a hospital have sepsis.
## Category A Agents of Bioterrorism

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Disease</th>
<th>Modes of Transmission</th>
<th>Isolation Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus anthracis</em></td>
<td>Anthrax</td>
<td>Inhalation of spores (inhalation anthrax); Non-contagious.</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handling of infected animal products (cutaneous anthrax)</td>
<td>Standard with Contact if drainage is excessive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ingestion of contaminated meat (gastrointestinal anthrax)</td>
<td>Standard</td>
</tr>
<tr>
<td><em>Yersinia pestis</em></td>
<td>Plague (Pneumonic likely in event of bioterrorist attack)</td>
<td>Inhalation of droplets (respiratory) in Pneumonic plague</td>
<td>Standard, with Droplet added until 48 hrs of therapy elapsed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bite of infected flea in Bubonic plague</td>
<td>Antibiotic prophylaxis for healthcare workers with close contact</td>
</tr>
<tr>
<td><em>Variola major</em></td>
<td>Smallpox</td>
<td>Inhalation of droplets (respiratory), or aerosols (rarely)</td>
<td>Combined Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact with skin lesions. Highly contagious</td>
<td>Contact, &amp; Airborne (if possible) until scabs have separated (3-4 wks)</td>
</tr>
<tr>
<td><em>Clostridium botulinum</em></td>
<td>Botulism</td>
<td>Ingestion of toxin in food (gastrointestinal)</td>
<td>Standard</td>
</tr>
<tr>
<td><em>toxin</em></td>
<td></td>
<td>Inhalation of toxin in aerosol (respiratory)</td>
<td>Standard</td>
</tr>
<tr>
<td><em>Francisella tularensis</em></td>
<td>Tularemia</td>
<td>Inhalation of aerosolized bacteria (respiratory)</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ingestion of contaminated food or drink (gastrointestinal)</td>
<td>Human to human transmission is rare</td>
</tr>
<tr>
<td><em>Filoviruses spp</em></td>
<td>Ebola Virus Disease, Marburg Hemorrhagic Fever</td>
<td>Zoonotic; unknown transmission from natural reservoir to human. Human to human transmission by close contact: exposure to mucous membranes, respiratory tract, or broken skin; Percutaneous exposure</td>
<td>Standard, Contact, &amp; Airborne until transmission mode is confirmed. If natural disease, can substitute Droplet for Airborne. Emphasis on sharps safety, barrier protection, hand hygiene, and patient isolation</td>
</tr>
<tr>
<td><em>Arenaviruses</em></td>
<td>Lassa Fever Argentine Hemorrhagic Fever Bolivian Hemorrhagic Fever Venezuelan Hemorrhagic Fever Brazilian Hemorrhagic Fever</td>
<td>Zoonotic; aerosol transmission of rodent urine or saliva; Direct contact with contaminated rodents or droppings; Ingestion of contaminated food or drink; Contact of broken skin with rodent excrement. Significant amount of virus in blood and body secretions</td>
<td>Standard, Contact, &amp; Airborne until transmission mode is confirmed. If natural disease, can substitute Droplet for Airborne. Emphasis on sharps safety, barrier protection, hand hygiene and patient isolation</td>
</tr>
</tbody>
</table>
Category B Agents of Bioterrorism

Agents with a categorization of second highest priority are classified as Category “B” agents of Bioterrorism. These agents are moderately easy to disperse, their infection results in a moderate degree of morbidity and low mortality, and their outbreak will require the CDC to enhance its diagnostic capacity and disease surveillance.

These agents include:
- Brucella spp.–Brucellosis
- Clostridium perfringens—Epsilon Toxin
- Salmonella spp.; Escherichia coli 0157:H7; Shigella spp.—Foodborne illness safety threats
- Burkholderia mallei—Glanders
- Burkholderia pseudomallei—Meliodosis
- Chlamydia psittaci—Psittacosis
- Coxiella burnetti—Q Fever
- Ricinus communis—Ricin toxin (castor beans)
- Staphlococcal enterotoxin B (SEB)—Produces a multi-system disease resembling sepsis (e.g. Toxic Shock Syndrome)
- Ricetetis prowazekii—Typhus Fever
- Alphaviruses—Viral encephalitis
- Vibrio cholerae, Cryptosporidium parvum—Waterborne illness safety threats
- Listeria monocytogenes—Listeriosis
- Campylobacter jejuni—Diarrheal and systemic illnesses
- Yersinia enterocolitica—Yersiosis
- Calciviruses—Norovirus (acute gastroenteritis)
- hepatitis A
- Cryptosporidium parvum, Cyclospora cayatanensis, Giardia lamblia, Entamoeba histolytica, toxoplasma gondii, Naegleria fowleri, Balamuthia mandrillaris—Protozoan illnesses

Category “C” Agents

Third highest priority agents are classified as Category “C” Agents of Bioterrorism. These microbes have the potential to be engineered for large-scale use because they are readily available and can be easily produced. An attack with these agents would produce high morbidity and mortality. Agents in this category include the emerging bioterrorism agents discussed above such as Nipah virus and hantavirus.

Procedures Following a Suspected Bioterrorist Attack

It is important to note that the microbes in all three of these categories are susceptible to antimicrobial agents in a similar way to genetically similar organisms. Present data suggests that current disinfection practices are sufficient to manage patient care equipment and surfaces in the event that a healthcare facility would treat a patient contaminated with these agents.

Physicians and healthcare workers are likely to be the first to notice a potential bioterrorist attack and should immediately report suspicious or unexplained illness to their supervisors, hospital authorities or the local health department. When the possibility of a bioterrorist event exists, there are certain steps public health officials will follow. The first step is to determine if there is indeed an outbreak of disease occurring. Unusual illnesses or patterns of illnesses, diseases occurring at the wrong times of the year, or diseases occurring out of geographic range are all cause for investigation.

If bioterrorism is confirmed, the local and state health departments will provide guidance to physicians, hospitals, and healthcare workers as well as the community, and they will work and communicate with other government agencies.

Due to the incubation periods of biological agents, a significant amount of time may have elapsed between a bioweapon attack and the time when victims manifest clinical symptoms. Days to weeks may have passed between the exposure of a victim and the onset of illness. For this reason, it is likely that there may have already been external decontamination of the patient. Patients that present with signs of illness following an attack with a biological agent will require external decontamination only in rare circumstances.

Infection Control and Decontamination for Bioterrorist Agents

Any exposure of the skin to an agent or aerosol from a biological warfare attack should be immediately washed with soap and water. Unless the skin is grossly contaminated, soap and water washing is the preferred method to remove the agent because chemical disinfectants may be caustic and will yield no additional benefits. There is also the possibility of predisposing the skin to a resistant superinfection and colonization because of the reduction of normal flora. When gross contamination of the skin does occur, a 0.5% sodium hypochlorite solution left on for a contact time of 10 to 15 minutes can be used to decontaminate the affected areas. The 0.5% solution can be made with one part Clorox bleach to 9 parts water since standard Clorox is a 5.25% sodium hypochlorite solution. Chlorine solutions must NOT be used in open body cavity wounds because they may lead to the formation of adhesions, and must NOT be used on patients with brain or spinal cord injuries. The 0.5% solution CAN be used on non-cavity wounds and the fluid can be removed by suction to a container for disposal. The resulting fluid from this decontamination should be non-hazardous within about 5 minutes. The treated area should then be irrigated with plenty of water or another available surgical solution.

If large amounts of the gross contaminant are present on fabric or clothing, a damp towel should be placed on top to prevent re-aerosolization, followed by a 5% solution of hypochlorite to saturate the contaminated area. Many fabrics will be damaged by this procedure. Contaminated equipment may also be decontaminated using a 5% hypochlorite solution with a 30-minute contact time. Since this is corrosive to most metals, a thorough rinsing is necessary followed by oiling of metal surfaces.

Personal Protective Equipment (PPE) used by the healthcare worker will vary depending on the agent and the illness manifested by patients. PPE may include dermal protection and respiratory protection. Contagious patients should be isolated until sufficient antibiotic therapy is administered and clinical condition improves. Contagious patients should also wear surgical masks when transportation is necessary. Strict use of PPE where indicated will prevent additional spread of infection.

Finally, it should be noted that because a bioterrorist attack is a criminal act, all evidence supporting an attack must be strong enough to stand up in a court of law. When applicable, any samples taken must follow an appropriate chain of custody in the event they will be used to prosecute suspected terrorists. Healthcare workers must be especially sensitive to the fact that properly performed documentation and charting becomes of utmost importance in cases of suspected bioterrorism.

Infection Control Practices in Non-Hospital Settings

Long-Term Care

On any given day in the United States, there are more patients in long-term care settings than there are in acute care facilities. Long-term care facilities (LTCFs) include skilled nursing facilities, assisted living facilities, and nursing homes. Most long-term care is provided in nursing homes to elderly patients, but some facilities provide psychiatric as well as medical care to both young patients and elderly patients. According to the CDC, over 4 million Americans reside in a nursing home or skilled nursing facility, and nearly 1 million people reside in an assisted living facility. Between 1 and 3 million infections occur in these facilities each year, and as many as 380,000 people die each year from infections in LTCFs.

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Residents of long-term care facilities present with a range of functional disability and disease, and infections are common. The most frequent endemic infections are those of the respiratory tract, urinary tract, gastrointestinal tract, and areas of the skin and soft tissue. GI infections primarily manifest as diarrhea, and common causes of gastrointestinal outbreaks are due to *E. coli* and *salmonella*, as well as the enteric viruses. The most frequent infections involve the urinary tract with prevalence rates ranging from 25% to 50% even though most patients are asymptomatic. Respiratory tract infections may include sinusitis, pharyngitis, bronchitis, and pneumonia; the latter is the only infection in the long-term care setting that is often fatal. Outbreaks of respiratory infections caused by influenza A are common. Skin and soft tissue infections include decubitus ulcers and infected vascular and diabetic foot ulcers. Non-bacterial causes of skin infection include candidiasis and herpes zoster. Scabies is often present and is difficult to contain.

Long-term Care residents seem particularly at risk for colonization with antimicrobial drug-resistant organisms, although the colonization usually occurs during a visit to an acute care setting. Some long-term facilities have reported colonization rates with MRSA as high as 30%. Numbers will continue to grow, as the population of senior citizens over the age of 65 increases.

Infection control can be quite problematic in long-term settings for a variety of reasons. Residents of these facilities are often highly functionally impaired; they may be incontinent, immobile, and have a minor or major neurocognitive disorder. The worse their functional status becomes, the greater the likelihood of infection or colonization with resistant organisms.

Another compounding circumstance is the increasing admission to long-term care of patients with invasive devices. Appropriate treatment and infection control guidelines must be developed in each facility for those patients with chronic tracheostomies and respiratory care needs, central lines, and percutaneous feeding tubes, among others.

According to the CDC, up to 70% of nursing home residents receive one or more courses of systemic antibiotics per year, and 40-75% of these prescribed antibiotics may be unnecessary or inappropriate. Antibiotic overuse contributes to risk of *Clostridium difficile* diarrhea infection, colonization or infection of antibiotic-resistant organisms, and adverse drug events and drug interactions. To address these concerns, in 2014 the CDC recommended an antibiotic stewardship program for all acute care hospitals with commitments and activities designed to “optimize the treatment of infections while reducing the adverse events associated with antibiotic use.” The CDC has also recommended that all nursing homes take steps to implement antibiotic stewardship activities. When hospitals and nursing homes commit to antibiotic stewardship policies and practices, long-term care patients are protected from unnecessary infection and their clinical care is greatly improved.

### Community and Home Health Care

Provision of home care services has also expanded exponentially in the last decade due to efforts to decrease hospital lengths of stay and shift care to ambulatory settings. Today, there are over 13,000 agencies that provide home care, and almost 1.5 million people working in home health care services. Most patients are elderly, with chronic conditions that require skilled care. However, a substantial proportion of home care patients are younger and may include postoperative patients, postpartum mothers and their babies, and patients with acute medical conditions such as diabetes and recent strokes. Services provided may include infusion therapy, tracheostomy care and ventilator support, dialysis, and other invasive procedures.

Limited data are available on the incidence of home-acquired infections and analysis of risk factors, so development of infection control programs specific to the home environment is difficult. Although the home care patient may have less clinical acuity in terms of the degree or intensity of care needed, and less exposure to healthcare-acquired pathogens, there may be other substantial risk factors to be considered. The home care patient may be of advanced age, and may have chronic diseases and reduced immune activity. The care provided by family members is likely to be less structured and controlled, and the environment may be lacking in proper sanitation and ventilation.

Given the relative risks encountered in
the home environment and the nature of the interventions, infection control strategies in the home care setting should focus on urinary tract care, respiratory care, wound care, infusion care, and enteral therapies. Practices recommended for intravenous therapy in the hospital setting should work well in the home. Procedures for dealing with urinary catheters should, however, be adapted to the specific circumstances of each home patient.

Ulcer and wound care may be a significant challenge. Home care patients may have a variety of wounds, such as stasis ulcers and pressure sores which are commonly colonized with gram negative flora. This increases the possibility that the patient’s new wounds may become infected with his own organisms. Thus, the procedures for wound care in the home should be based on a careful assessment of the real potential for contamination and infection.

Enteral therapy at home presents a risk for gastrointestinal infection. Reduction of this risk may require considerable patient and family teaching with regard to the need for refrigeration of feeding products and scrupulous cleaning of all items used in feeding preparation. Sterilization of appliances and kitchen tools is probably not necessary.

Standard Precautions should always be followed, just as with hospital-based patients. The use of gloves and gowns in the home care setting, however, is more likely to be for the protection of the home healthcare worker rather than the patient. The use of masks use may be limited to those patients with pulmonary tuberculosis.

A home healthcare worker who is treating a patient with multi-drug resistant organisms should be alert to the need for use of appropriate barriers. Reusable equipment should be dedicated to the use of that particular patient and left in the home. The home healthcare worker should plan to see the patient as the last appointment of the day, or at least after seeing patients at increased risk, such as those patients receiving wound care. Further study is needed to identify significant risks and appropriate risk reduction strategies for use in the home care setting.

**Dialysis Units**

Every year, there are over 250,000 bloodstream infections per year in the US. Most of those were associated with the presence of an intravascular device. Patients receiving dialysis are at increased risk of bloodstream infections (BSIs) and in particular center line-associated bloodstream infections (CSBSIs).

The number of patients with end-stage renal disease treated by maintenance hemodialysis in the United States has increased sharply during the past 30 to 40 years. In an environment where multiple patients receive dialysis concurrently, repeated opportunities exist for person-to-person transmission of infectious agents, directly or indirectly, via contaminated devices, equipment and supplies, environmental surfaces, or the hands of personnel. In addition, hemodialysis patients have weakened immune systems and require frequent hospitalizations and surgeries, all of which increase their risk for infection. In the U.S., 468,000 patients rely on dialysis. In 2017 80% of all end stage kidney disease patients had a central venous catheter. 28,000 ICU patients die annually from central line associated bloodstream infections.

The CDC encourages facilities to place the poster shown below in areas visible to patients, family members, and staff to raise awareness about BSI and the need for everyone to do their part in preventing these infections.

CDC Core Interventions that are proven to reduce BSI in the dialysis unit include the following:

2. Perform monthly observations of hand hygiene and share results with clinical staff.
3. Perform quarterly observations of catheter/vascular access care, assessing adherence to aseptic technique when connecting and disconnecting catheters during dressing changes and share results with clinical staff.
4. Perform staff education and competency training on infection control topics including access care and aseptic technique every 6-12 months and upon hiring.
5. Provide patient education and
development to all patients on infection prevention. Topics should include vascular access care, hand hygiene, risks related to catheter use, recognizing signs of infection, and instructions for access management when away from the dialysis unit.

6. Incorporate efforts for catheter reduction (example through patient education, vascular access coordinator) to reduce catheters by identifying and addressing barriers to permanent vascular access placement and catheter removal.

7. Use an alcohol-based chlorhexidine (>0.5%) solution for skin antisepsis as the first line skin antisepctic line for central line insertion and during dressing changes. For patients with chlorhexidine intolerance, use povidone-iodine (preferably with alcohol) or 70% alcohol as alternatives. Perform catheter hub disinfection with an appropriate antiseptic after cap is removed and before accessing. Perform every time catheter is accessed or disconnected. If a closed needleless connector device is used, disinfect connector device per manufacturer's instructions

8. Apply antimicrobial ointment or povidone-iodine ointment to catheter exit sites during dressing change. Use of chlorhexidine-impregnated sponge dressing might be an alternative. Specific information on selecting an antimicrobial ointment for hemodialysis catheter exit sites (selecting an antimicrobial ointment) is available on the CDC website at: https://www.cdc.gov/dialysis/prevention-tools/core-interventions.html

The CDC has also developed the following recommendations to minimize the spread of disease in the dialysis setting:

1. Disposable gloves should be used when caring for the patient or touching patient equipment at the dialysis station; gloves should be removed and hands washed between patients or stations.

2. Items taken into the dialysis station should be disposed of, be dedicated for use only on a single patient, or be cleaned and disinfected before being taken to a common clean area or used on another patient.

3. Non-disposable items that cannot be cleaned and disinfected (e.g., adhesive tape, cloth-covered blood pressure cuffs) should be dedicated for use only on a single patient.

4. Unused medications (including multiple dose vials containing diluents) or supplies (syringes, alcohol swabs, etc.) taken to a patient's station should be used only for that patient and should not be returned to a common clean area or used on other patients.

5. When multiple dose medication vials are used (including vials containing diluents), individual patient doses should be prepared in a clean (centralized) area away from dialysis stations and delivered separately to each patient. Multiple dose medication vials should not be carried from station to station.

6. Common medication carts should not be used to deliver medications to patients. Medication vials, syringes, alcohol swabs or supplies should not be carried in pockets. If trays are used to deliver medications to individual patients, they must be cleaned between patients.

7. Clean areas should be clearly designated for the preparation, handling and storage of medications and unused supplies and equipment. Clean areas should be clearly separated from contaminated areas where used supplies and equipment are handled. Medications or clean supplies should not be handled or stored in the same area or an adjacent area to locations where used equipment or blood samples are handled.

8. External venous and arterial pressure transducer filters/protectors should be used for each patient treatment to prevent blood contamination of the dialysis machine's pressure monitors. Filters/protectors should be changed between patient treatments, and not reused. Internal transducer filters do not need to be changed routinely between patients.

9. The dialysis station should be cleaned and disinfected (chairs, beds, tables, machines, etc.) between patients.

10. Special attention should be given to cleaning control panels on dialysis machines as well as other surfaces that are frequently touched and potentially contaminated with patients' blood.

11. All fluids that are associated with the prime waste should be discarded, and all surfaces should be cleaned and disinfected (including buckets attached to the machines.)

12. For dialyzers and blood tubing that will be reprocessed, dialyzer ports should be capped and tubing clamped. All used dialyzers and tubing should be placed in leak-proof containers for transport from the dialysis station to the reprocessing or disposal area.

All dialysis patients should undergo routine testing for hepatitis B (HBV) and hepatitis C (HCV) infections. All patients should be vaccinated against hepatitis B. Each patient should then be tested for anti-HBs one to two months after the last dose. If anti-HBs is > 10 mIU/mL, the patient is considered to be immune, and is then tested annually. If anti-HBs declines to < 10 mIU/mL, a booster dose should be administered. Anti HBs testing 1-2 months following the booster dose to assess response is not recommended. Hepatitis B vaccination for adult hemodialysis patients consists of high-dose 40µg Rcornvax HB administered at a schedule of 0,1, and 6 months, or high-dose 40µg Engerix administered at a schedule of 0,1, 2, and 6 months.

HBsAg-positive patients should be treated according to the facility's infection control practices for all patients. In addition, these patients should be dialyzed in a separate room using separate machines, equipment, instruments, and supplies. Staff members caring for HBsAg-positive patients should not care for HBV susceptible patients at the same time (for example during the same shift or during patient change-over).

The Professional and Infection Control

After all the mechanisms for disease transmission and principles of infection control have been presented, the healthcare professional remains the most important factor in the infection control prevention process because they are the first line of defense. When health-care workers apply their knowledge of disease transmission and their knowledge of federal regulations and recommendations in their daily work, they will make a significant impact on infection prevention in their community. It is only through the continual dedication of each and every caregiver that any infection control program will be successful.

References


environmental-guidelines-P.pdf


