SCIENCE OF INFECTION CONTROL PRINCIPLES

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Table of Contents

About the Authors

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Diana Harland, BS, CCRC, received her degree in Microbiology from the University of Texas at El Paso. She worked in pre-clinical research in retrovirology while in undergraduate school, and again later after graduation at Southwest Foundation for Biomedical Research in San Antonio, Texas. While at SWFBR, she worked in the department of Virology and Immunology at Biosafety Level 3-4 (BSL3-/BSL-4). She has extensive training at the preclinical level in NIH, OSHA and CDC guidelines for sterility and asepsis in tissue culture and retrovirology. She is a member of the Association for Clinical Research Professionals.

Denise Warren, RN, BS has been a nurse educator in a hospital setting. In this capacity, she has authored continuing education materials for nursing staff as well as training and competency manuals for various hospital units. She has worked closely and counseled patients on a variety of medical conditions in both an inpatient and outpatient setting. She continues to write health-related articles and continuing education courses.

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.

Instructional Objectives

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 and recognize its effectiveness against bloodborne 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. List appropriate methods necessary to assure sterilization of instruments and equipment in the hospital and/or clinic.
8. Outline Standard and Transmission-based Precautions.
9. Identify strategies to prevent the transmission of hepatitis.
10. Name a common mode of transmission for hepatitis B, hepatitis C, and HIV.
11. List procedures required to minimize risk of contracting the Human Immunodeficiency Virus (HIV).
12. Recognize the symptoms of H1N1 infection and be able to apply specific recommendation for H1N1 infection control.
13. Identify the modes of transmission of tuberculosis (TB) and know the TB control recommendations by the CDC and OSHA.
14. Understand the modes of transmission for Ebola and identify the relevant preventative measures.
15. List some reasons for the development of antibiotic resistant organisms.
16. Select some precautions necessary for a caregiver to avoid transmitting resistant microorganisms within the hospital or clinical setting.
17. List the most highly prioritized diseases of bioterrorism, as established by the CDC.
18. Enumerate the steps to take for decontamination and infection control of bioterrorist agents with respect to patient skin, patient clothing, equipment, and surfaces.
19. Apply infection control practices in the long-term care facility and in the home care setting.
20. Identify infection control practices for the dialysis unit.

Introduction

Infection control is not new to the practice of medicine or nursing. A glance into the history of medicine will clearly reveal that infections have always been a significant source of morbidity and mortality. The contagious nature of certain illnesses is well documented, and rudimentary control measures usually required infected persons to live apart from the non-infected population. Advances in medicine eventually led to the identification of specific disease producing organisms and mechanisms favorable for disease transmission. These advances led in turn to the development of effective measures to prevent or control the spread of communicable diseases and infections.

Life-threatening communicable diseases and infections are ever present. Many illnesses recognized since the earliest recorded history still persist as major health problems. One of the most alarming of these illnesses is tuberculosis (TB). 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) show that one-third of the world population (more than two billion people) are infected with tuberculosis. According to the CDC, in 2013, there were more than nine million new cases of TB and nearly 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 professionals 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 threats in infection control are the emergence of antibiotic resistant organisms, the 2009 pandemic influenza A (H1N1) virus or "swine flu," and most recently, in 2014, the Ebola virus. The Ebola virus initially appeared in 1976 during two simultaneous outbreaks in the Democratic Republic of Congo and in Sudan. The outbreak in the Congo occurred in a village near the Ebola River, from which the disease takes its name.

Ebola typically occurs in a series of outbreaks in Sub-Saharan regions of Africa. According to the World Health Organization, from its origination in 1976 to 2013, there were 1,716 reported cases of Ebola. However, the largest outbreak to date is the ongoing 2014 West Africa Ebola outbreak. This outbreak has primarily affected Liberia, Sierra Leone, Nigeria, and Guinea; however, confirmed

cases have now been identified in other parts of the country to include the United States. The World Health Organization has reported that there have been approximately 5,000 deaths associated with the 2014 outbreak.

The importance of having a thorough understanding of infection control principles cannot be overemphasized. Patients entering a healthcare setting are at risk of acquiring 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 an important part of every action the professional performs. Therefore, the healthcare worker must become the first line of defense against disease transmission.

Table 1

Estimates of Healthcare Associated Infections (HAIs) in US Hospitals Annually*

All Health Care Associated Infections	Estimated number of infections
Pneumonia	157,500
Surgical site infection	157,500
Gastrointestinal infection	123,100
Urinary tract infection	93,300
Primary bloodstream infection	71,900
Other types of infections	118,500
Estimated total number of infections in hospitals	**721,800**

*CDC 2011

Cost of Healthcare Associated Infections (HAIs)

Infectious diseases are responsible for 15 million (26%) of the 57 million annual deaths worldwide. This means that of all the worldwide deaths that occur each year, over one-fourth of these deaths are from an infectious disease. According to a 2009 Direct Medical Cost Report released by the CDC, the overall annual direct medical costs of HAI to U.S. hospitals ranges from $28.4 to $33.8 billion for urban consumers and $35.7 billion to $45 billion for inpatient hospital services.

According to a more recent 2013 study of HAIs in five U.S. hospitals, published by JAMA Internal Medicine, the overall direct medical costs associated of HAI in just five U.S. hospitals was $9.8 billion during 2013, with surgical site infections contributing the most toward the total costs. The narrow focus of this study along with progress made in reducing certain types of infections may help to explain why the cost estimates were much less than the previous 2009 report published by the CDC.

It is estimated that Americans make one billion doctor and hospital visits each year, and 1 in 20 persons (5%) of these patients will acquire a HAI. Because of the challenges faced by emerging infectious diseases and other HAIs, the CDC requested federal funding of $432.4 million, which was an increase of $70.3 million from the 2012 fiscal year. The CDC believes that the increased funding will help to modernize infectious disease outbreak investigation and reduce healthcare-associated infections. According to the CDC's 2011 HAI prevalence survey, there were approximately 722,000 HAIs in U.S acute care hospitals in 2011. About 75,000 hospital patients with HAIs died during their hospitalizations, and about half of all HAIs occurred outside of the intensive care unit. Estimates of HAIs in US hospitals are shown in **Table 1**. For additional information, Order course # 516 "Healthcare Associated Infections" for 2 Contact Hours. (https://www.nursece.com/courses/83-healthcare-associated-infections-preventing-the-preventable).

Guidelines, Standards, and Enforcement Directives

Infection control in the healthcare setting is a major focus of a variety of public and private organizations. Among the most important are:

CDC

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.

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.

JCAHO

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) is a nationally recognized organization that accredits healthcare organizations demonstrating significant compliance with published standards. JCAHO 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 for Healthcare Organizations.

Although JCAHO 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 by JCAHO for accreditation of a health facility are also required for Medicare and Medicaid participation. Facilities accredited by JCAHO can qualify for Medicare and Medicaid without undergoing separate quality inspections, thus easing the burden of duplicate federal and state regulatory agency inspections. Additional information is available at http://www.jcaho.org.

APIC

Hospital Infection Control Committees began to appear in the 1960s, after JCAHO recommended their use 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 www.apic.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 material 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 and 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 removing 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 don 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:

- Double gloves
- Waterproof boot covers worn at least mid-calf or full leg covers
- Single-use fluid resistant gown that extends to at least mid-calf or coveralls without an integrated hood
- Respirators including either a N95 respirator or a powered air purifying respirator (PAPR)
- Surgical hood to help ensure complete coverage of the neck and head
- Waterproof apron

It should also be noted that under the new CDC guidelines, goggles are no longer recommended, due to the fact that they may not provide complete skin coverage in comparison to a single-use, disposable face-shield.

All medical facilities should also designate areas for putting on and taking off PPE. These spaces should have clear separation between clean and potentially contaminated areas, and a trained observer should monitor PPE use and safe removal. The 2014 guidelines focus heavily on the use of PPE; however, they also advise that PPE is just one aspect of infection control. Other important areas of focus include prompt screening and triage of potentially infected patients, designation of site managers to help ensure correct implementation of precautions, limiting personnel in an Isolation room, and adequate environmental sanitation.

OSHA Bloodborne Pathogens Standard

The OSHA Bloodborne Pathogens Standard applies to all workers with potential occupational exposure to blood or to OPIM since there is no population that is risk-free from HIV, HBV, or other bloodborne infections. **Other Potentially Infectious Material** includes:

The following body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids;

Any unfixed tissue or 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.

Components of the Bloodborne Pathogens Standard

Components of the Bloodborne Pathogens Standard, based on the principles of Universal Precautions, are an approach to infection control used to prevent exposure to all blood or OPIM. The information in this course is in no way intended to be used in place of the Bloodborne Pathogen Standard or any other OSHA directives. Rather, it is meant to be a compilation of material presented in a format that will make it easier for the healthcare professional to understand. Components of the Bloodborne Pathogen Standard include:

Training

OSHA requires that employers provide all employees who may be exposed to blood or other contaminated body fluids with a cost-free training program held during working hours. Employees should receive training during orientation or at the time of an initial assignment where work exposure may occur, and then yearly for review and reinforcement regulations, and updates on any changes. Employers must also provide additional training during the year when any changes (such as modification of tasks and procedures) take place that might affect the employees' potential exposure. All training must be appropriate for the language, educational level, and literacy of the employees.

Training programs must include an explanation of the epidemiology and symptoms of bloodborne diseases and modes of transmission of the pathogens. It must also 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 http://www.osha.gov.

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 protections (SESIPs),** needleless systems, and other mechanical devices used to reduce the handling of contaminated needles. SESIPs 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 still be washed with soap and running 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, undergarments, 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 employee. If this should happen, investigation and documentation must take place to determine if changes can be made to prevent a future occurrence.

The healthcare worker must remove personal protective clothing and equipment before departing the work area, or whenever the equipment or clothing becomes contaminated. If an item or garment is penetrated with fluids it should be removed immediately or as soon as feasible. Used PPE must be placed in designated containers for storage, decontamination or disposal.

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 and goggles or face shields, 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 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 travel only short distances (up to 3 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 decontamination 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 coverings 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 transfer of records may be found at http://www.osha.gov.

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 needlesticks 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 (possibly 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 2014 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 recommend by the U.S. Public Health Service at future dates, the vaccine boosters must also be made available to employees at no cost.

Post Exposure Follow-up

Any employee who has had an exposure incident must report the exposure immediately 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

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, client placement away from other susceptible clients, work practice controls such as policies for specimen collection and transportation, and 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.

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.

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 patient contact should not wear artificial nails, tips, wraps, gels, acrylics, any nail jewels, etc. Natural nails should be no longer than the fingertip 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 sanitizers are more effective at killing pathogens and are the least damaging to skin when compared to soap and water. They require less handwashing time and can easily be placed in areas where needed most. For these reasons, alcohol based hand rubs are the preferred and recommended method of hand decontamination unless the hands are visibly soiled with blood, body fluids or protein based-substances.

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 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:
   A. visibly dirty
   B. contaminated with blood or body fluids
   C. 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 A 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:
   A. Before direct contact with all patients, and before donning gloves and performing invasive procedures
   B. After contact with blood, body fluids, excretions, mucous membranes, non-intact skin, or wound dressings
   C. After contact with patient intact skin (for example when taking blood pressure)
   D. During patient care, if hands are moving from a contaminated body site to a clean body site
   E. After contact with inanimate objects and medical equipment near the patient (such as bedrails, IV pumps, computer keyboards)
   F. After removing gloves and other PPE
   G. Before preparing or eating food
   H. 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.

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.

My Five Moments for Hand Hygiene:

1. Before touching a patient
2. Before a clean or aseptic procedure is begun
3. After exposure to a body fluid
4. After touching a patient
5. After touching patient surroundings

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.

The proper handwashing technique for using soap and water is as follows:

- Wet hands and apply a sufficient amount of soap.
- 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 to 30 seconds.
- Rinse hands well under running water.
- Dry hands with a paper towel, and if possible use the paper towel to turn off the faucet on sinks that do not have foot controls or automatic shut off.

The proper handwashing technique for using an alcohol-based hand rub is as follows:

- Apply the rub to the palm of one hand.
- Rub hands together, wetting all surfaces and focusing on fingernails and fingertips.
- Continue until hands are dry. Drying time should take a minimum of 15-20 seconds if sufficient amount of rub was applied. If hands are dry in less than15 seconds, an insufficient amount of product was used.

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. A terrific resource for educating the pediatric patient is the "Henry the Hand" Foundation, developed by Dr. William Sawyer. Henry, a cute little hand-shaped dude, teaches kids to properly wash hands and keep hands away from eyes, nose and mouth by the saying "Don't touch the T-Zone!" More information can be found at http://www.henrythehand.com

Care of the Environment

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 Enterococci 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

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 to the most soiled 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.

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.

Products designed for use on patients' skin are known as antiseptics and are not suitable for environmental cleaning. The only exceptions are isopropyl and ethyl alcohol. Both can be effective antiseptics and environmental disinfectants. It should be noted that alcohol is inactivated by organic debris; therefore, if alcohol is used as an environmental disinfectant, 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. It should be noted 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 and environmental surfaces exposed to CJD requires 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.

Patient Care Equipment

Cleaning of 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 on inanimate objects that cause infection except bacterial spores. Disinfection can be further divided into high-level disinfection, intermediate level disinfection, and low-level disinfection. **High-level disinfection** is defined as complete elimination of all microorganisms 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.

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 30 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. 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 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, linens, 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, or patients on contact precautions.

All equipment that requires reprocessing must be thoroughly cleaned before being disinfected or sterilized. Each institution must establish equipment 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.

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 cabinet or closet that is free from dust, moisture and insects. Storage shelves should be eight to ten inches up from the floor to permit routine cleaning; 18-20 inches from the ceiling to ensure adequate functioning of fire sprinklers; and six to eight inches in from an outside wall 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. Any item dropped on the floor must be discarded or reprocessed before use.

Event-related sterility recognizes that a product remains sterile until some event causes the item to become contaminated. Each institution will establish storage times and specific storage conditions.

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, as defined by the CDC, incorporate the principles from OSHA as outlined above. In review, these precautions 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 on not they contain visible blood, 3) non-intact skin and 4) mucous membranes.

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.

Although it has not been specifically implicated in the transmission of HIV 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 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 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. 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 and Sharps

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 about one out of every four needle stick injuries involves IV therapy equipment. Many injuries result during disassembly, but they may 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 may also present a problem.

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.

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 hands-free waste containers. 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 three feet.

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 bedrails, 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.

Droplet Precautions

Droplet precautions are designed to reduce the risk of droplet transmission of infective agents. 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 feet or less. For these reasons, special ventilation systems and air handling are not required to prevent droplet transmission.

Surgical masks must be worn for close contact within three 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), and M. tuberculosis.

All personnel entering an isolation room must wear 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 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 also maintains a list of approved respirators on their website (http://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. When transport is necessary, any infectious skin lesions must be covered and patients must wear a surgical

mask and observe respiratory hygiene/cough etiquette.

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 laboratory tests that confirm suspected illness can take several days for results, transmission-based precautions are used 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 using transmission-based precautions will outweigh the cost until laboratory tests yield a definitive diagnosis. See **Tables 2 and 3**.

Specific Infections

Bloodborne Infections

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 fatigue, vague abdominal pain, loss of appetite, and intermittent nausea and vomiting. Infection with hepatitis B can lead to cirrhosis or liver failure and liver cancer. Although the number of new cases in the U.S. has declined due to the highly effective vaccine, statistics from the CDC showed that in 2012 there were 700,000 to 1.4 million Americans living with chronic HBV. These same statistics revealed 2,895 new cases of acute HBV in 2012.

Sexual exposure, perinatal exposure or occupational contact with infected blood and body fluids transmits hepatitis B. 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. Up to 40% of infected people do not know how or when they were exposed to the virus.

Vaccination against Hepatitis B is a safe and effective method to prevent infection. The HBV vaccine has been available since 1981. 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. 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. For additional information, order course # 2032 "Hepatitis B" for 2 Contact Hours. (https://www.nursece.com/courses/70-hepatitis-b)

Hepatitis C

Hepatitis C (HCV), formerly known as Hepatitis Non A-Non B (NANB), is the most common chronic bloodborne infection in the United States. Most people with Hepatitis C are chronically infected but might not be aware of their infection because they are not clinically ill. Clinical illness is similar to other types of hepatitis, presenting with jaundice and flu-like symptoms such as fatigue, vague abdominal pain, loss of appetite, and intermittent nausea and vomiting. Serologic testing is necessary to determine the specific hepatitis virus causing illness. Surveillance data from the CDC shows that there were approximately 800 to 1000 cases of acute HCV reported every year from 2006 to 2012. According to this data, there was a significant increase of 45% in reported cases of HCV infection from 2012 to 2010 along with a 75% increase from 2012 to 2012. Annual cases of acute HCV increased from 850 in 2010 to 1,229 in 2011, and to 1,778 in 2012. Researchers believed that this increase is due to a higher incidence of HCV infection among adolescents and young adults, particularly in eastern and midwestern states.

Surveillance data from 2012 also showed that approximately 3.2 million Americans were chronically infected with HCV. Hepatitis C is transmitted in the same manner as Hepatitis B, although sexual contact is a less likely method of transmission. Screening blood, organ and tissue donors, counseling to reduce and/or modify high-risk practices, and compliance with the procedures outlined in standard precautions offer the best protection against Hepatitis C. For additional information, Order course # 2009 "Hepatitis C" for 2 Contact Hours. (https://www.nursece.com/courses/105-hepatitis-c)

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. The modes of HDV transmission are similar to those for HBV, with percutaneous exposures the most efficient. Sexual transmission of HDV is less efficient than for HBV; perinatal HDV transmission is rare. 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, compared with 15%-30% of patients with chronic HBV infection alone. 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.

Human Immunodeficiency Virus (HIV) Infection

HIV infection resulting in Acquired Immunodeficiency Syndrome, AIDS, is a severe life-threatening clinical condition first recognized in 1981. At the end of 2011, the CDC estimated that 1.2 million people in the U.S. were living with either diagnosed or undiagnosed HIV/AIDS. Approximately 47,500 people become infected with HIV/AIDS every year. In 2011, the greatest percentage of diagnosed HIV/AIDS cases were from men who have sex with men, and men and women who practice high risk heterosexual contact (having sexual contact with persons either known to be infected with HIV or known to have a high risk of contracting HIV.) In the U.S., there is a new HIV infection every 9.5 minutes. African Americans continue to be the most affected group comprising only 12% of the U.S. population but representing almost half of the more than one million people estimated to be living with HIV/AIDS.

Sexual exposure, perinatal exposure, and occupational contact with infected blood and body fluids all transmit HIV. Within a few weeks to months after contracting HIV, many people develop a mononucleosis-like illness lasting for a week or two. Infected people may then be without clinical symptoms for months or years before clinical symptoms, including opportunistic infections, appear. Onset of clinical illness is usually insidious with nonspecific symptoms such as lymphadenopathy, anorexia, weight loss, chronic diarrhea, fever, and fatigue. The severity of HIV-related opportunistic infections is generally related to the degree of immune dysfunction.

The primary method of preventing occupational exposure to HIV and other bloodborne pathogens is to follow Standard infection control practices. Healthcare workers must assume that **all blood and body fluids** from all patients are **potentially infectious**. Safety devices have also been developed to help prevent

Table 2

* Empiric Use of Transmission Based Precautions

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions (Always includes Standard Precautions)
Diarrhea		
Acute diarrhea with a likely infectious cause in an incontinent or diapered patient	Enteric pathogens§	Contact Precautions (pediatrics and adult)
Meningitis	Neisseria meningitidis	Droplet Precautions for first 24 hrs of antimicrobial therapy; mask and face protection for intubation
Rash Or Exanthems, Generalized, Etiology Unknown		
Petechial/ecchymotic with fever (general)	Neisseria meningitides	Droplet Precautions for first 24 hrs of antimicrobial therapy
- If positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever	Ebola, Lassa, Marburg viruses	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 aerosol-generating procedure performed
Vesicular	Varicella-zoster, herpes simplex, variola (smallpox), vaccinia viruses	Airborne plus Contact Precautions;
	Vaccinia virus	Contact Precautions only if herpes simplex, localized zoster in an immunocompetent host or vaccinia viruses most likely
Maculopapular with cough, coryza and fever	Rubeola (measles) virus	Airborne Precautions
Respiratory Infections		
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for human immunodeficiency virus (HIV) infection	M. tuberculosis, Respiratory viruses, S. pneumoniae, S. aureus (MSSA or MRSA)	Airborne Precautions plus Contact precautions
Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection	M. tuberculosis, Respiratory viruses, S. pneumoniae, S. aureus (MSSA or MRSA)	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
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	M. tuberculosis, severe acute respiratory syndrome virus (SARS-CoV), avian influenza	Airborne plus Contact Precautions plus eye protection. If SARS and tuberculosis unlikely, use Droplet Precautions instead of Airborne Precautions.
Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children	Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, Human metapneumovirus	Contact plus Droplet Precautions; Droplet Precautions may be discontinued when adenovirus and influenza have been ruled out
Skin or Wound Infection		
Abscess or draining wound that cannot be covered	Staphylococcus aureus (MSSA or MRSA), group A streptococcus	Contact Precautions Add Droplet Precautions for the first 24 hours of appropriate antimicrobial therapy if invasive Group A streptococcal disease is suspected

http://www.cdc.gov/hicpac/2007IP/2007ip_table2.html

Continued from Table 2

** 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.

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, there should be plans for post exposure management for healthcare workers. CDC has issued guidelines for the management of these exposures to HIV and recommendations for Post-Exposure Prophylaxis (PEP). Check with your facility employee health or infection control staff to learn the policies in place at your institution.

Ebola Virus Disease (EVD)

Ebola, previously known as Ebola hemorrhagic fever, is an acute illness that can be fatal if untreated. Ebola is marked by severe headache, weakness, vomiting, hemorrhagic fever, diarrhea, and muscle pain. Advance stages may progress to severe bleeding, coma, organ failure and ultimately death. Symptoms start between two days to three weeks after exposure to the virus. If death occurs from EBV, it is usually six to sixteen days after the first symptoms begin, and the ultimate cause of death is usually due to low blood pressure from fluid loss. The disease virus lives in animal hosts, and humans can contract it from infected animals. After initial transmission, the virus is spread from person to person. According to the CDC, Ebola is spread by direct contact with blood, secretions, or other bodily fluids of an infected person and from contact with contaminated surfaces. The virus enters the body through the nose, mouth, eyes or breaks in the skin.

The most extensive recent outbreak in 2014 was in West Africa. This outbreak affected Sierra Leone, Liberia, Nigeria, and Guinea; however, confirmed cases have now been identified in other parts of the world to including the US. The World Health Organization (WHO) has reported about 7,900 deaths associated with the 2014 outbreak. Due to the gravity of this current outbreak, the WHO has announced the Ebola virus an international public health emergency. Additionally, recent media attention concerning nurses who contracted the disease from taking care of patients has sparked an expressed concern from the public. The CDC has also released public statements concerning the possible transmission and spread of this potentially fatal disease.

Diagnosis of the Ebola Virus

During the early phase of infection, it is often difficult to distinguish the Ebola virus 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.

There are no vaccines for Ebola; however, survival rates may be improved through early supportive care, which includes hydration with oral or intravenous fluids and close attention to intravascular volume. Management should also include comfort-care measures that reduce the symptoms associated with the virus. In some cases, blood products such as platelets or frozen plasma may be introduced to assist with blood loss.

Prevention of Ebola

Proper infection prevention technique is vital in controlling outbreaks of Ebola. Some of the worst outbreaks have been caused by the improper sterilization of medical equipment. Recommended infection control measures include the use of sterilizing equipment, barrier isolation, protective clothing including gloves, gowns, and masks. 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 watching them for signs of illness for at least 21 days. If any of these people contract the disease, they should then be isolated, tested, and treated.

In 2014, the CDC issued an advisory to all healthcare workers concerning the Ebola virus. 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. 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.

Respiratory Infections

H1N1 Influenza

The H1N1 "Swine Flu," first detected in April 2009 was estimated by the CDC to have 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, CDC estimates that between 8,330 and 17,160 deaths related to H1N1 occurred, with a mid level range of 11,690 deaths. Data from CDC surveillance continues to show that when compared to seasonal flu, people younger than 65 years of age are more severely affected than people 65 and over. The most recent 2014 CDC data revealed that from the period of September 29, 2013 to February 8, 2014, there were 571 reported deaths associated with the H1N1 flu, and out of those deaths, approximately 62% were between the ages 25 to 64. The majority of people that have died from H1N1 this year were already suffering from another condition, such as obesity or diabetes.

H1N1 Infection

Symptoms of H1N1 flu include fever, chills, cough, sore throat, headache, body aches, congestion, rhinitis, nausea, diarrhea and

Table 3

CDC Clinical Syndromes and Conditions That Warrant Empiric Precautions	
www.bt.cdc.gov - Abbreviations used in this table: RT = respiratory tract; GIT = gastrointestinal tract; CXR = chest x-ray; CT = computerized axial tomography; CSF = cerebrospinal fluid; and LD50 - lethal dose for 50% of experimental animals; HCWs = healthcare worker; BSL = biosafety level; PAPR = powered air purifying respirator; PCR = polymerase chain reaction; IHC = immunohistochemistry	
Disease	**Anthrax**
Site(s) of Infection; Trans- mission Mode Cutaneous and inhalation disease have occurred in past bioterrorist incidents	Cutaneous (contact with spores);RT (inhalation of spores);GIT (ingestion of spores - rare) Comment: Spores can be inhaled into the lower respiratory tract. The infectious dose of B. anthracis 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 B. anthracis is estimated to be 8,000 - 50,000 spores; the infectious dose may be as low as 1-3 spores
Incubation Period	Cutaneous: 1 to12 days; RT: Usually 1 to 7 days but up to 43 days reported; GIT: 15-72 hours
Clinical Features	Cutaneous: Swabs of lesion (under eschar) for IHC, PCR and culture; punch biopsy for IHC, PCR and culture; vesicular fluid aspirate for Gram stain and culture; blood culture if systemic symptoms; acute and 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. RT: 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 RT cases. GIT: ; if intestinal form, necrotic, ulcerated edematous lesions develop in intestines with fever, nausea and vomiting, progression to hematemesis and bloody diarrhea; 25-60% fatal
Diagnosis	convalescent sera for ELISA serology RT: CXR or CT demonstrating wide mediastinal widening and/or pleural effusion, hilar abnormalities; blood for culture and PCR; pleural effusion for culture, PCR and IHC; CSF if meningeal signs present for IHC, PCR and culture; acute and convalescent sera for ELISA serology; pleural and/or bronchial biopsies IHC. GIT: blood and ascites fluid, stool samples, rectal swabs, and swabs of oropharyngeal lesions if present for culture, PCR and IHC
Infectivity	Cutaneous: Person-to-person transmission from contact with lesion of untreated patient possible, but ex- tremely rare. RT and GIT: Person-to-person transmission does not occur. Aerosolized powder, environmental exposures: Highly infectious if aerosolized
Recommended Precautions	Cutaneous: Standard Precautions; Contact Precautions if uncontained copious drainage. RT and GIT: Standard Precautions. Aerosolized powder, environmental exposures: Respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them (http://www.cdc.gov/mmwr/preview/ mmwrhtml/mm5135a3.htm) Hand hygiene: Handwashing for 30-60 seconds with soap and water or 2% chlorhexidene gluconate after spore contact (alcohol handrubs inactive against spores [Weber DJ JAMA 2003; 289:1274]). Post-exposure prophylaxis following environmental exposure: 60 days of antimicrobials (either doxycycline, ciprofloxacin, or levofloxacin) and post-exposure vaccine under IND
Disease	**Botulism**
Site(s) of Infection; Transmission Mode	GIT: Ingestion of toxin-containing food, RT: Inhalation of toxin containing aerosol cause disease. Comment: Toxin ingested or potentially delivered by aerosol in bioterrorist incidents. LD50 for type A is 0.001 μg/ml/kg.
Incubation Period	1-5 days.
Clinical Features	Ptosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia followed by symmetrical descending paralysis and respiratory failure.
Diagnosis	Clinical diagnosis; identification of toxin in stool, serology unless toxin-containing material available for toxin neutralization bioassays.
Infectivity	Not transmitted from person to person. Exposure to toxin necessary for disease.
Recommended Precautions	Standard Precautions.

Table 3 continued

Disease	Ebola Hemorrhagic Fever
Site(s) of Infection; Transmission Mode	As a rule infection develops after exposure of mucous membranes or RT, or through broken skin or percutaneous injury.
Incubation Period	2-19 days, usually 5-10 days
Clinical Features	Febrile illnesses with malaise, myalgias, headache, vomiting and diarrhea that are rapidly complicated by hypotension, shock, and hemorrhagic features. Massive hemorrhage in < 50% pts.
Diagnosis	Etiologic diagnosis can be made using RT-PCR, serologic detection of antibody and antigen, pathologic assessment with immunohistochemistry and viral culture with EM confirmation of morphology,
Infectivity	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; transmis- sion in healthcare settings has been reported but is prevented by use of barrier precautions. occurring VHFs.
Recommended Precautions	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.
Disease	**Plague2**
Site(s) of Infection; Transmission Mode	Comment: Pneumonic plague most likely to occur if used as a biological weapon, but some cases of RT: Inhalation of respiratory droplets. bubonic and primary septicemia may also occur. Infective dose 100 to 500 bacteria
Incubation Period	1 to 6, usually 2 to 3 days.
Clinical Features	Pneumonic: fever, chills, headache, cough, dyspnea, rapid progression of weakness, and in a later stage hemoptysis, circulatory collapse, and bleeding diathesis
Diagnosis	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.
Infectivity	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.
Recommended Precautions	Standard Precautions, Droplet Precautions until patients have received 48 hours of appropriate therapy. Chemoprophylaxis: Consider antibiotic prophylaxis for HCWs with close contact exposure.

2 Pneumonic plague is not as contagious as is often thought. Historical accounts and contemporary evidence indicate that persons with plague usually only transmit the infection when the disease is in the end stage. These persons cough copious amounts of bloody sputum that contains many plague bacteria. Patients in the early stage of primary pneumonic plague (approximately the first 20-24 h) apparently pose little risk [1, 2]. Antibiotic medication rapidly clears the sputum of plague bacilli, so that a patient generally is not infective within hours after initiation of effective antibiotic treatment [3]. This means that in modern times many patients will never reach a stage where they pose a significant risk to others. Even in the end stage of disease, transmission only occurs after close contact. Simple protective measures, such as wearing masks, good hygiene, and avoiding close contact, have been effective to interrupt transmission during many pneumonic plague outbreaks [2]. In the United States, the last known cases of person to person transmission of pneumonic plague occurred in 1925 [2].

1. Wu L-T. A treatise on pneumonic plague. Geneva: League of Nations, 1926. III. Health. 2. Kool JL. Risk of person to person transmission of pneumonic plague. Clinical Infectious Diseases, 2005; 40 (8): 1166-1172

3. Butler TC. Plague and other Yersinia infections. In: Greenough WB, ed. Current topics in infectious disease. New York: Plenum Medical Book Company, 1983.

vomiting. Absence of fever is seen in 10 to 50% of laboratory confirmed cases of H1N1. Incubation periods can range from 1 to 4 days with an average of 2 days. Viral shedding begins the day before the onset of illness and can continue for 5 to 7 days or more, with the greatest amount of virus shed during the first 2-3 days of illness. Viral shedding appears to correlate with the amount of fever present: The higher the fever, the greater the amount of virus that is shed. H1N1 is transmitted through close contact in similar ways to seasonal influenza. Transmission can occur through droplet exposure of mucosal surfaces by respiratory secretions including sneezing and coughing. Other modes of transmission include contact with an infected patient or fomite, and small particle aerosols in the vicinity of the infected patient. All respiratory secretions and bodily fluids including stools are considered to be infectious.

Prevention of H1N1

Preventing the transmission of H1N1 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 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 H1N1 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 H1N1

- Employers should provide vaccination with incentives if necessary.
- Respiratory hygiene/cough etiquette should be enforced.
- Facility access and triage procedures should be established and controlled.
- Visitor access and movement in the facility should be managed.
- Policies and procedures for patient placement and transport should be established.
- The number of healthcare workers entering isolation rooms should be limited.
- Standard Precautions should be used for all patients, and fit-tested disposable N95 respirators should be used for workers in close contact with patients having suspected or confirmed H1N1 infection.
- Strict hand hygiene should be used before and after patient contact, contact with respiratory secretions, and before putting on and after removal of PPE.

Tuberculosis

Tuberculosis remains the second most common cause of death in the world from an infectious disease, superseded only by death from HIV. As stated in the introduction to this course, statistics from the CDC and the WHO show that one-third of the world population (more than 2 billion people) are infected with tuberculosis, and each year, there are more than 9 million new cases of TB and nearly 2 million deaths related to TB. Because there had been a decline in the number of TB cases in the U.S. dating back from the 1950s, it was thought that TB would eventually be eliminated in the U.S. altogether. Unfortunately, in 1985 the number of TB cases began to increase, and between 1985 and 1991 there was an 18% increase in the number of reported cases. The CDC identified two important reasons for the resurgence of TB in the U.S.: the HIV epidemic and the emergence of Multi-drug Resistant TB (MDR-TB). Fortunately, because of diligent federal and community responses, the rate of TB has declined steadily in more recent years.

Mycobacterium Tuberculosis (MTB) Infection

Tuberculosis is caused by Mycobacterium tuberculosis (MTB), a slow growing, acid-fast aerobic bacillus. It is spread through airborne particles, or droplet nuclei generated when persons who have pulmonary or laryngeal TB sneeze, cough, speak or sing. Droplet nuclei are very small (1-5 microns in diameter) particles 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 hospitals, prisons, or living quarters. TB is generally not transmitted through contact with environmental surfaces or the personal items of an infected person.

Infection occurs when a susceptible person inhales droplet nuclei containing MTB. These inhaled droplet nuclei are small enough to reach the alveoli of the lungs where the MTB is taken up by alveolar macrophages and spread throughout the body. MTB 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 organisms remain dormant and viable for many years. This condition is referred to as a **latent tuberculosis infection (LTBI).** Persons with LTBI usually have a positive TB skin test but do not have symptoms of active TB and are not infectious. 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.

The probability that a person will become 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, however, 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 MTB have an even greater risk of developing active TB.

As latent infection progresses to active disease, the person begins to display signs and symptoms of the illness including lethargy, fever, night sweats, loss of appetite and weight loss. Weight loss is the primary reason the disease was once called "consumption." The person with active infection often develops 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 an artery, the person may experience massive hemorrhage.

Tuberculosis Transmission and Control

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 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 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. According to the CDC, the average cost of treating a patient with TB increases with higher resistance. In 2014, direct costs averaged $134,000 per MDR TB and $430,000 per XDR TB patient; in comparison, estimated cost per non-MDR TB patient is $17,000. Drug resistance was extensive, care was complex, treatment completion rates were high, and treatment was expensive. Costs are even greater when including loss in productivity experienced by patients receiving ongoing treatments.

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.

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.

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.

Table 4

Infection Control Program for Settings Expecting to Encounter TB Patients*

- Assign and train a TB Infection Control Manager
- Collaborate with the local health department to develop administrative controls including
  1. A risk assessment
  2. A written infection control plan, including protocols for identifying, evaluating and managing infectious TB patients based on risk assessment
  3. Testing and evaluation of healthcare workers
  4. Training and education of healthcare workers
  5. Problem evaluation and contact investigation
  6. Coordination of discharge
- Develop a plan for accepting TB patients or suspected TB patients transferred from another healthcare setting
- Implement and maintain environmental controls, including airborne infection isolation rooms (AIIRs)
- Implement a respiratory protection program
- Provide ongoing training and education of all healthcare workers

*Source: CDC "Guidelines for Preventing the Transmission of M. Tuberculosis in Healthcare Settings", June 2009

Tuberculosis Safety for Healthcare Workers

OSHA mandated standards for tuberculosis include the following:

1. Use of personal protective equipment
2. Use of respiratory protection
   A. 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.
   B. mandatory fit-testing procedures
   C. mandatory user seal-check procedures
   D. respiratory cleaning procedures
   E. mandatory information for employees using respirators when not required under the standard.
3. General environmental controls
4. Recording criteria for work-related tuberculosis cases

Specific information regarding any of OSHA's mandated TB guidelines may be found at http://www.osha.gov.

Tuberculosis Control Recommendations

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 on 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; and
3. the use of personal respiratory protection in areas where there is still a risk for exposure to M. tuberculosis (e.g., AIIRs). **Table 4** illustrates the CDC recommendations for an infection control program for settings expecting to encounter TB patients.

Administrative controls reduce the risk of exposing uninfected persons to persons who may transmit TB. These measures include (a) development and implementation of effective

policies and procedures to ensure rapid identification, isolation, diagnosis and treatment of persons likely to have TB; (b) implementation of effective work practice controls such as wearing appropriate respiratory protection and keeping the doors to isolation rooms closed; (c) educating and training personnel about TB; and (d) screening healthcare workers for TB infection and active disease.

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 nearby source rooms of infection (AIIRs) using high efficiency particulate air (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 level of protection and are intended for use in situations where there is high risk of infection with MTB. Risk to healthcare workers can be reduced by the implementation and training of a respiratory protection program, and by teaching patients respiratory hygiene and cough etiquette.

TB Respiratory Protection

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.

Respiratory protection devices must be classified as 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 MTB, 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

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.

Screening

Healthcare workers should be skin tested for tuberculosis on a recurring and routine basis. The frequency of testing should be determined by the likelihood of exposure to infectious TB. Each facility should conduct an initial and periodic reassessment of TB risk. This risk assessment should be used to determine the frequency of skin testing. Different areas of the facility may require different frequency of testing depending on the type of patients served and the procedures performed. In 2014, the CDC introduced the "Latent Tuberculosis Infection (LTBI) mobile application for health care providers. This app, which is compatible with Apple iPads, iPhones, and Android devices, makes it easy for healthcare providers to locate the CDC's most recent guidelines for the diagnosis and treatment of TB. Features on this app include:

- CDC guidelines on TB Infection
- Treatment tables explaining regimen options
- TB testing and diagnosis recommendations
- TB training and education resources
- Sample TB testing documentation forms

The Prion Diseases

Creutzfeldt-Jakob Disease (CJD)

CJD is a rapidly progressive, invariably 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 occur in humans and animals. TSEs are characterized by deposits of amyloid protein (prions) and microscopic vacuoles in the grey matter of the brain. CJD occurs worldwide and the estimated annual incidence in the United States has been reported to be about one case 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 a sporadic disease with no recognizable pattern of transmission. A smaller proportion of patients (5 to 15%) develop CJD because of inherited mutations of the prion protein gene. These inherited forms include **Gerstmann-Straussler-Scheinker syndrome and Fatal familial insomnia**. Iatrogenic 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 trans-plants. No iatrogenic CJD cases associated with exposure to the CJD agent from surfaces such as floors, walls, or countertops have been identified.

Mad Cow Disease (BSE)

Since 1996, evidence has been increasing for a causal relationship between ongoing outbreaks in Europe of a TSE disease in cattle, called **Bovine spongiform encephalopathy (BSE, or "mad cow disease"),** and a disease in humans, called variant **Creutzfeldt-Jakob disease (vCJD).** 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. Both disorders are invariably fatal brain diseases with unusually long incubation periods measured in years, and are apparently caused by prions as well. To date, there have been no cases of vCJD acquired indigenously 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 United Kingdom, however, it is believed that two cases of vCJD were acquired through bloodborne transmission.

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 care of bed sores. Special precautions are recommended for lab workers handling potentially infected tissue samples and for autopsy, handling of a body following autopsy, or 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. Specific sterilization practices for reprocessing medical instruments that come into contact with high infectivity tissues of patients diagnosed with CDJ or vCDJ can be found at the http://www.cdc.gov; or at the World Health Organization website http://www.who.int

Multiple Drug Resistant Organisms

Bacteria adapt to their environment like most other living organisms, and part of the bacteria's adaptation has led to the development of antibiotic resistance. Antibiotics were introduced into medicine in the late 1940s, and antibiotic resistance soon followed. A penicillinase-producing Staphylococcus aureus (S. aureus) first appeared in the 1950s, Methicillin-resistant S. aureus (MRSA) in the 1960s, gram-negative bacilli resistant to aminoglycosides (gentamicin, tobramycin) in the 1970s, MRSA resistance to fluoroquinolones in the 1980s, and vancomycin resistance among enterococci in the 1990s. Unfortunately, resistant organisms continue to appear. More recently, three classes of vancomycin-resistant staph aureus (VRSA) have been identified. These are classified as: vancomycin-intermediate staphaureus (VISA), heterogenous vancomycin intermediate staph aureus (hVisa); and high-level vancomycin-resistant staph aureus (VRSA). All three differ in their degree of susceptibility to vancomycin, and can no longer be treated with this drug. However, to date, all isolates have been susceptible to other Food and Drug Administration (FDA) approved drugs.

There are several different types of MRSA as well as a variety of different strains of Staph aureus bacteria. Each strain has unique ways of infecting patients as well as different means of protecting itself from antibiotic treatments. An antibiotic that may be effective for one strain can be useless against another. Some strains of MRSA can cause deadly and aggressively spreading infections; however, most types of MRSA are milder and easier to treat. The following types of MRSA and Staph infections are the most common:

- **Vancomycin-Resistant Staph Aureus (VRSA)** - This type of Staph has become immune to a many types of antibiotics
- **Methicillin-Sensitive Staph 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 bacteria culture tests.
- **Vancomycin-Intermediate Staph Aureus (VISA)** - This is similar to VRSA, but the bacteria are only partially resistant to the vancomycin.
- **Oxacillin-Resistant Staph aureus (ORSA)** - As the name suggests, this variation is resistant to Oxacillin, an antibiotic of the same class as methicillin.
- **CA-MRSA**. These are strains of MRSA, which 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, which 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 found on livestock caretakers.

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.

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 might 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 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 on healthcare workers' hands.

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, moreover, 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 and other antibiotic resistant organisms.

Control Recommendations

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 patients colonized or infected with resistant microorganisms. If private rooms are not available, cohorting patients (having patients with the same diagnosis share a room) should be considered.

- Hands should be washed with an antimicrobial agent such as alcohol-based waterless cleaners.
- Gowns should be worn when entering the room if the healthcare worker anticipates his/her clothing will have substantial contact with the patient or his 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 the client 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.

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 don't kill viruses

Environmental Disinfection and Sterilization Requirements

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.

Agents of Bioterrorism

There continues to be public concern about the threat 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. The US State Department recognizes more than 17 different countries that are suspected of having offensive biological weapons programs in place. 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 or the virus that causes, Severe Acute Respiratory Syndrome. (SARS) 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 were given the highest priority because:

(1) are easily transmitted from person to person or easily dispersed; (2) result in high morbidity and mortality rates; (3) have the potential to cause widespread panic and social disruption of the public; and (4) require special preparedness to deal with should an outbreak occur. The category "A" agents are listed in **Table 5**.

Category "B" Agents

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 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---Melioidosis
- Chlamydia psittaci---Psittacosis
- Coxiella burnetti---Q Fever
- Ricinus communis---Ricin toxin (castor beans)
- Staphlococcal enterotoxin B---produces a multi-system disease resembling sepsis (e.g. Toxic Shock Syndrome)
- Rickettsia prowazekii-Typhus Fever
- Alphaviruses---Viral encephalitis
- Vibrio cholerae; Cryptosporidium parvum-Waterborne illness safety threats

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.

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.

Table 5

Category "A" Agents of Bioterrorism

Pathogen	Disease	Modes of Transmission	Isolation Precautions
Bacillus anthracis	Anthrax	Inhalation of spores (inhalation anthrax); Non-contagious.	Standard
		Handling of infected animal products (cutaneous anthrax)	Standard with Contact if drainage is excessive
		Ingestion of contaminated meat (gastrointestinal anthrax)	Standard
Yersinia pestis	Plague (Pneumonic likely in event of bioterrorist attack)	Inhalation of droplets (respiratory) in Pneumonic plague;	Standard, with Droplet added until 48 hrs of therapy elapsed;
		Bite of infected flea in Bubonic plague	Antibiotic prophylaxis for healthcare workers with close contact.
Variola major	Smallpox	Inhalation of droplets (respiratory), or aerosols (rarely);	Combined Standard
		Contact with skin lesions. Highly contagious.	Contact, & Airborne (if possible) until scabs have separated (3-4 wks)
Clostridium botulinum toxin	Botulism	Ingestion of toxin in food (gastrointestinal)	Standard
		Inhalation of toxin in aerosol (respiratory)	Standard
Francisella tularensis	Tularemia	Inhalation of aerosolized bacteria (respiratory);	Standard;
		Ingestion of contaminated food or drink (gastrointestinal)	Human to human transmission is rare.
Filoviruses spp	Ebola Hemorrhagic Fever Marburg Hemorrhagic Fever	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.	Standard, Contact, & 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.
Arenaviruses	Lassa Fever Argentine Hemorrhagic Fever Bolivian Hemorrhagic Fever Venezuelan Hemorrhagic Fever Brazilian Hemorrhagic Fever	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.	Standard, Contact, & 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

Due to 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 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 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 are in long-term care settings than there are in acute care facilities. Most long-term care is provided in nursing homes to elderly patients, but some facilities provide psychiatric as well as medical care to the young as well as to the old. 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, skin and soft tissue, and gastrointestinal tract, primarily manifesting as diarrhea. Common causes of gastrointestinal outbreaks are E. coli and salmonella, as well as the enteric viruses. The most frequent infections involve the urinary tract, and prevalence rates range 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 infection 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 difficult to contain.

Long-term Care residents seem particularly at risk for colonization with antimicrobial drug-resistant organisms, although the colonization usually occurs in 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 Over-65 population 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 confused or demented. The worse their functional status becomes, the greater the likelihood of infection or colonization with resistant organisms. Because the usually permanent functional impairment has led to admission to the long-term care facility, it may be unrealistic to believe that endemic infections can be prevented among these residents to any significant degree. A series of clinical studies has demonstrated the limited effectiveness of a variety of infection control approaches in long-term facilities, including vitamin supplementation, routine versus PRN percutaneous feeding tube changes, clean versus sterile intermittent catheterization technique, and aggressive treatment to eradicate MRSA colonization. Further evaluation of the effectiveness of specific interventions is needed.

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.

Community/Home 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 12,000 agencies that provide home care. 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.

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 the feeding and scrupulous cleaning of all items used in its 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. Use of mask 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

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 hands of personnel. The CDC has developed the following recommendations to minimize the spread of disease in these settings:

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.

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.

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.

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.

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.

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.

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.

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.

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

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.

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.)

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 should be considered to be susceptible, and revaccinated with an additional three doses, then retested for anti-HBs. If anti-HBs is >10 mIU/mL, the patient is considered to be immune, and is then retested annually. If anti-HBs declines to <10 mIU/mL at any time, the patient should be given a booster dose of vaccine and continue to be retested annually.

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 (e.g., during the same shift or during patient change-over).

The Professional and Infection Control

After all of the facts have been presented in any infection control program and after all of the suggestions and requirements for preventing the transmission of disease have been made, there remains one controlling factor. That factor is vital in order for any program, no matter how well planned or presented, to be successful.

That factor is YOU, the professional. You are the most important part of any infection control program because you are the one who makes it function properly. Without the dedication of each individual caregiver, an infection control program is destined for failure. The foregoing facts and requirements, along with your continual dedication, will assist you in assuring that your infection control program is successful. Remember: Spread the Word, Not the Germs.

References and Suggested Readings

"Arenaviruses Factsheet." 2014. Accessed on December 3, 2014 at http://www.cdc.gov/ncezid/dhcpp/bacterial_special/

Baize S, Pannetier D, Oestereich L, et al. Emergence of Zaire Ebola Virus Disease in Guiena. N Engl J Med. 2014 Centers for Disease Control and Prevention, Special Pathogens Branch:

Centers for Disease Control and Prevention, Guideline for Isolation Precautions: Infection Control and Prevention, Accessed on December 3, 2014 at http://www.cdc.gov/tb/topic/infectioncontrol/default.htm

Centers for Disease Control and Prevention, "Hand Hygiene In Healthcare Settings" Accessed on December 3, 2014 at:http://www.cdc.gov/handhygiene/

Centers for Disease Control and Prevention, "Surveillance of Viral Hepatitis - United States, 2012" Accessed on December 3, 2014 at: http://www.cdc.gov/hepatitis/Statistics/2012Surveillance/index.htm

Centers for Disease Control and Prevention: "TB Infection Control In Healthcare Settings" Accessed on December 3, 2014 at: http://www.cdc.gov/tb/topic/infectioncontrol/default.htm.

Centers for Disease Control and Prevention, "2014 Budget Request Summary" Accessed on December 3, 2014 at: http://www.cdc.gov/fmo/topic/Budget%20Information/appropriations_budget_form_pdf/FY2014_Budget_Request_Summary.pdf

Centers for Disease Control and Prevention, "Long Term Care Services in the United States" Accessed on December 3, 2014 at: The Centers for Disease Control and Prevention, "2014 Budget Request Summary" Accessed on December 3, 2014 at:

Centers for Disease Control and Prevention, Special Pathogens Branch: "Filoviruses Factsheet." 2013. Accessed on December 3, 2014 at: http://www.cdc.gov/ncezid/dhcpp/bacterial_special/

Centers for Disease Control and Prevention, Special Pathogens Branch: "Arenaviruses Factsheet." 2014. Accessed on December 3, 2014 at http://www.cdc.gov/ncezid/dhcpp/bacterial_special/

Centers for Disease Control and Prevention, Special Pathogens Branch: "Arenaviruses Factsheet." 2014. Accessed on December 3, 2014 at Evaluating Patients for Ebola: CDC Recommendations for Clinicians Accessed at: http://www.cdc.gov/vhf/ebola/pdf/ebola-algorithm.pdf

Centers for Disease Control and Prevention, "2014 West Africa Ebola Outbreak" Accessed on December 3, 2014 at:http://www.cdc.gov/vhf/ebola/pdf/ebola-algorithm.pdf

Gatherer D. The 2014 Ebola Virus Outbreak in West Africa. J Gen Virol. 2014; 95(8): 1619-1624

Marks SM, Flood J, Seaworth B, Hirsch-Moverman Y, Armstrong L, Mase S, et al. Treatment practices, outcomes, and costs of multidrug-resistant and extensively drug-resistant tuberculosis, 2005, Äì2007. Emerg Infect Dis. 2014 May Accessed January 26, 2015.

Morens, David M; Folkers, Gregory K.; and Fauci, Anthony S. The Challenge of "Emerging and Re-Emerging Infectious Diseases." Nature Volume 430; 8 Jul. Avail at: http://www3.niaid.nih.gov/about/directors/pdf/nature_to_web.pdf

Roddy P, Howard N, Van Kerkhove MD, et al. Clinical manifestations and case management of Ebola fever caused by newly identified virus strain, PLoS One. 2012; 7(12): 596-598

Storr, J. "Five Moments for Hand Hygiene a focused, targeted approach to patient safety." International Journal of Infection Control, North America, Volume 5 Number 2, 14 Mar 2009. Avail. at: http://www.ijic.info/article/view/3629/3200.

United States Department of Homeland Security Presidential Directive 18: "Medical Countermeasures Against Weapons of Mass Destruction." Avail at: http://www.dhs.gov/xabout/laws/gc_1219175362551.shtm#1.

U.S. Department of State, "Condition (10) (C) Report: Compliance With the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction," Avail at: http://www.state.gov/t/avc/rls/rpt/2013/index.htm Centers for Disease Control and Prevention Emergency Preparedness and Response, Bioterrorism. Avail at: http://www.bt.cdc.gov/agent/agentlist-category.asp

World Health Organization: "Save Lives - Clean Your Hands: WHO's Global Annual Campaign." Accessed on December 3, 2014 at: http://www.who.int/gpsc/5may/en/

Zimlichman E, Henderson D, Tamir O, et al. Healthcare-Associated Infections: A Meta-anylysis of Costs and Financial Impact on the US Healthcare Syste. JAMA Internal Medicine. 2013; 245-67

