

Infection Control

Infection Control

Goals & Objectives

Course Description

“Infection Control” is an asynchronous online continuing education course for physical therapists and physical therapist assistants. This course presents updated information about the management of infectious agents including sections on risks, precautions, transmission, intervention, and prevention.

Course Rationale

The purpose of this course is to present physical therapists and physical therapist assistants with current information about the management of infectious agents. Course participants will use this information to effectively limit exposure and transmission of communicable pathogens among healthcare workers, patients, and other at-risk populations.

Course Goals and Objectives

Upon completion of this course, the participant will be able to:

1. Differentiate and understand the three different modes of infectious agent transmission
2. Recognize infectious agents of special interest and understand the pathologies and challenges associated with these organisms.
3. Differentiate between the various categories of precautions, and know when each should be applied.
4. Identify transmission risks associated with different types of healthcare settings.
5. Identify transmission risks associated with special patient populations.
6. Recognize administrative measures used to prevent transmission of infectious agents.
7. Identify the appropriate use and purpose of each of the Personal Protective Equipment options.
8. Identify the practices utilized to prevent exposure to bloodborne pathogens.
9. Identify appropriate environmental measures, strategies and techniques used to prevent infectious agent transmission.
10. Recognize how to manage visitors to control infectious agent transmission.
11. Identify the precaution practices associated with specific pathogens.

Course Provider – Innovative Educational Services

Course Instructor - Michael Niss, DPT

Target Audience – physical therapists and physical therapist assistants.

Course Educational Level – Introductory / intermediate

Course Prerequisites – None

Method of Instruction/Availability – Online text-based course available continuously

Criteria for issuance of CE Credits - A score of 70% or greater on the course post-test.

Continuing Education Credits – 5 hours

Determination of Credits - Mergener Formula: $.9 \times [-22.3 + (0.00209 \times 114,654) + (2.78 \times 25) + (15.5 \times 3)] = 300 \text{ minutes} = 5.0 \text{ hours}$

Fees - \$49.95

Conflict of Interest – No conflict of interest exists for the presenter or provider of this course.

Refund Policy - Unrestricted 100% refund upon request. The request for a refund by the learner shall be honored in full without penalty or other consideration of any kind. The request for a refund may be made by the learner at any time without limitations before, during, or after course participation.

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Infection Control Course Outline

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Introduction

Healthcare-associated infection (HAI) in the hospital is among the most common adverse events in healthcare. CDC estimates there are approximately 1.7 million healthcare-associated infections in U.S. hospitals and 99,000 associated deaths each year. There are approximately 4.5 infections per 100 hospital admissions, 9.3 infections per 1000 patient days in Intensive Care Units (ICUs), and 2 surgical site infections per 100 operations. These estimates are based on best available data, but some infections are known to be underreported, so the actual number of healthcare-associated infections may be higher.

Estimates of the economic impact of healthcare-associated infections vary because of differences in how the data are defined and analyzed. Data from published studies indicate the estimated cost of healthcare-associated infection ranges from \$10,500 per case for bloodstream, urinary tract, and pneumonia infections to \$111,000 per case for antibiotic-resistant bloodstream infection in transplant patients.

Healthcare-associated infections are defined as infections affecting patients who receive either medical or surgical treatments. The procedures and devices used to treat patients can also place them at increased risk for healthcare-associated infections. A patient's skin, the natural protection against bacteria entering the blood, is continually compromised by the insertion of needles and tubes to deliver lifesaving medicine. Microbial pathogens can be transmitted through tubes and devices that are going into patients, providing a pathway into the blood stream and lungs. Because of the number of procedures and the seriousness of patient conditions, patients treated in the ICU have the highest risk of healthcare-associated infections.

The frequency of healthcare-associated infections varies by body site. In the United States from, the most frequent healthcare-associated infections reported to the National Nosocomial Infections Surveillance (NNIS) system, overall, were urinary tract infections (34%), followed by surgical site infections (17%), bloodstream infections (14%), and pneumonia (13%).

Transmission of Infectious Agents

Transmission Overview

Transmission of infectious agents within a healthcare setting requires three elements: a source (or reservoir) of infectious agents, a susceptible host with a portal of entry receptive to the agent, and a mode of transmission for the agent.

Sources of Infectious Agents

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Infectious agents transmitted during healthcare derive primarily from human sources but inanimate environmental sources also are implicated in transmission. Human reservoirs include patients, healthcare personnel, and household members and other visitors. Such source individuals may have active infections, may be in the asymptomatic and/or incubation period of an infectious disease, or may be transiently or chronically colonized with pathogenic microorganisms, particularly in the respiratory and gastrointestinal tracts. The endogenous flora of patients (e.g., bacteria residing in the respiratory or gastrointestinal tract) also are the source of HAIs.

Susceptible Hosts

Infection is the result of a complex interrelationship between a potential host and an infectious agent. Most of the factors that influence infection and the occurrence and severity of disease are related to the host. However, characteristics of the host-agent interaction as it relates to pathogenicity, virulence and antigenicity are also important, as are the infectious dose, mechanisms of disease production and route of exposure. There is a spectrum of possible outcomes following exposure to an infectious agent. Some persons exposed to pathogenic microorganisms never develop symptomatic disease while others become severely ill and even die. Some individuals are prone to becoming transiently or permanently colonized but remain asymptomatic. Still others progress from colonization to symptomatic disease either immediately following exposure, or after a period of asymptomatic colonization. The immune state at the time of exposure to an infectious agent, interaction between pathogens, and virulence factors intrinsic to the agent are important predictors of an individuals' outcome. Host factors such as extremes of age and underlying disease, human immunodeficiency virus/acquired immune deficiency syndrome, malignancy, and transplants can increase susceptibility to infection as do a variety of medications that alter the normal flora (e.g., antimicrobial agents, gastric acid suppressants, corticosteroids, antirejection drugs, antineoplastic agents, and immunosuppressive drugs). Surgical procedures and radiation therapy impair defenses of the skin and other involved organ systems. Indwelling devices such as urinary catheters, endotracheal tubes, central venous and arterial catheters and synthetic implants facilitate development of HAIs by allowing potential pathogens to bypass local defenses that would ordinarily impede their invasion and by providing surfaces for development of biofilms that may facilitate adherence of microorganisms and protect from antimicrobial activity. Some infections associated with invasive procedures result from transmission within the healthcare facility; others arise from the patient's endogenous flora.

Modes of Transmission

Several classes of pathogens can cause infection, including bacteria, viruses, fungi, parasites, and prions. The modes of transmission vary by type of organism and some infectious agents may be transmitted by more than one route: some are transmitted primarily by direct or indirect contact, (e.g., *Herpes simplex* virus [HSV], respiratory syncytial virus, *Staphylococcus aureus*), others by the droplet, (e.g., influenza virus, *B. pertussis*) or airborne routes (e.g., *M. tuberculosis*). Other infectious agents, such as bloodborne viruses (e.g., hepatitis B and C viruses [HBV, HCV] and HIV are transmitted rarely in healthcare settings, via percutaneous or mucous membrane exposure. Importantly, not all infectious agents are transmitted from person to person. The three principal routes of transmission are summarized below.

Contact Transmission

The most common mode of transmission, contact transmission is divided into two subgroups: direct contact and indirect contact.

Direct Contact Transmission - Direct transmission occurs when microorganisms are transferred from one infected person to another person without a contaminated intermediate object or person. Opportunities for direct contact transmission between patients and healthcare personnel include:

- blood or other blood-containing body fluids from a patient directly enters a caregiver's body through contact with a mucous membrane or breaks (i.e., cuts, abrasions) in the skin.
- mites from a scabies-infested patient are transferred to the skin of a caregiver while he/she is having direct ungloved contact with the patient's skin.
- a healthcare provider develops herpetic whitlow on a finger after contact with HSV when providing oral care to a patient without using gloves or HSV is transmitted to a patient from a herpetic whitlow on an ungloved hand of a healthcare worker (HCW).

Indirect Contact Transmission - Indirect transmission involves the transfer of an infectious agent through a contaminated intermediate object or person. In the absence of a point-source outbreak, it is difficult to determine how indirect transmission occurs. However, extensive evidence suggests that the contaminated hands of healthcare personnel are important contributors to indirect contact transmission. Examples of opportunities for indirect contact transmission include:

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- Hands of healthcare personnel may transmit pathogens after touching an infected or colonized body site on one patient or a contaminated inanimate object, if hand hygiene is not performed before touching another patient.
- Patient-care devices (e.g., electronic thermometers, glucose monitoring devices) may transmit pathogens if devices contaminated with blood or body fluids are shared between patients without cleaning and disinfecting between patients.
- Shared toys may become a vehicle for transmitting respiratory viruses (e.g., respiratory syncytial virus) or pathogenic bacteria (e.g., *Pseudomonas aeruginosa*) among pediatric patients.
- Instruments that are inadequately cleaned between patients before disinfection or sterilization (e.g., endoscopes or surgical instruments) or that have manufacturing defects that interfere with the effectiveness of reprocessing may transmit bacterial and viral pathogens.
- Clothing, uniforms, laboratory coats, or isolation gowns used as personal protective equipment (PPE), may become contaminated with potential pathogens after care of a patient colonized or infected with an infectious agent, (e.g., MRSA, VRE, and *C. difficile*). Although contaminated clothing has not been implicated directly in transmission, the potential exists for soiled garments to transfer infectious agents to successive patients.

Droplet Transmission

Droplet transmission is, technically, a form of contact transmission, and some infectious agents transmitted by the droplet route also may be transmitted by the direct and indirect contact routes. However, in contrast to contact transmission, respiratory droplets carrying infectious pathogens transmit infection when they travel directly from the respiratory tract of the infectious individual to susceptible mucosal surfaces of the recipient, generally over short distances, necessitating facial protection. Respiratory droplets are generated when an infected person coughs, sneezes, or talks, or during procedures such as suctioning, endotracheal intubation, cough induction by chest physical therapy and cardiopulmonary resuscitation. Evidence for droplet transmission comes from epidemiological studies of disease outbreaks, experimental studies and from information on aerosol dynamics. Nasal mucosa, conjunctivae and less frequently the mouth, are susceptible portals of entry for respiratory viruses. The maximum distance for droplet transmission is currently unresolved, although pathogens transmitted by the droplet route have not been transmitted through the air over long distances, in contrast to the airborne pathogens discussed below. Historically, the area of defined risk has been a distance of <3 feet around the patient. Using this distance for donning masks has been effective in preventing transmission of infectious agents via the droplet route. However, experimental studies with smallpox and investigations during the global SARS outbreaks of 2003 suggest

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that droplets from patients with these two infections could reach persons located 6 feet or more from their source. It is likely that the distance droplets travel depends on the velocity and mechanism by which respiratory droplets are propelled from the source, the density of respiratory secretions, environmental factors such as temperature and humidity, and the ability of the pathogen to maintain infectivity over that distance. Thus, a distance of <3 feet around the patient is best viewed as an example of what is meant by “a short distance from a patient” and should not be used as the sole criterion for deciding when a mask should be donned to protect from droplet exposure. Based on these considerations, it may be prudent to don a mask when within 6 to 10 feet of the patient or upon entry into the patient’s room, especially when exposure to emerging or highly virulent pathogens is likely. More studies are needed to improve understanding of droplet transmission under various circumstances.

Droplet size is another variable under discussion. Droplets traditionally have been defined as being >5 μm in size. Droplet nuclei, particles arising from desiccation of suspended droplets, have been associated with airborne transmission and defined as <5 μm in size, a reflection of the pathogenesis of pulmonary tuberculosis which is not generalizable to other organisms.

Observations of particle dynamics have demonstrated that a range of droplet sizes, including those with diameters of 30 μm or greater, can remain suspended in the air. The behavior of droplets and droplet nuclei affect recommendations for preventing transmission. Whereas fine airborne particles containing pathogens that are able to remain infective may transmit infections over long distances, requiring AIIR to prevent its dissemination within a facility; organisms transmitted by the droplet route do not remain infective over long distances, and therefore do not require special air handling and ventilation.

Examples of infectious agents that are transmitted via the droplet route include *Bordetella pertussis*, influenza virus, adenovirus, rhinovirus, *Mycoplasma pneumoniae*, SARS-associated coronavirus (SARS-CoV), group A streptococcus, and *Neisseria meningitidis*. Although respiratory syncytial virus may be transmitted by the droplet route, direct contact with infected respiratory secretions is the most important determinant of transmission and consistent adherence to Standard plus Contact Precautions prevents transmission in healthcare settings.

Rarely, pathogens that are not transmitted routinely by the droplet route are dispersed into the air over short distances. For example, although *S. aureus* is transmitted most frequently by the contact route, viral upper respiratory tract infection has been associated with increased dispersal of *S. aureus* from the nose into the air for a distance of 4 feet under both outbreak and experimental conditions.

Airborne Transmission

Airborne transmission occurs by dissemination of either airborne droplet nuclei or small particles in the respirable size range containing infectious agents that remain infective over time and distance (e.g., spores of *Aspergillus spp.*, and *Mycobacterium tuberculosis*). Microorganisms carried in this manner may be dispersed over long distances by air currents and may be inhaled by susceptible individuals who have not had face-to-face contact with (or been in the same room with) the infectious individual. Preventing the spread of pathogens that are transmitted by the airborne route requires the use of special air handling and ventilation systems (e.g., AIIRs) to contain and then safely remove the infectious agent. Infectious agents to which this applies include *Mycobacterium tuberculosis*, rubeola virus (measles), and varicella-zoster virus (chickenpox). In addition, it is speculated that variola virus (smallpox) may be transmitted over long distances through the air under unusual circumstances and AIIRs are recommended for this agent as well; however, droplet and contact routes are the more frequent routes of transmission for smallpox. In addition to AIIRs, respiratory protection with NIOSH certified N95 or higher level respirator is recommended for healthcare personnel entering the AIIR to prevent acquisition of airborne infectious agents such as *M. tuberculosis*.

For certain other respiratory infectious agents, such as influenza and rhinovirus, and even some gastrointestinal viruses (e.g., norovirus and rotavirus) there is some evidence that the pathogen may be transmitted via small-particle aerosols, under natural and experimental conditions. Such transmission has occurred over distances longer than 3 feet but within a defined airspace (e.g., patient room), suggesting that it is unlikely that these agents remain viable on air currents that travel long distances. AIIRs are not required routinely to prevent transmission of these agents. Additional issues concerning examples of small particle aerosol transmission of agents that are most frequently transmitted by the droplet route are discussed below.

Airborne Transmission from Patients - The emergence of SARS in 2002, the importation of monkeypox into the United States in 2003, and the emergence of avian influenza present challenges to the assignment of isolation categories because of conflicting information and uncertainty about possible routes of transmission. Although SARS-CoV is transmitted primarily by contact and/or droplet routes, airborne transmission over a limited distance (e.g. within a room), has been suggested, though not proven. This is true of other infectious agents such as influenza virus and noroviruses. Influenza viruses are transmitted primarily by close contact with respiratory droplets and acquisition by healthcare personnel has been prevented by Droplet Precautions, even when positive pressure rooms were used in one center. Observations of a protective effect of UV lights in preventing influenza among patients with tuberculosis during the influenza pandemic of 1957-'58 have been used to suggest airborne transmission.

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In contrast to the strict interpretation of an airborne route for transmission (i.e., long distances beyond the patient room environment), short distance transmission by small particle aerosols generated under specific circumstances (e.g., during endotracheal intubation) to persons in the immediate area near the patient has been demonstrated. Also, aerosolized particles <100 μm can remain suspended in air when room air current velocities exceed the terminal settling velocities of the particle. SARS-CoV transmission has been associated with endotracheal intubation, noninvasive positive pressure ventilation, and cardiopulmonary resuscitation. Although the most frequent routes of transmission of noroviruses are contact and food and waterborne routes, several reports suggest that noroviruses may be transmitted through aerosolization of infectious particles from vomitus or fecal material. It is hypothesized that the aerosolized particles are inhaled and subsequently swallowed.

Concerns about unknown or possible routes of transmission of agents associated with severe disease and no known treatment often result in more extreme prevention strategies than may be necessary; therefore, recommended precautions could change as the epidemiology of an emerging infection is defined and controversial issues are resolved.

Airborne Transmission from the Environment - Some airborne infectious agents are derived from the environment and do not usually involve person-to-person transmission. For example, anthrax spores present in a finely milled powdered preparation can be aerosolized from contaminated environmental surfaces and inhaled into the respiratory tract. Spores of environmental fungi (e.g., *Aspergillus spp.*) are ubiquitous in the environment and may cause disease in immunocompromised patients who inhale aerosolized (e.g., via construction dust) spores. As a rule, neither of these organisms is subsequently transmitted from infected patients.

Environmental sources of respiratory pathogens (eg. *Legionella*) transmitted to humans through a common aerosol source is distinct from direct patient-to-patient transmission.

Other Sources of Infection

Transmission of infection from sources other than infectious individuals include those associated with common environmental sources or vehicles (e.g. contaminated food, water, or medications (e.g. intravenous fluids). Although *Aspergillus spp.* have been recovered from hospital water systems, the role of water as a reservoir for immunosuppressed patients remains uncertain. Vectorborne transmission of infectious agents from mosquitoes, flies, rats, and other vermin also can occur in healthcare settings.

Infectious Agents of Special Infection Control Interest

Clostridium difficile

Clostridium difficile is a spore-forming gram positive anaerobic bacillus that was first isolated from stools of neonates in 1935 and identified as the most commonly identified causative agent of antibiotic-associated diarrhea and pseudomembranous colitis. This pathogen is a major cause of healthcare-associated diarrhea and has been responsible for many large outbreaks in healthcare settings that were extremely difficult to control. Important factors that contribute to healthcare-associated outbreaks include environmental contamination, persistence of spores for prolonged periods of time, resistance of spores to routinely used disinfectants and antiseptics, hand carriage by healthcare personnel to other patients, and exposure of patients to frequent courses of antimicrobial agents. Antimicrobials most frequently associated with increased risk of *C. difficile* include third generation cephalosporins, clindamycin, vancomycin, and fluoroquinolones.

Since 2001, outbreaks and sporadic cases of *C. difficile* with increased morbidity and mortality have been observed in several U.S. states, Canada, England and the Netherlands. The same strain of *C. difficile* has been implicated in these outbreaks.

Standardization of testing methodology and surveillance definitions is needed for accurate comparisons of trends in rates among hospitals. It is hypothesized that the incidence of disease and apparent heightened transmissibility of this new strain may be due, at least in part, to the greater production of toxins A and B, increasing the severity of diarrhea and resulting in more environmental contamination. Considering the greater morbidity, mortality, length of stay, and costs associated with *C. difficile* disease in both acute care and long term care facilities, control of this pathogen is now even more important than previously.

Prevention of transmission focuses on syndromic application of Contact Precautions for patients with diarrhea, accurate identification of patients, environmental measures (e.g., rigorous cleaning of patient rooms) and consistent hand hygiene. Use of soap and water, rather than alcohol based handrubs, for mechanical removal of spores from hands, and a bleach-containing disinfectant (5000 ppm) for environmental disinfection, may be valuable when there is transmission in a healthcare facility.

Multidrug-Resistant Organisms (MDROs)

In general, MDROs are defined as microorganisms – predominantly bacteria – that are resistant to one or more classes of antimicrobial agents. The following are some of the more common MDROs:

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- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Vancomycin resistant enterococcus (VRE)
- Multidrug-resistant *Streptococcus pneumoniae* (MDRSP)
- Multidrug-resistant gram-negative bacilli (MDR- GNB)
- Vancomycin-resistant *Staphylococcus aureus* (VRSA)

Although the names of certain MDROs suggest resistance to only one agent (e.g., methicillin-resistant *Staphylococcus aureus* [MRSA], vancomycin resistant enterococcus [VRE]), these pathogens are usually resistant to all but a few commercially available antimicrobial agents. This latter feature defines MDROs that are considered to be epidemiologically important and deserve special attention in healthcare facilities.

MDROs are transmitted by the same routes as antimicrobial susceptible infectious agents. Patient-to-patient transmission in healthcare settings, usually via hands of healthcare workers (HCWs), has been a major factor accounting for the increase in MDRO incidence and prevalence, especially for MRSA and VRE in acute care facilities. Preventing the emergence and transmission of these pathogens requires a comprehensive approach that includes administrative involvement and measures (e.g., nurse staffing, communication systems, performance improvement processes to ensure adherence to recommended infection control measures), education and training of medical and other healthcare personnel, judicious antibiotic use, comprehensive surveillance for targeted MDROs, application of infection control precautions during patient care, environmental measures (e.g., cleaning and disinfection of the patient care environment and equipment, dedicated single-patient-use of non-critical equipment), and decolonization therapy when appropriate.

The prevention and control of MDROs is a national priority - one that requires that all healthcare facilities and agencies assume responsibility and participate in community-wide control programs.

Noroviruses

Noroviruses, formerly referred to as Norwalk-like viruses, are members of the *Caliciviridae* family. These agents are transmitted via contaminated food or water and from person-to-person, causing explosive outbreaks of gastrointestinal disease. Environmental contamination also has been documented as a contributing factor in ongoing transmission during outbreaks. Reported outbreaks in hospitals, nursing homes, cruise ships, hotels, schools, and large crowded shelters established for hurricane evacuees, demonstrate their highly contagious nature, the disruptive impact they have in healthcare facilities and the community, and the difficulty of controlling outbreaks in settings where people share common facilities and space.

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The average incubation period for gastroenteritis caused by noroviruses is 12-48 hours and the clinical course lasts 12-60 hours. Illness is characterized by acute onset of nausea, vomiting, abdominal cramps, and/or diarrhea. The disease is largely self-limited; rarely, death caused by severe dehydration can occur, particularly among the elderly with debilitating health conditions.

The epidemiology of norovirus outbreaks shows that even though primary cases may result from exposure to a fecally-contaminated food or water, secondary and tertiary cases often result from person-to-person transmission that is facilitated by contamination of fomites and dissemination of infectious particles, especially during the process of vomiting. Widespread, persistent and inapparent contamination of the environment and fomites can make outbreaks extremely difficult to control.

These clinical observations and the detection of norovirus DNA on horizontal surfaces 5 feet above the level that might be touched normally suggest that, under certain circumstances, aerosolized particles may travel distances beyond 3 feet. It is hypothesized that infectious particles may be aerosolized from vomitus, inhaled, and swallowed. In addition, individuals who are responsible for cleaning the environment may be at increased risk of infection. Development of disease and transmission may be facilitated by the low infectious dose (i.e., <100 viral particles) and the resistance of these viruses to the usual cleaning and disinfection agents (i.e., may survive < 10 ppm chlorine). There are insufficient data to determine the efficacy of alcohol-based hand rubs against noroviruses when the hands are not visibly soiled.

The average incubation period for norovirus-associated gastroenteritis is 12 to 48 hours, with a median of approximately 33 hours. Illness is characterized by acute-onset vomiting; watery, non-bloody diarrhea with abdominal cramps, and nausea. In addition, myalgia, malaise, and headache are commonly reported. Low-grade fever is present in about half of cases. Dehydration is the most common complication and may require intravenous replacement fluids. Symptoms usually last 24 to 60 hours. Volunteer studies suggest that up to 30% of infections may be asymptomatic.

Noroviruses are highly contagious, with as few as 100 virus particles thought to be sufficient to cause infection. Noroviruses are transmitted primarily through the fecal-oral route, either by direct person-to-person spread or fecally contaminated food or water. Noroviruses can also spread via a droplet route from vomitus. These viruses are relatively stable in the environment and can survive freezing and heating to 60°C (140°F). In healthcare facilities, transmission can additionally occur through hand transfer of the virus to the oral mucosa via contact with materials, fomites, and environmental surfaces that have been contaminated with either feces or vomitus.

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CDC recommends either chlorine bleach or U.S. Environmental Protection Agency (EPA) approved disinfectants for use in controlling norovirus outbreaks. All disinfectants should be used on clean surfaces for maximum performance. Please see the U.S. Environmental Protection Agency (EPA) website for a list of hospital disinfectants registered by the EPA with specific claims for activity against noroviruses. It should be noted that evidence for efficacy of disinfectants against norovirus are usually based on data of efficacy against feline calicivirus (FCV) as a surrogate for norovirus. However, feline calicivirus (a virus of the respiratory system in cats) has different physio-chemical properties to norovirus and there is debate on how well data on inactivation of FCV reflects efficacy against norovirus.

Chlorine bleach should be applied to hard, non-porous, environmental surfaces at a minimum concentration of 1000 ppm (generally a dilution 1-part household bleach solution to 50 parts water) This concentration has been demonstrated in the laboratory to be effective against surrogate viruses with properties similar to those of norovirus.

Acinetobacter

Acinetobacter is a group of bacteria commonly found in soil and water. It can also be found on the skin of healthy people, especially healthcare personnel. While there are many types or “species” of *Acinetobacter* and all can cause human disease, *Acinetobacter baumannii* accounts for about 80% of reported infections.

Outbreaks of *Acinetobacter* infections typically occur in intensive care units and healthcare settings housing very ill patients. *Acinetobacter* infections rarely occur outside of healthcare settings.

Acinetobacter causes a variety of diseases, ranging from pneumonia to serious blood or wound infections and the symptoms vary depending on the disease.

Typical symptoms of pneumonia could include fever, chills, or cough.

Acinetobacter may also “colonize” or live in a patient without causing infection or symptoms, especially in tracheostomy sites or open wounds.

Acinetobacter poses very little risk to healthy people. However, people who have weakened immune systems, chronic lung disease, or diabetes may be more susceptible to infections with *Acinetobacter*. Hospitalized patients, especially very ill patients on a ventilator, those with a prolonged hospital stay, or those who have open wounds, are also at greater risk for *Acinetobacter* infection.

Acinetobacter can be spread to susceptible persons by person-to-person contact, contact with contaminated surfaces, or exposure in the environment.

Hepatitis A (HAV)

Nosocomial hepatitis A occurs infrequently, and transmission to personnel usually occurs when the source patient has unrecognized hepatitis and is fecally

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incontinent or has diarrhea. Other risk factors for hepatitis A virus (HAV) transmission to personnel include activities that increase the risk of fecal-oral contamination such as (a) eating or drinking in patient care areas, (b) not washing hands after handling an infected infant, and (c) sharing food, beverages, or cigarettes with patients, their families, or other staff members.

HAV is transmitted primarily by the fecal-oral route. It has not been reported to occur after inadvertent needlesticks or other contact with blood, but it has rarely been reported to be transmitted by transfusion of blood products. The incubation period for HAV is 15 to 50 days. Fecal excretion of HAV is greatest during the incubation period of disease before the onset of jaundice. Once disease is clinically obvious, the risk of transmitting infection is decreased. However, some patients admitted to the hospital with HAV, particularly immunocompromised patients, may still be shedding virus because of prolonged or relapsing disease, and such patients are potentially infective. Fecal shedding of HAV, formerly believed to continue only as long as 2 weeks after onset of dark urine, has been shown to occur as late as 6 months after diagnosis of infection in premature infants. Anicteric infection is typical in young children and infants.

Hepatitis B

HBV is transmitted through activities that involve percutaneous or mucosal contact with infectious blood or body fluids. HBV is not spread through food or water, sharing eating utensils, breastfeeding, hugging, kissing, hand holding, coughing, or sneezing.

The presence of signs and symptoms varies by age. Most children under age 5 years and newly infected immunosuppressed adults are asymptomatic, whereas 30%–50% of persons aged ≥ 5 years have initial signs and symptoms. When present, signs and symptoms can include

- Jaundice
- Fever
- Fatigue
- Loss of appetite
- Nausea
- Vomiting
- Abdominal pain
- Dark urine
- Clay-colored bowel movements
- Joint pain

Persons with chronic HBV infection might be asymptomatic, have no evidence of liver disease, or have a spectrum of disease ranging from chronic hepatitis to cirrhosis or hepatocellular carcinoma (a type of liver cancer).

Group A Streptococcus (GAS)

Group A streptococcus is a bacterium often found in the throat and on the skin. People may carry group A streptococci in the throat or on the skin and have no symptoms of illness. Most healthy people who come in contact with GAS will not develop invasive GAS disease. Most GAS infections are relatively mild illnesses such as "strep throat," or impetigo. However, occasionally, these bacteria can cause severe and even life-threatening diseases in people with chronic illnesses like cancer, diabetes, and kidney dialysis, and those who use medications such as steroids.

Group A streptococci are spread through direct contact with mucus from the nose or throat of persons who are infected or through contact with infected wounds or sores on the skin. Ill persons, such as those who have strep throat or skin infections, are most likely to spread the infection. Persons who carry the bacteria but have no symptoms are much less contagious. Treating an infected person with an antibiotic for 24 hours or longer generally eliminates their ability to spread the bacteria. However, it is important to complete the entire course of antibiotics as prescribed. It is not likely that household items like plates, cups, or toys spread these bacteria.

Severe, sometimes life-threatening, GAS disease may occur when bacteria get into parts of the body where bacteria usually are not found, such as the blood, muscle, or the lungs. These infections are termed "invasive GAS disease." Two of the most severe, but least common, forms of invasive GAS disease are necrotizing fasciitis and Streptococcal Toxic Shock Syndrome. Necrotizing fasciitis (occasionally described by the media as "the flesh-eating bacteria") destroys muscles, fat, and skin tissue. Streptococcal toxic shock syndrome (STSS), causes blood pressure to drop rapidly and organs (e.g., kidney, liver, lungs) to fail. STSS is not the same as the "toxic shock syndrome" frequently associated with tampon usage. About 20% of patients with necrotizing fasciitis and more than half with STSS die. About 10%-15% of patients with other forms of invasive group A streptococcal disease die.

Pseudomonas aeruginosa

P. aeruginosa is an aerobic, motile, gram-negative rod bacterium able to grow and survive in almost any environment. It lives primarily in water, soil, and vegetation. However, despite abundant opportunities for spread, *P. aeruginosa* rarely causes community-acquired infections in immunocompetent patients. As a result, the pathogen is viewed as opportunistic.

Pseudomonas aeruginosa is the most common gram-negative bacterium found in nosocomial infections. *P. aeruginosa* is responsible for 16% of nosocomial pneumonia cases, 12% of hospital-acquired urinary tract infections, 8% of surgical wound infections, and 10% of bloodstream infections.

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Immunocompromised patients, such as neutropenic cancer and bone marrow transplant patients, are particularly susceptible to opportunistic infections. In this group of patients, *P. aeruginosa* is responsible for pneumonia and septicemia with attributable deaths reaching 30%. *P. aeruginosa* is also one of the most common and lethal pathogens responsible for ventilator-associated pneumonia in intubated patients, with directly attributable death rates reaching 38%. In burn patients, *P. aeruginosa* bacteremia has declined as a result of better wound treatment and dietary changes (removal of raw vegetables, which can be contaminated with *P. aeruginosa*, from the diet). However, *P. aeruginosa* outbreaks in burn units are still associated with high (60%) death rates. In the expanding AIDS population, *P. aeruginosa* bacteremia is associated with 50% of deaths. Cystic fibrosis (CF) patients are characteristically susceptible to chronic infection by *P. aeruginosa*, which is responsible for high rates of illness and death in this population.

Respiratory Syncytial Virus (RSV)

Respiratory syncytial virus (RSV) is one of the common viruses that cause coughs and colds in the winter period. The virus is an enveloped RNA virus, in the same family as the human parainfluenza viruses and mumps and measles viruses.

The respiratory virus is transmitted by large droplets and by secretions, so you may catch it if you touch an infected person and then touch your own eyes, nose or mouth. The virus can survive on surfaces or objects for about 4-7 hours. Transmission can be prevented through standard infection control practices such as hand washing. The incubation period – the delay between infection and the appearance of symptoms – is short at about three to five days.

For most people, RSV infection causes a respiratory illness that is generally mild. For a small number of people who are at risk of more severe respiratory disease, RSV infection might cause pneumonia or even death. RSV is best known for causing bronchiolitis in infants. Bronchiolitis occurs when bronchioles, become inflamed and fill with mucus, making it difficult for a child to breathe. Over 60% of children have been infected by their first birthday, and over 80% by two years of age. The antibodies that develop following early childhood infection do not prevent further RSV infections throughout life. The full extent to which adults are affected by RSV remains unknown.

The very young (under 1 year of age) and the elderly are at the greatest risk. While most RSV infections usually cause mild illness, infants aged less than 6 months frequently develop the most severe disease (bronchiolitis and pneumonia), which may result in hospitalization. Children born prematurely, or with underlying chronic lung disease, and the elderly with chronic disease are also at increased risk of developing severe disease.

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RSV infection causes symptoms similar to a cold, including rhinitis (runny nose, sneezing or nasal congestion), cough, and sometimes fever. Ear infections and croup (a barking cough caused by inflammation of the upper airways) can also occur in children.

Hemorrhagic Fever Viruses (HFV)

The hemorrhagic fever viruses are a mixed group of viruses that cause serious disease with high fever, skin rash, bleeding diathesis, and in some cases, high mortality; the disease caused is referred to as viral hemorrhagic fever (VHF). Among the more commonly known HFVs are Ebola and Marburg viruses (Filoviridae), Lassa virus (Arenaviridae), Crimean-Congo hemorrhagic fever and Rift Valley Fever virus (Bunyaviridae), and Dengue and Yellow fever viruses (Flaviviridae).

These viruses are transmitted to humans via contact with infected animals or via arthropod vectors. While none of these viruses is endemic in the United States, outbreaks in affected countries provide potential opportunities for importation by infected humans and animals. Furthermore, there are concerns that some of these agents could be used as bioweapons. Person-to-person transmission is documented for Ebola, Marburg, Lassa and Crimean-Congo hemorrhagic fever viruses. In resource-limited healthcare settings, transmission of these agents to healthcare personnel, patients and visitors has been described and in some outbreaks has accounted for a large proportion of cases. Transmissions within households also have occurred among individuals who had direct contact with ill persons or their body fluids, but not to those who did not have such contact.

Person-to-person transmission is associated primarily with direct blood and body fluid contact. Percutaneous exposure to contaminated blood carries a particularly high risk for transmission and increased mortality. The finding of large numbers of Ebola viral particles in the skin and the lumina of sweat glands has raised concern that transmission could occur from direct contact with intact skin though epidemiologic evidence to support this is lacking. Postmortem handling of infected bodies is an important risk for transmission. In rare situations, cases in which the mode of transmission was unexplained among individuals with no known direct contact, have led to speculation that airborne transmission could have occurred. However, airborne transmission of naturally occurring HFVs in humans has not been seen.

In the laboratory setting, animals have been infected experimentally with Marburg or Ebola viruses via direct inoculation of the nose, mouth and/or conjunctiva, and by using mechanically generated virus-containing aerosols. Transmission of Ebola virus among laboratory primates in an animal facility has been described. Secondarily infected animals were in individual cages and separated by approximately 3 meters. Although the possibility of airborne transmission was

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suggested, the authors were not able to exclude droplet or indirect contact transmission in this incidental observation.

Guidance on infection control precautions for HFVs that are transmitted person-to-person have been published by CDC and by the Johns Hopkins Center for Civilian Biodefense Strategies. Inconsistencies among the various recommendations have raised questions about the appropriate precautions to use in U.S. hospitals. In less developed countries, outbreaks of HFVs have been controlled with basic hygiene, barrier precautions, safe injection practices, and safe burial practices. The preponderance of evidence on HFV transmission indicates that Standard, Contact and Droplet Precautions with eye protection are effective in protecting healthcare personnel and visitors who may attend an infected patient. Single gloves are adequate for routine patient care; double-gloving is advised during invasive procedures (e.g., surgery) that pose an increased risk for blood exposure. Routine eye protection (i.e. goggles or face shield) is particularly important. Fluid-resistant gowns should be worn for all patient contact. Airborne Precautions are not required for routine patient care; however, use of AIIRs is prudent when procedures that could generate infectious aerosols are performed (e.g., endotracheal intubation, bronchoscopy, suctioning, autopsy procedures involving oscillating saws). N95 or higher level respirators may provide added protection for individuals in a room during aerosol-generating procedures. When a patient with a syndrome consistent with hemorrhagic fever also has a history of travel to an endemic area, precautions are initiated upon presentation and then modified as more information is obtained. Patients with hemorrhagic fever syndrome in the setting of a suspected bioweapon attack should be managed using Airborne Precautions, including AIIRs, since the epidemiology of a potentially weaponized hemorrhagic fever virus is unpredictable.

Severe Acute Respiratory Syndrome (SARS CoV)

SARS is a newly discovered respiratory disease that emerged in China late in 2002 and spread to several countries; Mainland China, Hong Kong, Hanoi, Singapore, and Toronto were affected significantly. SARS is caused by SARS CoV, a previously unrecognized member of the coronavirus family. The incubation period from exposure to the onset of symptoms is 2 to 7 days but can be as long as 10 days and uncommonly even longer. The illness is initially difficult to distinguish from other common respiratory infections. Signs and symptoms usually include fever and chills and rigors, sometimes accompanied by headache, myalgia, and mild to severe respiratory symptoms.

Radiographic finding of atypical pneumonia is an important clinical indicator of possible SARS. Compared with adults, children have been affected less frequently, have milder disease, and are less likely to transmit SARS-CoV. The overall case fatality rate is approximately 6.0%; underlying disease and advanced age increase the risk of mortality.

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Outbreaks in healthcare settings, with transmission to large numbers of healthcare personnel and patients have been a striking feature of SARS; undiagnosed, infectious patients and visitors were important initiators of these outbreaks. The relative contribution of potential modes of transmission is not precisely known. There is ample evidence for droplet and contact transmission; however, opportunistic airborne transmission cannot be excluded. For example, exposure to aerosol-generating procedures (e.g., endotracheal intubation, suctioning) was associated with transmission of infection to large numbers of healthcare personnel outside of the United States. Therefore, aerosolization of small infectious particles generated during these and other similar procedures could be a risk factor for transmission to others within a multi-bed room or shared airspace.

A review of the infection control literature generated from the SARS outbreaks of 2003 concluded that the greatest risk of transmission is to those who have close contact, are not properly trained in use of protective infection control procedures, do not consistently use PPE; and that N95 or higher respirators may offer additional protection to those exposed to aerosol-generating procedures and high risk activities.

Control of SARS requires a coordinated, dynamic response by multiple disciplines in a healthcare setting. Early detection of cases is accomplished by screening persons with symptoms of a respiratory infection for history of travel to areas experiencing community transmission or contact with SARS patients, followed by implementation of Respiratory Hygiene/Cough Etiquette (i.e., placing a mask over the patient's nose and mouth) and physical separation from other patients in common waiting areas. The precise combination of precautions to protect healthcare personnel has not been determined. The CDC recommends Standard Precautions, with emphasis on the use of hand hygiene, Contact Precautions with emphasis on environmental cleaning due to the detection of SARS CoV RNA on surfaces in rooms occupied by SARS patients, Airborne Precautions, including use of fit-tested NIOSH-approved N95 or higher level respirators, and eye protection.

In Hong Kong, the use of Droplet and Contact Precautions, which included use of a mask but not a respirator, was effective in protecting healthcare personnel. However, in Toronto, consistent use of an N95 respirator was slightly more protective than a mask. It is noteworthy that there was no transmission of SARS-CoV to public hospital workers in Vietnam despite inconsistent use of infection control measures, including use of PPE, which suggests other factors (e.g., severity of disease, frequency of high risk procedures or events, environmental features) may influence opportunities for transmission.

SARS-CoV also has been transmitted in the laboratory setting through breaches in recommended laboratory practices. Research laboratories where SARS-CoV

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was under investigation were the source of most cases reported after the first series of outbreaks in the winter and spring of 2003.

Precautions to Prevent Transmission of Infectious Agents

There are two tiers of precautions to prevent transmission of infectious agents, Standard Precautions and Transmission-Based Precautions.

Standard Precautions are intended to be applied to the care of all patients in all healthcare settings, regardless of the suspected or confirmed presence of an infectious agent. Implementation of Standard Precautions constitutes the primary strategy for the prevention of healthcare-associated transmission of infectious agents among patients and healthcare personnel.

Transmission-Based Precautions are for patients who are known or suspected to be infected or colonized with infectious agents, including certain epidemiologically important pathogens, which require additional control measures to effectively prevent transmission. Since the infecting agent often is not known at the time of admission to a healthcare facility, Transmission-Based Precautions are used empirically, according to the clinical syndrome and the likely etiologic agents at the time, and then modified when the pathogen is identified or a transmissible infectious etiology is ruled out.

Standard Precautions

Standard Precautions combine the major features of Universal Precautions (UP) and Body Substance Isolation (BSI), and are based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions include a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which healthcare is delivered. These include: hand hygiene; use of gloves, gown, mask, eye protection, or face shield, depending on the anticipated exposure; and safe injection practices. Also, equipment or items in the patient environment likely to have been contaminated with infectious body fluids must be handled in a manner to prevent transmission of infectious agents (e.g. wear gloves for direct contact, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient).

The application of Standard Precautions during patient care is determined by the nature of the HCW-patient interaction and the extent of anticipated blood, body fluid, or pathogen exposure. For some interactions (e.g., performing venipuncture), only gloves may be needed; during other interactions (e.g., intubation), use of gloves, gown, and face shield or mask and goggles is necessary. Education and training on the principles and rationale for

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recommended practices are critical elements of Standard Precautions because they facilitate appropriate decision-making and promote adherence when HCWs are faced with new circumstances.

New Elements of Standard Precautions

Infection control problems that are identified in the course of outbreak investigations often indicate the need for new recommendations or reinforcement of existing infection control recommendations to protect patients. Because such recommendations are considered a standard of care and may not be included in other guidelines, they are added here to Standard Precautions. Three such areas of practice that have been added are: Respiratory Hygiene/Cough Etiquette, safe injection practices, and use of masks for insertion of catheters or injection of material into spinal or epidural spaces via lumbar puncture procedures (e.g., myelogram, spinal or epidural anesthesia). While most elements of Standard Precautions evolved from Universal Precautions that were developed for protection of healthcare personnel, these new elements of Standard Precautions focus on protection of patients.

Respiratory Hygiene/Cough Etiquette - The transmission of SARS CoV in emergency departments by patients and their family members during the widespread SARS outbreaks in 2003 highlighted the need for vigilance and prompt implementation of infection control measures at the first point of encounter within a healthcare setting (e.g., reception and triage areas in emergency departments, outpatient clinics, and physician offices). The strategy proposed has been termed Respiratory Hygiene/Cough Etiquette and is intended to be incorporated into infection control practices as a new component of Standard Precautions. The strategy is targeted at patients and accompanying family members and friends with undiagnosed transmissible respiratory infections, and applies to any person with signs of illness including cough, congestion, rhinorrhea, or increased production of respiratory secretions when entering a healthcare facility.

The term cough etiquette is derived from recommended source control measures for *M. tuberculosis*. The elements of Respiratory Hygiene/Cough Etiquette include:

- 1) Education of healthcare facility staff, patients, and visitors;
- 2) Posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends;
- 3) Source control measures (e.g., covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and appropriate);
- 4) Hand hygiene after contact with respiratory secretions; and

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5) Spatial separation, ideally >3 feet, of persons with respiratory infections in common waiting areas when possible.

Covering sneezes and coughs and placing masks on coughing patients are proven means of source containment that prevent infected persons from dispersing respiratory secretions into the air. Masking may be difficult in some settings, (e.g., pediatrics, in which case, the emphasis by necessity may be on cough etiquette. Physical proximity of <3 feet has been associated with an increased risk for transmission of infections via the droplet route (e.g., *N. meningitides* and group A streptococcus and therefore supports the practice of distancing infected persons from others who are not infected.

These measures should be effective in decreasing the risk of transmission of pathogens contained in large respiratory droplets (e.g., influenza virus, adenovirus, *B. pertussis* and *Mycoplasma pneumoniae*).

Although fever will be present in many respiratory infections, patients with pertussis and mild upper respiratory tract infections are often afebrile. Therefore, the absence of fever does not always exclude a respiratory infection. Patients who have asthma, allergic rhinitis, or chronic obstructive lung disease also may be coughing and sneezing. While these patients often are not infectious, cough etiquette measures are prudent.

Healthcare personnel are advised to observe Droplet Precautions (i.e., wear a mask) and hand hygiene when examining and caring for patients with signs and symptoms of a respiratory infection. Healthcare personnel who have a respiratory infection are advised to avoid direct patient contact, especially with high risk patients. If this is not possible, then a mask should be worn while providing patient care.

Safe Injection Practices - The investigation of four large outbreaks of HBV and HCV among patients in ambulatory care facilities in the United States identified a need to define and reinforce safe injection practices. The four outbreaks occurred in a private medical practice, a pain clinic, an endoscopy clinic, and a hematology/oncology clinic. The primary breaches in infection control practice that contributed to these outbreaks were 1) reinsertion of used needles into a multiple-dose vial or solution container (e.g., saline bag) and 2) use of a single needle/syringe to administer intravenous medication to multiple patients. In one of these outbreaks, preparation of medications in the same workspace where used needle/syringes were dismantled also may have been a contributing factor.

These and other outbreaks of viral hepatitis could have been prevented by adherence to basic principles of aseptic technique for the preparation and administration of parenteral medications. These include the use of a sterile,

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single-use, disposable needle and syringe for each injection given and prevention of contamination of injection equipment and medication. Whenever possible, use of single-dose vials is preferred over multiple-dose vials, especially when medications will be administered to multiple patients.

Outbreaks related to unsafe injection practices indicate that some healthcare personnel are unaware of, do not understand, or do not adhere to basic principles of infection control and aseptic technique. A survey of US healthcare workers who provide medication through injection found that 1% to 3% reused the same needle and/or syringe on multiple patients. Among the deficiencies identified in recent outbreaks were a lack of oversight of personnel and failure to follow-up on reported breaches in infection control practices in ambulatory settings. Therefore, to ensure that all healthcare workers understand and adhere to recommended practices, principles of infection control and aseptic technique need to be reinforced in training programs and incorporated into institutional policies that are monitored for adherence.

Transmission-Based Precautions

There are three categories of Transmission-Based Precautions: Contact Precautions, Droplet Precautions, and Airborne Precautions.

Transmission-Based Precautions are used when the route(s) of transmission is (are) not completely interrupted using Standard Precautions alone. For some diseases that have multiple routes of transmission (e.g., SARS), more than one Transmission-Based Precautions category may be used. When used either singly or in combination, they are always used in addition to Standard Precautions. When Transmission-Based Precautions are indicated, efforts must be made to counteract possible adverse effects on patients (i.e., anxiety, depression and other mood disturbances, perceptions of stigma, reduced contact with clinical staff, and increases in preventable adverse events in order to improve acceptance by the patients and adherence by HCWs.

Contact Precautions

Contact Precautions are intended to prevent transmission of infectious agents, including epidemiologically important microorganisms, which are spread by direct or indirect contact with the patient or the patient's environment. Contact Precautions also apply where the presence of excessive wound drainage, fecal incontinence, or other discharges from the body suggest an increased potential for extensive environmental contamination and risk of transmission. A single patient room is preferred for patients who require Contact Precautions. When a single-patient room is not available, consultation with infection control personnel is recommended to assess the various risks associated with other patient placement options (e.g., cohorting, keeping the patient with an existing roommate).

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In multi-patient rooms, >3 feet spatial separation between beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients. Healthcare personnel caring for patients on Contact Precautions wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment. Donning PPE upon room entry and discarding before exiting the patient room is done to contain pathogens, especially those that have been implicated in transmission through environmental contamination (e.g., VRE, *C. difficile*, noroviruses and other intestinal tract pathogens; RSV).

Droplet Precautions

Droplet Precautions are intended to prevent transmission of pathogens spread through close respiratory or mucous membrane contact with respiratory secretions. Because these pathogens do not remain infectious over long distances in a healthcare facility, special air handling and ventilation are not required to prevent droplet transmission. Infectious agents for which Droplet Precautions are indicated include *B. pertussis*, influenza virus, adenovirus, rhinovirus, *N. meningitides*, and group A streptococcus (for the first 24 hours of antimicrobial therapy).

A single patient room is preferred for patients who require Droplet Precautions. When a single-patient room is not available, consultation with infection control personnel is recommended to assess the various risks associated with other patient placement options (e.g., cohorting, keeping the patient with an existing roommate). Spatial separation of > 3 feet and drawing the curtain between patient beds is especially important for patients in multi-bed rooms with infections transmitted by the droplet route.

Healthcare personnel wear a mask (a respirator is not necessary) for close contact with infectious patient; the mask is generally donned upon room entry. Patients on Droplet Precautions who must be transported outside of the room should wear a mask if tolerated and follow Respiratory Hygiene/Cough Etiquette.

Airborne Precautions

Airborne Precautions prevent transmission of infectious agents that remain infectious over long distances when suspended in the air (e.g., rubeola virus [measles], varicella virus [chickenpox], *M. tuberculosis*, and possibly SARS-CoV).

The preferred placement for patients who require Airborne Precautions is in an airborne infection isolation room (AIIR). An AIIR is a single-patient room that is equipped with special air handling and ventilation capacity that meet the American Institute of Architects/Facility Guidelines Institute (AIA/FGI) standards for AIIRs (i.e., monitored negative pressure relative to the surrounding area, 12 air exchanges per hour for new construction and renovation and 6 air exchanges

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per hour for existing facilities, air exhausted directly to the outside or recirculated through HEPA filtration before return).

Some states require the availability of such rooms in hospitals, emergency departments, and nursing homes that care for patients with *M. tuberculosis*. A respiratory protection program that includes education about use of respirators, fit-testing, and user seal checks is required in any facility with AIIRs. In settings where Airborne Precautions cannot be implemented due to limited engineering resources (e.g., physician offices), masking the patient, placing the patient in a private room (e.g., office examination room) with the door closed, and providing N95 or higher level respirators or masks if respirators are not available for healthcare personnel will reduce the likelihood of airborne transmission until the patient is either transferred to a facility with an AIIR or returned to the home environment, as deemed medically appropriate.

Healthcare personnel caring for patients on Airborne Precautions wear a mask or respirator, depending on the disease-specific recommendations, that is donned prior to room entry. Whenever possible, non-immune HCWs should not care for patients with vaccine-preventable airborne diseases (e.g., measles, chickenpox, and smallpox).

Applications of Transmission-Based Precautions

Diagnosis of many infections requires laboratory confirmation. Since laboratory tests, especially those that depend on culture techniques, often require two or more days for completion, Transmission-Based Precautions must be implemented while test results are pending based on the clinical presentation and likely pathogens. Use of appropriate Transmission-Based Precautions at the time a patient develops symptoms or signs of transmissible infection, or arrives at a healthcare facility for care, reduces transmission opportunities. While it is not possible to identify prospectively all patients needing Transmission-Based Precautions, certain clinical syndromes and conditions carry a sufficiently high risk to warrant their use empirically while confirmatory tests are pending.

Discontinuation of Transmission-Based Precautions

Transmission-Based Precautions remain in effect for limited periods of time (i.e., while the risk for transmission of the infectious agent persists or for the duration of the illness. For most infectious diseases, this duration reflects known patterns of persistence and shedding of infectious agents associated with the natural history of the infectious process and its treatment.

For some diseases (e.g., pharyngeal or cutaneous diphtheria, RSV), Transmission-Based Precautions remain in effect until culture or antigen-detection test results document eradication of the pathogen and, for RSV, symptomatic disease is resolved. For other diseases, (e.g., *M. tuberculosis*) state laws and regulations, and healthcare facility policies, may dictate the duration of precautions).

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In immunocompromised patients, viral shedding can persist for prolonged periods of time (many weeks to months) and transmission to others may occur during that time; therefore, the duration of contact and/or droplet precautions may be prolonged for many weeks.

The duration of Contact Precautions for patients who are colonized or infected with MDROs remains undefined. MRSA is the only MDRO for which effective decolonization regimens are available. However, carriers of MRSA who have negative nasal cultures after a course of systemic or topical therapy may resume shedding MRSA in the weeks that follow therapy.

Although early guidelines for VRE suggested discontinuation of Contact Precautions after three stool cultures obtained at weekly intervals proved negative, subsequent experiences have indicated that such screening may fail to detect colonization that can persist for >1 year. Likewise, available data indicate that colonization with VRE, MRSA, and possibly MDR-GNB, can persist for many months, especially in the presence of severe underlying disease, invasive devices, and recurrent courses of antimicrobial agents. It may be prudent to assume that MDRO carriers are colonized permanently and manage them accordingly. Alternatively, an interval free of hospitalizations, antimicrobial therapy, and invasive devices (e.g., 6 or 12 months) before reculturing patients to document clearance of carriage may be used.

Transmission-Based Precautions in Ambulatory and Home Care Settings

Although Transmission-Based Precautions generally apply in all healthcare settings, exceptions exist. For example, in home care, AIIRs are not available. Furthermore, family members already exposed to diseases such as varicella and tuberculosis would not use masks or respiratory protection, but visiting HCWs would need to use such protection. Similarly, management of patients colonized or infected with MDROs may necessitate Contact Precautions in acute care hospitals and in some long term care facilities when there is continued transmission, but the risk of transmission in ambulatory care and home care, has not been defined. Consistent use of Standard Precautions may suffice in these settings, but more information is needed.

Transmission Risks Specific to Type of Healthcare Settings

Numerous factors influence differences in transmission risks among the various healthcare settings. These include the population characteristics (e.g., increased susceptibility to infections, type and prevalence of indwelling devices), intensity of care, exposure to environmental sources, length of stay, and frequency of interaction between patients/residents with each other and with HCWs. These factors, as well as organizational priorities, goals, and resources, influence how different healthcare settings adapt transmission prevention guidelines to meet

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their specific needs. Infection control management decisions are informed by data regarding institutional experience/epidemiology, trends in community and institutional HAIs, local, regional, and national epidemiology, and emerging infectious disease threats.

Hospitals

Infection transmission risks are present in all hospital settings. However, certain hospital settings and patient populations have unique conditions that predispose patients to infection and merit special mention. These are often sentinel sites for the emergence of new transmission risks that may be unique to that setting or present opportunities for transmission to other settings in the hospital.

Intensive Care Units

Intensive care units (ICUs) serve patients who are immunocompromised by disease state and/or by treatment modalities, as well as patients with major trauma, respiratory failure and other life-threatening conditions (e.g., myocardial infarction, congestive heart failure, overdoses, strokes, gastrointestinal bleeding, renal failure, hepatic failure, multi-organ system failure, and the extremes of age).

Although ICUs account for a relatively small proportion of hospitalized patients, infections acquired in these units accounted for >20% of all HAIs. In the National Nosocomial Infection Surveillance (NNIS) system, 26.6% of HAIs were reported from ICU and high risk nursery (NICU) patients. This patient population has increased susceptibility to colonization and infection, especially with MDROs and *Candida* sp., because of underlying diseases and conditions, invasive medical devices and technology used in their care (e.g. central venous catheters and other intravascular devices, mechanical ventilators, extracorporeal membrane oxygenation, hemodialysis, filtration, pacemakers), the frequency of contact with healthcare personnel, prolonged length of stay, and prolonged exposure to antimicrobial agents. Furthermore, adverse patient outcomes in this setting are more severe and are associated with a higher mortality. Outbreaks associated with a variety of bacterial, fungal and viral pathogens due to common source and person-to-person transmissions are frequent in adult and pediatric ICUs.

Burn Units

Burn wounds can provide optimal conditions for colonization, infection, and transmission of pathogens; infection acquired by burn patients is a frequent cause of morbidity and mortality. In patients with a burn injury involving >30% of the total body surface area (TBSA), the risk of invasive burn wound infection is particularly high. Infections that occur in patients with burn injury involving <30% TBSA are usually associated with the use of invasive devices. Methicillin-susceptible *Staphylococcus aureus*, MRSA, enterococci, including VRE, gram-negative bacteria, and *Candida* are prevalent pathogens in burn infections and outbreaks of these organisms have been reported.

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Burn wound infections caused by *Aspergillus* sp. or other environmental molds may result from exposure to supplies contaminated during construction or to dust generated during construction or other environmental disruption.

Hydrotherapy equipment is an important environmental reservoir of gram negative organisms. Its use for burn care is discouraged based on demonstrated associations between use of contaminated hydrotherapy equipment and infections. Burn wound infections and colonization, as well as bloodstream infections, caused by multidrug-resistant *P. aeruginosa*, *A. baumannii*, and MRSA have been associated with hydrotherapy; excision of burn wounds in operating rooms is preferred.

Advances in burn care, specifically early excision and grafting of the burn wound, use of topical antimicrobial agents, and institution of early enteral feeding, have led to decreased infectious complications. Other advances have included prophylactic antimicrobial usage, selective digestive decontamination (SDD), and use of antimicrobial-coated catheters (ACC), but few epidemiologic studies and no efficacy studies have been performed to show the relative benefit of these measures.

There is no consensus on the most effective infection control practices to prevent transmission of infections to and from patients with serious burns. There also is controversy regarding the need for and type of barrier precautions for routine care of burn patients. Unfortunately, to date, there have been no studies that define the most effective combination of infection control precautions for use in burn settings. Prospective studies in this area are needed.

Pediatrics

Studies of the epidemiology of HAIs in children have identified unique infection control issues in this population. Pediatric intensive care unit (PICU) patients and the lowest birth weight babies in the high risk nursery (HRN) have had high rates of central venous catheter-associated bloodstream infections. Additionally, there is a high prevalence of community-acquired infections among hospitalized infants and young children who have not yet become immune either by vaccination or by natural infection. The result is more patients and their sibling visitors with transmissible infections present in pediatric healthcare settings, especially during seasonal epidemics (e.g., pertussis, respiratory viral infections including those caused by RSV, influenza viruses, parainfluenza virus, human metapneumovirus, and adenoviruses; rubeola [measles], varicella [chickenpox], and rotavirus).

Close physical contact between healthcare personnel and infants and young children (eg. cuddling, feeding, playing, changing soiled diapers, and cleaning copious uncontrolled respiratory secretions) provides abundant opportunities for transmission of infectious material. Practices and behaviors such as congregation of children in play areas where toys and bodily secretions are easily shared and family members rooming-in with pediatric patients can further increase the risk of transmission.

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Pathogenic bacteria have been recovered from toys used by hospitalized patients; contaminated bath toys were implicated in an outbreak of multidrug-resistant *P. aeruginosa* on a pediatric oncology unit.

In addition, several patient factors increase the likelihood that infection will result from exposure to pathogens in healthcare settings (e.g., immaturity of the neonatal immune system, lack of previous natural infection and resulting immunity, prevalence of patients with congenital or acquired immune deficiencies, congenital anatomic anomalies, and use of life-saving invasive devices in neonatal and pediatric intensive care units). There are theoretical concerns that infection risk will increase in association with innovative practices used in the NICU for the purpose of improving developmental outcomes. Such factors include co-bedding and kangaroo care that may increase opportunity for skin-to-skin exposure of multiple gestation infants to each other and to their mothers, respectively; although infection risks may actually be reduced among infants receiving kangaroo care. Children who attend child care centers and pediatric rehabilitation units may increase the overall burden of antimicrobial resistance (eg. by contributing to the reservoir of community-associated MRSA [CA-MRSA]). Patients in chronic care facilities may have increased rates of colonization with resistant GNBs and may be sources of introduction of resistant organisms to acute care settings.

Non-acute Healthcare Settings

Healthcare is provided in various settings outside of hospitals including facilities, such as long-term care facilities (LTCF), homes for the developmentally disabled, settings where behavioral health services are provided, rehabilitation centers and hospices. In addition, healthcare may be provided in non-healthcare settings such as workplaces with occupational health clinics, adult day care centers, assisted living facilities, homeless shelters, jails and prisons, school clinics and infirmaries. Each of these settings has unique circumstances and population risks to consider when designing and implementing an infection control program. Several of the most common settings and their particular challenges are discussed below.

Long-term Care

The designation long-term health facility (LTCF) applies to a diverse group of residential settings, ranging from institutions for the developmentally disabled to nursing homes for the elderly and pediatric chronic-care facilities. Nursing homes for the elderly predominate numerically and frequently represent long-term care as a group of facilities. Approximately 1.8 million Americans reside in the nation's 16,500 nursing homes. Estimates of HAI rates of 1.8 to 13.5 per 1000 resident-care days have been reported with a range of 3 to 7 per 1000 resident-care days in the more rigorous studies.

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LTCFs are different from other healthcare settings in that elderly patients at increased risk for infection are brought together in one setting and remain in the facility for extended periods of time; for most residents, it is their home. An atmosphere of community is fostered and residents share common eating and living areas, and participate in various facility-sponsored activities. Since able residents interact freely with each other, controlling transmission of infection in this setting is challenging. Residents who are colonized or infected with certain microorganisms are, in some cases, restricted to their room. However, because of the psychosocial risks associated with such restriction, it has been recommended that psychosocial needs be balanced with infection control needs in the LTCF setting. Documented LTCF outbreaks have been caused by various viruses (e.g., influenza virus, rhinovirus, adenovirus, and norovirus) and bacteria, including group A streptococcus, *B. pertussis*, non-susceptible *S. pneumoniae*, other MDROs, and *Clostridium difficile*. These pathogens can lead to substantial morbidity and mortality, and increased medical costs; prompt detection and implementation of effective control measures are required.

Risk factors for infection are prevalent among LTCF residents. Age related declines in immunity may affect responses to immunizations for influenza and other infectious agents, and increase susceptibility to tuberculosis. Immobility, incontinence, dysphagia, underlying chronic diseases, poor functional status, and age-related skin changes increase susceptibility to urinary, respiratory and cutaneous and soft tissue infections, while malnutrition can impair wound healing. Medications (e.g., drugs that affect level of consciousness, immune function, gastric acid secretions, and normal flora, including antimicrobial therapy) and invasive devices (e.g., urinary catheters and feeding tubes) heighten susceptibility to infection and colonization in LTCF residents.

Finally, limited functional status and total dependence on healthcare personnel for activities of daily living have been identified as independent risk factors for infection and for colonization with MRSA and ESBL-producing *K. pneumoniae*.

Because residents of LTCFs are hospitalized frequently, they can transfer pathogens between LTCFs and healthcare facilities in which they receive care. This is also true for pediatric long-term care populations. Pediatric chronic care facilities have been associated with importing extended-spectrum cephalosporin-resistant, gram-negative bacilli into one PICU. Children from pediatric rehabilitation units may contribute to the reservoir of community associated MRSA.

Ambulatory Care

In the past decade, healthcare delivery in the United States has shifted from the acute, inpatient hospital to a variety of ambulatory and community-based settings, including the home. Ambulatory care is provided in hospital-based outpatient clinics, nonhospital-based clinics and physician offices, public health clinics, free-standing dialysis centers, ambulatory surgical centers, urgent care

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centers, and many others. Ambulatory care now accounts for most patient encounters with the health care system. In these settings, adapting transmission prevention guidelines is challenging because patients remain in common areas for prolonged periods waiting to be seen by a healthcare provider or awaiting admission to the hospital, examination or treatment rooms are turned around quickly with limited cleaning, and infectious patients may not be recognized immediately. Furthermore, immunocompromised patients often receive chemotherapy in infusion rooms where they stay for extended periods of time along with other types of patients.

There are few data on the risk of HAIs in ambulatory care settings. Transmission of bloodborne pathogens (i.e., hepatitis B and C viruses and, rarely, HIV) in outbreaks, sometimes involving hundreds of patients, continues to occur in ambulatory settings. These outbreaks often are related to common source exposures, usually a contaminated medical device, multi-dose vial, or intravenous solution. In all cases, transmission has been attributed to failure to adhere to fundamental infection control principles, including safe injection practices and aseptic technique.

Airborne transmission of *M.tuberculosis* and measles in ambulatory settings, most frequently emergency departments, has been reported. Measles virus was transmitted in physician offices and other outpatient settings during an era when immunization rates were low and measles outbreaks in the community were occurring regularly. Rubella has been transmitted in the outpatient obstetric setting; there are no published reports of varicella transmission in the outpatient setting. In the ophthalmology setting, adenovirus type 8 epidemic keratoconjunctivitis has been transmitted via incompletely disinfected ophthalmology equipment and/or from healthcare workers to patients, presumably by contaminated hands.

If transmission in outpatient settings is to be prevented, screening for potentially infectious symptomatic and asymptomatic individuals, especially those who may be at risk for transmitting airborne infectious agents (e.g., *M. tuberculosis*, varicella-zoster virus, rubeola [measles]), is necessary at the start of the initial patient encounter. Upon identification of a potentially infectious patient, implementation of prevention measures, including prompt separation of potentially infectious patients and implementation of appropriate control measures (e.g., Respiratory Hygiene/Cough Etiquette and Transmission-Based Precautions) can decrease transmission risks. Transmission of MRSA and VRE in outpatient settings has not been reported, but the association of CA-MRSA in healthcare personnel working in an outpatient HIV clinic with environmental CA-MRSA contamination in that clinic, suggests the possibility of transmission in that setting. Patient-to-patient transmission of *Burkholderia species* and *Pseudomonas aeruginosa* in outpatient clinics for adults and children with cystic fibrosis has been confirmed.

Home Care

Home care in the United States is delivered by over 20,000 provider agencies that include home health agencies, hospices, durable medical equipment providers, home infusion therapy services, and personal care and support services providers. Home care is provided to patients of all ages with both acute and chronic conditions. The scope of services ranges from assistance with activities of daily living and physical and occupational therapy to the care of wounds, infusion therapy, and chronic ambulatory peritoneal dialysis (CAPD). The incidence of infection in home care patients, other than those associated with infusion therapy is not well studied. However, data collection and calculation of infection rates have been accomplished for central venous catheter-associated bloodstream infections in patients receiving home infusion therapy and for the risk of blood contact through percutaneous or mucosal exposures, demonstrating that surveillance can be performed in this setting.

Transmission risks during home care are presumed to be minimal. The main transmission risks to home care patients are from an infectious healthcare provider or contaminated equipment; providers also can be exposed to an infectious patient during home visits. Since home care involves patient care by a limited number of personnel in settings without multiple patients or shared equipment, the potential reservoir of pathogens is reduced. Infections of home care providers, that could pose a risk to home care patients include infections transmitted by the airborne or droplet routes (e.g., chickenpox, tuberculosis, influenza), and skin infestations (e.g., scabies and lice) and infections (e.g., impetigo) transmitted by direct or indirect contact. There are no published data on indirect transmission of MDROs from one home care patient to another, although this is theoretically possible if contaminated equipment is transported from an infected or colonized patient and used on another patient.

Home health care also may contribute to antimicrobial resistance; a review of outpatient vancomycin use found 39% of recipients did not receive the antibiotic according to recommended guidelines. This issue has been very challenging in the home care industry and practice has been inconsistent and frequently not evidence-based.

Other Healthcare Delivery Sites

Facilities that are not primarily healthcare settings, but in which healthcare is delivered, include clinics in correctional facilities and shelters. Both settings can have suboptimal features, such as crowded conditions and poor ventilation. Economically disadvantaged individuals who may have chronic illnesses and healthcare problems related to alcoholism, injection drug use, poor nutrition, and/or inadequate shelter often receive their primary healthcare at sites such as these. Infectious diseases of special concern for transmission include tuberculosis, scabies, respiratory infections (e.g., *N. meningitides*, *S. pneumoniae*), sexually transmitted and bloodborne diseases (e.g., HIV, HBV,

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HCV, syphilis, gonorrhea), hepatitis A virus (HAV), diarrheal agents such as norovirus, and foodborne diseases. A high index of suspicion for tuberculosis and CA-MRSA in these populations is needed as outbreaks in these settings or among the populations they serve is relatively frequent.

Patient encounters in these types of facilities provide an opportunity to deliver recommended immunizations and screen for *M. tuberculosis* infection in addition to diagnosing and treating acute illnesses. Recommended infection control measures in these non-traditional areas designated for healthcare delivery are the same as for other ambulatory care settings. Therefore, these settings must be equipped to observe Standard Precautions and, when indicated, Transmission-Based Precautions.

Transmission Risks Associated with Special Patient Populations

As new treatments emerge for complex diseases, unique infection control challenges associated with special patient populations need to be addressed.

Immunocompromised Patients

Patients who have congenital primary immune deficiencies or acquired disease (eg. treatment-induced immune deficiencies) are at increased risk for numerous types of infections while receiving healthcare and may be located throughout the healthcare facility. The specific defects of the immune system determine the types of infections that are most likely to be acquired (e.g., viral infections are associated with T-cell defects and fungal and bacterial infections occur in patients who are neutropenic). As a general group, immunocompromised patients can be cared for in the same environment as other patients; however, it is always advisable to minimize exposure to other patients with transmissible infections such as influenza and other respiratory viruses.

The use of more intense chemotherapy regimens for treatment of childhood leukemia may be associated with prolonged periods of neutropenia and suppression of other components of the immune system, extending the period of infection risk and raising the concern that additional precautions may be indicated for select groups. With the application of newer and more intense immunosuppressive therapies for a variety of medical conditions (e.g., rheumatologic disease, inflammatory bowel disease), immunosuppressed patients are likely to be more widely distributed throughout a healthcare facility rather than localized to single patient units (e.g. hematology-oncology).

Cystic Fibrosis Patients

Patients with cystic fibrosis (CF) require special consideration when developing infection control guidelines. Compared to other patients, CF patients require

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additional protection to prevent transmission from contaminated respiratory therapy equipment. Infectious agents such as *Burkholderia cepacia* complex and *P. aeruginosa* have unique clinical and prognostic significance. In CF patients, *B. cepacia* infection has been associated with increased morbidity and mortality, while delayed acquisition of chronic *P. aeruginosa* infection may be associated with an improved long-term clinical outcome.

Person-to-person transmission of *B. cepacia* complex has been demonstrated among children and adults with CF in healthcare settings, during various social contacts, most notably attendance at camps for patients with CF, and among siblings with CF.

Successful infection control measures used to prevent transmission of respiratory secretions include segregation of CF patients from each other in ambulatory and hospital settings (including use of private rooms with separate showers), environmental decontamination of surfaces and equipment contaminated with respiratory secretions, elimination of group chest physiotherapy sessions, and disbanding of CF camps. The Cystic Fibrosis Foundation published a consensus document with evidence based recommendations for infection control practices for CF patients.

Therapies Associated with Potentially Transmissible Infectious Agents

Gene Therapy

Gene therapy has been attempted using a number of different viral vectors, including non-replicating retroviruses, adenoviruses, adeno-associated viruses, and replication-competent strains of poxviruses. Unexpected adverse events have restricted the prevalence of gene therapy protocols. The infectious hazards of gene therapy are theoretical at this time, but require meticulous surveillance due to the possible occurrence of in vivo recombination and the subsequent emergence of a transmissible genetically altered pathogen. Greatest concern attends the use of replication-competent viruses, especially vaccinia. Currently, no reports have documented transmission of a vector virus from a gene therapy recipient to another individual, but surveillance is ongoing.

Donation of Human Biological Products

The potential hazard of transmitting infectious pathogens through biologic products is a small but ever present risk, despite donor screening. Reported infections transmitted by transfusion or transplantation include West Nile Virus infection, cytomegalovirus infection, Creutzfeldt-Jacob disease, hepatitis C, infections with *Clostridium* spp. and group A streptococcus, malaria, babesiosis, Chagas disease, lymphocytic choriomeningitis, and rabies. Therefore, it is

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important to consider receipt of biologic products when evaluating patients for potential sources of infection.

Xenotransplantation

Xenotransplantation is the transplantation of nonhuman cells, tissues, and organs into humans. This potentially exposes patients to zoonotic pathogens. Transmission of known zoonotic infections (e.g., trichinosis from porcine tissue), constitutes one concern, but also of concern is the possibility that transplantation of nonhuman cells, tissues, or organs may transmit previously unknown zoonotic infections (xenozoonoses) to immunosuppressed human recipients.

Prevention of Transmission of Infectious Agents

Administrative Measures

Healthcare organizations can demonstrate a commitment to preventing transmission of infectious agents by incorporating infection control into the objectives of the organization's patient and occupational safety programs. An infrastructure to guide, support, and monitor adherence to Standard and Transmission-Based Precautions will facilitate fulfillment of the organization's mission and achievement of the Joint Commission on Accreditation of Healthcare Organization's patient safety goal to decrease HAIs.

Policies and procedures that explain how Standard and Transmission-Based Precautions are applied, including systems used to identify and communicate information about patients with potentially transmissible infectious agents, are essential to ensure the success of these measures and may vary according to the characteristics of the organization.

Several administrative factors may affect the transmission of infectious agents in healthcare settings: institutional culture, individual worker behavior, and the work environment. Each of these areas is suitable for performance improvement monitoring and incorporation into the organization's patient safety goals.

Infection Control Professionals (ICP)

The effectiveness of infection surveillance and control programs in preventing nosocomial infections in United States hospitals was assessed by the CDC through the Study on the Efficacy of Nosocomial Infection Control (SENIC Project) conducted 1970-76. In a representative sample of US general hospitals, those with a trained infection control physician or microbiologist involved in an infection control program, and at least one infection control nurse per 250 beds, were associated with a 32% lower rate of four infections studied (CVC-associated bloodstream infections, ventilator-associated pneumonias, catheter-related urinary tract infections, and surgical site infections).

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Since that landmark study was published, responsibilities of ICPs have expanded commensurate with the growing complexity of the healthcare system, the patient populations served, and the increasing numbers of medical procedures and devices used in all types of healthcare settings. The scope of work of ICPs was first assessed in 1982 by the Certification Board of Infection Control (CBIC), and has been re-assessed every five years since that time. The findings of these task analyses have been used to develop and update the Infection Control Certification Examination, offered for the first time in 1983. With each survey, it is apparent that the role of the ICP is growing in complexity and scope, beyond traditional infection control activities in acute care hospitals.

Activities currently assigned to ICPs in response to emerging challenges include:

- 1) Surveillance and infection prevention at facilities other than acute care hospitals e.g., ambulatory clinics, day surgery centers, long term care facilities, rehabilitation centers, home care;
- 2) Oversight of employee health services related to infection prevention, e.g. assessment of risk and administration of recommended treatment following exposure to infectious agents, tuberculosis screening, influenza vaccination, respiratory protection fit testing, and administration of other vaccines as indicated, such as smallpox vaccine in 2003;
- 3) Preparedness planning for annual influenza outbreaks, pandemic influenza, SARS, bioweapons attacks
- 4) Adherence monitoring for selected infection control practices;
- 5) Oversight of risk assessment and implementation of prevention measures associated with construction and renovation;
- 6) Prevention of transmission of MDROs;
- 7) Evaluation of new medical products that could be associated with increased infection risk. e.g., intravenous infusion materials;
- 8) Communication with the public, facility staff, and state and local health departments concerning infection control-related issues; and
- 9) Participation in local and multi-center research projects

Institutional Safety Culture and Organizational Characteristics

Safety culture (or safety climate) refers to a work environment where a shared commitment to safety on the part of management and the workforce is understood and followed. The authors of the Institute of Medicine Report, *To Err is Human*, acknowledge that causes of medical error are multifaceted but emphasize repeatedly the pivotal role of system failures and the benefits of a safety culture. A safety culture is created through:

- 1) Actions management takes to improve patient and worker safety;
- 2) Worker participation in safety planning;
- 3) Availability of appropriate protective equipment;
- 4) Influence of group norms regarding acceptable safety practices; and
- 5) The organization's socialization process for new personnel.

Safety and patient outcomes can be enhanced by improving or creating organizational characteristics within patient care units.

Each of these factors has a direct bearing on adherence to transmission prevention recommendations. Measurement of an institutional culture of safety is useful for designing improvements in healthcare.

Adherence of Healthcare Personnel to Recommended Guidelines

Adherence to recommended infection control practices decreases transmission of infectious agents in healthcare settings. However, several observational studies have shown limited adherence to recommended practices by healthcare personnel. Observed adherence to universal precautions ranged from 43% to 89%. However, the degree of adherence depended frequently on the practice that was assessed and, for glove use, the circumstance in which they were used. Appropriate glove use has ranged from a low of 15% to a high of 82%. However, 92% and 98% adherence with glove use have been reported during arterial blood gas collection and resuscitation, respectively, procedures where there may be considerable blood contact. Differences in observed adherence have been reported among occupational groups in the same healthcare facility and between experienced and non-experienced professionals. In surveys of healthcare personnel, self-reported adherence was generally higher than that reported in observational studies. Furthermore, where an observational component was included with a self-reported survey, self-perceived adherence was often greater than observed adherence. Among nurses and physicians, increasing years of experience is a negative predictor of adherence. Education to improve adherence is the primary intervention that has been studied. While positive changes in knowledge and attitude have been demonstrated, there often has been limited or no accompanying change in behavior. Self-reported adherence is

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higher in groups that have received an educational intervention. Educational interventions that incorporated videotaping and performance feedback were successful in improving adherence during the period of study; the long-term effect of these interventions is not known. The use of videotape also served to identify system problems (e.g., communication and access to personal protective equipment) that otherwise may not have been recognized.

Use of engineering controls and facility design concepts for improving adherence is gaining interest. While introduction of automated sinks had a negative impact on consistent adherence to hand washing, use of electronic monitoring and voice prompts to remind healthcare workers to perform hand hygiene, and improving accessibility to hand hygiene products, increased adherence and contributed to a decrease in HAIs. More information is needed regarding how technology might improve adherence.

Improving adherence to infection control practices requires a multifaceted approach that incorporates continuous assessment of both the individual and the work environment. Evidence indicates that a single intervention (e.g., a hand washing campaign or putting up new posters about transmission precautions) would likely be ineffective in improving healthcare personnel adherence. Improvement requires that the organizational leadership make prevention an institutional priority and integrate infection control practices into the organization's safety culture. It has been concluded that variations in organizational factors (e.g., safety climate, policies and procedures, education and training) and individual factors (e.g., knowledge, perceptions of risk, past experience) were determinants of adherence to infection control guidelines for protection against SARS and other respiratory pathogens.

Surveillance for Healthcare-Associated Infections (HAIs)

Surveillance is an essential tool for case-finding of single patients or clusters of patients who are infected or colonized with epidemiologically important organisms (e.g., susceptible bacteria such as *S. aureus*, *S. pyogenes* or Enterobacter-Klebsiella spp; MRSA, VRE, and other MDROs; *C. difficile*; RSV; influenza virus) for which transmission-based precautions may be required. Surveillance is defined as the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health.

Surveillance of both process measures and the infection rates to which they are linked are important for evaluating the effectiveness of infection prevention efforts and identifying indications for change.

The Study on the Efficacy of Nosocomial Infection Control (SENIC) found that different combinations of infection control practices resulted in reduced rates of nosocomial surgical site infections, pneumonia, urinary tract infections, and

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bacteremia in acute care hospitals; however, surveillance was the only component essential for reducing all four types of HAIs.

The essential elements of a surveillance system are:

- 1) Standardized definitions;
- 2) Identification of patient populations at risk for infection;
- 3) Statistical analysis (e.g. risk-adjustment, calculation of rates using appropriate denominators, trend analysis using methods such as statistical process control charts); and
- 4) Feedback of results to the primary caregivers.

Data gathered through surveillance of high-risk populations, device use, procedures, and/or facility locations (e.g., ICUs) are useful for detecting transmission trends. Identification of clusters of infections should be followed by a systematic epidemiologic investigation to determine commonalities in persons, places, and time; and guide implementation of interventions and evaluation of the effectiveness of those interventions.

Targeted surveillance based on the highest risk areas or patients has been preferred over facility-wide surveillance for the most effective use of resources. However, surveillance for certain epidemiologically important organisms may need to be facility-wide. Surveillance methods will continue to evolve as healthcare delivery systems change and user-friendly electronic tools become more widely available for electronic tracking and trend analysis.

Education of HCWs, Patients, and Families

Education and training of healthcare personnel are a prerequisite for ensuring that policies and procedures for Standard and Transmission-Based Precautions are understood and practiced. Understanding the scientific rationale for the precautions will allow HCWs to apply procedures correctly, as well as safely modify precautions based on changing requirements, resources, or healthcare settings.

Education on the principles and practices for preventing transmission of infectious agents should begin during training in the health professions and be provided to anyone who has an opportunity for contact with patients or medical equipment (e.g., nursing and medical staff; therapists and technicians, including respiratory, physical, occupational, radiology, and cardiology personnel; phlebotomists; housekeeping and maintenance staff; and students). In healthcare facilities, education and training on Standard and Transmission-Based

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Precautions are typically provided at the time of orientation and should be repeated as necessary to maintain competency; updated education and training are necessary when policies and procedures are revised or when there is a special circumstance, such as an outbreak that requires modification of current practice or adoption of new recommendations. Education and training materials and methods appropriate to the HCW's level of responsibility, individual learning habits, and language needs, can improve the learning experience.

Education programs for healthcare personnel have been associated with sustained improvement in adherence to best practices and a related decrease in device-associated HAIs in teaching and non-teaching settings and in medical and surgical ICUs.

In addition to targeted education to improve specific practices, periodic assessment and feedback of the HCWs knowledge, and adherence to recommended practices are necessary to achieve the desired changes and to identify continuing education needs. Effectiveness of this approach for isolation practices has been demonstrated for control of RSV.

Patients, family members, and visitors can be partners in preventing transmission of infections in healthcare settings. Information about Standard Precautions, especially hand hygiene, Respiratory Hygiene/Cough Etiquette, vaccination (especially against influenza) and other routine infection prevention strategies may be incorporated into patient information materials that are provided upon admission to the healthcare facility. Additional information about Transmission-Based Precautions is best provided at the time they are initiated.

Fact sheets, pamphlets, and other printed material may include information on the rationale for the additional precautions, risks to household members, room assignment for Transmission-Based Precautions purposes, explanation about the use of personal protective equipment by HCWs, and directions for use of such equipment by family members and visitors. Such information may be particularly helpful in the home environment where household members often have primary responsibility for adherence to recommended infection control practices. Healthcare personnel must be available and prepared to explain this material and answer questions as needed.

Hand Hygiene

Hand hygiene has been cited frequently as the single most important practice to reduce the transmission of infectious agents in healthcare settings and is an essential element of Standard Precautions. The term "hand hygiene" includes both hand washing with either plain or antiseptic-containing soap and water, and use of alcohol-based products (gels, rinses, foams) that do not require the use of water. In the absence of visible soiling of hands, approved alcohol based products for hand disinfection are preferred over antimicrobial or plain soap and

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water because of their superior microbicidal activity, reduced drying of the skin, and convenience. Improved hand hygiene practices have been associated with a sustained decrease in the incidence of MRSA and VRE infections primarily in the ICU.

The effectiveness of hand hygiene can be reduced by the type and length of fingernails. Individuals wearing artificial nails have been shown to harbor more pathogenic organisms, especially gram negative bacilli and yeasts, on the nails and in the subungual area than those with native nails. In 2002, CDC/HICPAC recommended that artificial fingernails and extenders not be worn by healthcare personnel who have contact with high-risk patients (e.g., those in ICUs, ORs) due to the association with outbreaks of gram negative bacillus and candidal infections as confirmed by molecular typing of isolates. The need to restrict the wearing of artificial fingernails by all healthcare personnel who provide direct patient care or by healthcare personnel who have contact with other high risk groups (e.g., oncology, cystic fibrosis patients), has not been studied, but has been recommended by some experts. At this time such decisions are at the discretion of an individual facility's infection control program. There is less evidence that jewelry affects the quality of hand hygiene. Although hand contamination with potential pathogens is increased with ring-wearing, no studies have related this practice to HCW-to-patient transmission of pathogens.

Personal Protective Equipment (PPE)

PPE refers to a variety of barriers and respirators used alone or in combination to protect mucous membranes, airways, skin, and clothing from contact with infectious agents. The selection of PPE is based on the nature of the patient interaction and/or the likely mode(s) of transmission.

Gloves

Gloves are used to prevent contamination of healthcare personnel hands when

- 1) Anticipating direct contact with blood or body fluids, mucous membranes, non-intact skin and other potentially infectious material;
- 2) Having direct contact with patients who are colonized or infected with pathogens transmitted by the contact route e.g., VRE, MRSA, RSV
- 3) Handling or touching visibly or potentially contaminated patient care equipment and environmental surfaces.

Gloves can protect both patients and healthcare personnel from exposure to infectious material that may be carried on hands. The extent to which gloves will protect healthcare personnel from transmission of bloodborne pathogens (e.g., HIV, HBV, HCV) following a needlestick or other puncture that penetrates the glove barrier has not been determined. Although gloves may reduce the volume

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of blood on the external surface of a sharp, the residual blood in the lumen of a hollowbore needle would not be affected; therefore, the effect on transmission risk is unknown.

Gloves manufactured for healthcare purposes are subject to FDA evaluation and clearance. Nonsterile disposable medical gloves made of a variety of materials (e.g., latex, vinyl, nitrile) are available for routine patient care. The selection of glove type for non-surgical use is based on a number of factors, including the task that is to be performed, anticipated contact with chemicals and chemotherapeutic agents, latex sensitivity, sizing, and facility policies for creating a latex-free environment.

For contact with blood and body fluids during non-surgical patient care, a single pair of gloves generally provides adequate barrier protection. However, there is considerable variability among gloves; both the quality of the manufacturing process and type of material influence their barrier effectiveness. While there is little difference in the barrier properties of unused intact gloves, vinyl gloves have higher failure rates than latex or nitrile gloves when tested under simulated and actual clinical conditions. For this reason, either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity and/or will involve more than brief patient contact. It may be necessary to stock gloves in several sizes. Heavier, reusable utility gloves are indicated for non-patient care activities, such as handling or cleaning contaminated equipment or surfaces.

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

Discarding gloves between patients is necessary to prevent transmission of infectious material. Gloves must not be washed for subsequent reuse because microorganisms cannot be removed reliably from glove surfaces and continued glove integrity cannot be ensured. Furthermore, glove reuse has been associated with transmission of MRSA and gram-negative bacilli.

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

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Isolation Gowns

Isolation gowns are used as specified by Standard and Transmission-Based Precautions, to protect the HCW's arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material. The need for and type of isolation gown selected is based on the nature of the patient interaction, including the anticipated degree of contact with infectious material and potential for blood and body fluid penetration of the barrier. The wearing of isolation gowns and other protective apparel is mandated by the OSHA Bloodborne Pathogens Standard.

Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered PPE.

When applying Standard Precautions, an isolation gown is worn only if contact with blood or body fluid is anticipated. However, when Contact Precautions are used (i.e., to prevent transmission of an infectious agent that is not interrupted by Standard Precautions alone and that is associated with environmental contamination), donning of both gown and gloves upon room entry is indicated to address unintentional contact with contaminated environmental surfaces. The routine donning of isolation gowns upon entry into an intensive care unit or other high-risk area does not prevent or influence potential colonization or infection of patients in those areas.

Isolation gowns are always worn in combination with gloves, and with other PPE when indicated. Gowns are usually the first piece of PPE to be donned. Full coverage of the arms and body front, from neck to the mid-thigh or below will ensure that clothing and exposed upper body areas are protected. Several gown sizes should be available in a healthcare facility to ensure appropriate coverage for staff members. Isolation gowns should be removed before leaving the patient care area to prevent possible contamination of the environment outside the patient's room. Isolation gowns should be removed in a manner that prevents contamination of clothing or skin. The outer, "contaminated", side of the gown is turned inward and rolled into a bundle, and then discarded into a designated container for waste or linen to contain contamination.

Face Protection

Masks - Masks are used for three primary purposes in healthcare settings:

- 1) Placed on healthcare personnel to protect them from contact with infectious material from patients e.g., respiratory secretions and sprays of blood or body fluids, consistent with Standard Precautions and Droplet Precautions;
- 2) Placed on healthcare personnel when engaged in procedures requiring sterile technique to protect patients from exposure to infectious agents carried in a healthcare worker's mouth or nose, and

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3) Placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others (i.e., Respiratory Hygiene/Cough Etiquette).

Masks may be used in combination with goggles to protect the mouth, nose and eyes, or a face shield may be used instead of a mask and goggles, to provide more complete protection for the face, as discussed below. Masks should not be confused with particulate respirators that are used to prevent inhalation of small particles that may contain infectious agents transmitted via the airborne route as described below.

The mucous membranes of the mouth, nose, and eyes are susceptible portals of entry for infectious agents, as can be other skin surfaces if skin integrity is compromised (e.g., by acne, dermatitis). Therefore, use of PPE to protect these body sites is an important component of Standard Precautions. The protective effect of masks for exposed healthcare personnel has been demonstrated.

Procedures that generate splashes or sprays of blood, body fluids, secretions, or excretions (e.g., endotracheal suctioning, bronchoscopy, invasive vascular procedures) require either a face shield (disposable or reusable) or mask and goggles. The wearing of masks, eye protection, and face shields in specified circumstances when blood or body fluid exposures are likely to occur is mandated by the OSHA Bloodborne Pathogens Standard. Appropriate PPE should be selected based on the anticipated level of exposure.

Two mask types are available for use in healthcare settings: surgical masks that are cleared by the FDA and required to have fluid-resistant properties, and procedure or isolation masks. No studies have been published that compare mask types to determine whether one mask type provides better protection than another. Since procedure/isolation masks are not regulated by the FDA, there may be more variability in quality and performance than with surgical masks. Masks come in various shapes (e.g., molded and non-molded), sizes, filtration efficiency, and method of attachment (e.g., ties, elastic, ear loops). Healthcare facilities may find that different types of masks are needed to meet individual healthcare personnel needs.

Goggles and Face Shields - The eye protection chosen for specific work situations (e.g., goggles or face shield) depends upon the circumstances of exposure, other PPE used, and personal vision needs. Personal eyeglasses and contact lenses are NOT considered adequate eye protection. NIOSH states that, eye protection must be comfortable, allow for sufficient peripheral vision, and must be adjustable to ensure a secure fit. It may be necessary to provide several different types, styles, and sizes of protective equipment. Indirectly-vented goggles with a manufacturer's anti-fog coating may provide the most reliable practical eye protection from splashes, sprays, and respiratory droplets from

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multiple angles. Newer styles of goggles may provide better indirect airflow properties to reduce fogging, as well as better peripheral vision and more size options for fitting goggles to different workers. Many styles of goggles fit adequately over prescription glasses with minimal gaps. While effective as eye protection, goggles do not provide splash or spray protection to other parts of the face.

It is important to remind healthcare personnel that even if Droplet Precautions are not recommended for a specific respiratory tract pathogen, protection for the eyes, nose and mouth by using a mask and goggles, or face shield alone, is necessary when it is likely that there will be a splash or spray of any respiratory secretions or other body fluids as defined in Standard Precautions

Disposable or non-disposable face shields may be used as an alternative to goggles. As compared with goggles, a face shield can provide protection to other facial areas in addition to the eyes. Face shields extending from chin to crown provide better face and eye protection from splashes and sprays; face shields that wrap around the sides may reduce splashes around the edge of the shield.

Removal of a face shield, goggles and mask can be performed safely only after gloves have been removed, and hand hygiene performed. The ties, ear pieces and/or headband used to secure the equipment to the head are considered “clean” and therefore safe to touch with bare hands. The front of a mask, goggles and face shield are considered contaminated.

Respiratory Protection

Respiratory protection currently requires the use of a respirator with N95 or higher filtration to prevent inhalation of infectious particles. Respiratory protection is broadly regulated by OSHA under the general industry standard for respiratory protection which requires that U.S. employers in all employment settings implement a program to protect employees from inhalation of toxic materials. OSHA program components include medical clearance to wear a respirator; provision and use of appropriate respirators, including fit-tested NIOSH-certified N95 and higher particulate filtering respirators; education on respirator use and periodic re-evaluation of the respiratory protection program.

When selecting particulate respirators, models with inherently good fit characteristics (i.e., those expected to provide protection factors of 10 or more to 95% of wearers) are preferred. A user-seal check (formerly called a “fit check”) should be performed by the wearer of a respirator each time a respirator is donned to minimize air leakage around the facepiece. The optimal frequency of fit-testing has not been determined; re-testing may be indicated if there is a change in facial features of the wearer, onset of a medical condition that would affect respiratory function in the wearer, or a change in the model or size of the initially assigned respirator.

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Respiratory protection was first recommended for protection of preventing U.S. healthcare personnel from exposure to *M. tuberculosis* in 1989. The incremental benefit from respirator use, in addition to administrative and engineering controls (i.e., AIIRs, early recognition of patients likely to have tuberculosis and prompt placement in an AIIR, and maintenance of a patient with suspected tuberculosis in an AIIR until no longer infectious), for preventing transmission of airborne infectious agents (e.g., *M. tuberculosis*) is undetermined. Although some studies have demonstrated effective prevention of *M. tuberculosis* transmission in hospitals where surgical masks, instead of respirators, were used in conjunction with other administrative and engineering controls, the CDC currently recommends N95 or higher level respirators for personnel exposed to patients with suspected or confirmed tuberculosis. Currently this is also true for other diseases that could be transmitted through the airborne route, including SARS and smallpox.

Respirators are also currently recommended to be worn during the performance of aerosol-generating procedures (e.g., intubation, bronchoscopy, suctioning) on patients with SARS Co-V infection, avian influenza and pandemic influenza. Although Airborne Precautions are recommended for preventing airborne transmission of measles and varicella-zoster viruses, there are no data upon which to base a recommendation for respiratory protection to protect susceptible personnel against these two infections; transmission of varicella-zoster virus has been prevented among pediatric patients using negative pressure isolation alone. Whether respiratory protection (i.e., wearing a particulate respirator) would enhance protection from these viruses has not been studied. Since the majority of healthcare personnel have natural or acquired immunity to these viruses, only immune personnel generally care for patients with these infections.

Although there is no evidence to suggest that masks are not adequate to protect healthcare personnel in these settings, for purposes of consistency and simplicity, or because of difficulties in ascertaining immunity, some facilities may require the use of respirators for entry into all AIIRs, regardless of the specific infectious agent. In some healthcare settings, particulate respirators used to provide care for patients *with M. tuberculosis* are reused by the same HCW. This is an acceptable practice providing the respirator is not damaged or soiled, the fit is not compromised by change in shape, and the respirator has not been contaminated with blood or body fluids. There are no data on which to base a recommendation for the length of time a respirator may be reused.

Practices to Prevent HCW Exposure to Bloodborne Pathogens

Prevention of Sharps-Related Injuries

Injuries due to needles and other sharps have been associated with transmission of HBV, HCV and HIV to healthcare personnel. The prevention of sharps injuries has always been an essential element of Universal and now Standard Precautions. These include measures to handle needles and other sharp devices

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in a manner that will prevent injury to the user and to others who may encounter the device during or after a procedure. These measures apply to routine patient care and do not address the prevention of sharps injuries and other blood exposures during surgical and other invasive procedures.

Since 1991, when OSHA first issued its Bloodborne Pathogens Standard to protect healthcare personnel from blood exposure, the focus of regulatory and legislative activity has been on implementing a hierarchy of control measures. This has included focusing attention on removing sharps hazards through the development and use of engineering controls. The federal Needlestick Safety and Prevention Act signed into law in November, 2000 authorized OSHA's revision of its Bloodborne Pathogens Standard to more explicitly require the use of safety-engineered sharp devices. The CDC has provided guidance on sharps injury prevention, including for the design, implementation and evaluation of a comprehensive sharps injury prevention program.

Prevention of Mucous Membrane Contact

Exposure of mucous membranes of the eyes, nose and mouth to blood and body fluids has been associated with the transmission of bloodborne viruses and other infectious agents to healthcare personnel. The prevention of mucous membrane exposures has always been an element of Universal and now Standard Precautions for routine patient care and is subject to OSHA bloodborne pathogen regulations.

Safe work practices, in addition to wearing PPE, are used to protect mucous membranes and non-intact skin from contact with potentially infectious material. These include keeping gloved and ungloved hands that are contaminated from touching the mouth, nose, eyes, or face; and positioning patients to direct sprays and splatter away from the face of the caregiver. Careful placement of PPE before patient contact will help avoid the need to make PPE adjustments and possible face or mucous membrane contamination during use.

In areas where the need for resuscitation is unpredictable, mouthpieces, pocket resuscitation masks with one-way valves, and other ventilation devices provide an alternative to mouth-to-mouth resuscitation, preventing exposure of the caregiver's nose and mouth to oral and respiratory fluids during the procedure.

Precautions During Aerosol-Generating Procedures

The performance of procedures that can generate small particle aerosols (aerosol-generating procedures), such as bronchoscopy, endotracheal intubation, and open suctioning of the respiratory tract, have been associated with transmission of infectious agents to healthcare personnel, including *M. tuberculosis*, SARS-CoV and *N. meningitidis*. Protection of the eyes, nose and mouth, in addition to gown and gloves, is recommended during performance of these procedures in accordance with Standard Precautions. Use of a particulate respirator is recommended during aerosol-generating procedures when the

aerosol is likely to contain *M. tuberculosis*, SARS-CoV, or avian or pandemic influenza viruses.

Patient Placement

Hospitals and Long-Term Care Settings

Options for patient placement include single patient rooms, two patient rooms, and multi-bed wards. Of these, single patient rooms are preferred when there is a concern about transmission of an infectious agent. Although some studies have failed to demonstrate the efficacy of single patient rooms to prevent HAIs, other published studies, including one commissioned by the American Institute of Architects and the Facility Guidelines Institute, have documented a beneficial relationship between private rooms and reduction in infectious and noninfectious adverse patient outcomes. The AIA notes that private rooms are the trend in hospital planning and design. However, most hospitals and long-term care facilities have multi-bed rooms and must consider many competing priorities when determining the appropriate room placement for patients (e.g., reason for admission; patient characteristics, such as age, gender, mental status; staffing needs; family requests; psychosocial factors; reimbursement concerns).

In the absence of obvious infectious diseases that require specified airborne infection isolation rooms (e.g., tuberculosis, SARS, chickenpox), the risk of transmission of infectious agents is not always considered when making placement decisions. When there are only a limited number of single-patient rooms, it is prudent to prioritize them for those patients who have conditions that facilitate transmission of infectious material to other patients (e.g., draining wounds, stool incontinence, uncontained secretions) and for those who are at increased risk of acquisition and adverse outcomes resulting from HAI (e.g., immunosuppression, open wounds, indwelling catheters, anticipated prolonged length of stay, total dependence on HCWs for activities of daily living).

Single-patient rooms are always indicated for patients placed on Airborne Precautions and in a Protective Environment and are preferred for patients who require Contact or Droplet Precautions. During a suspected or proven outbreak caused by a pathogen whose reservoir is the gastrointestinal tract, use of single patient rooms with private bathrooms limits opportunities for transmission, especially when the colonized or infected patient has poor personal hygiene habits, fecal incontinence, or cannot be expected to assist in maintaining procedures that prevent transmission of microorganisms (e.g., infants, children, and patients with altered mental status or developmental delay). In the absence of continued transmission, it is not necessary to provide a private bathroom for patients colonized or infected with enteric pathogens as long as personal hygiene practices and Standard Precautions, especially hand hygiene and appropriate environmental cleaning, are maintained. Assignment of a dedicated commode to a patient, and cleaning and disinfecting fixtures and equipment that may have fecal contamination (e.g., bathrooms, commodes, scales used for weighing

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diapers) and the adjacent surfaces with appropriate agents may be especially important when a single-patient room cannot be used since environmental contamination with intestinal tract pathogens is likely from both continent and incontinent patients.

Results of several studies to determine the benefit of a single-patient room to prevent transmission of *Clostridium difficile* are inconclusive. Some studies have shown that being in the same room with a colonized or infected patient is not necessarily a risk factor for transmission. However, for children, the risk of healthcare-associated diarrhea is increased with the increased number of patients per room. Thus, patient factors are important determinants of infection transmission risks, and the need for a single-patient room and/or private bathroom for any patient is best determined on a case-by-case basis.

Cohorting is the practice of grouping together patients who are colonized or infected with the same organism to confine their care to one area and prevent contact with other patients. Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology, and mode of transmission of the infectious agent. It is generally preferred not to place severely immunosuppressed patients in rooms with other patients. Cohorting has been used extensively for managing outbreaks of MDROs including MRSA, VRE, MDR-ESBLs; *Pseudomonas aeruginosa*; methicillin-susceptible *Staphylococcus aureus*; RSV; adenovirus keratoconjunctivitis; rotavirus; and SARS.

Assigning or cohorting healthcare personnel to care only for patients infected or colonized with a single target pathogen limits further transmission of the target pathogen to uninfected patients, but is difficult to achieve in the face of current staffing shortages in hospitals and residential healthcare sites.

During the seasons when RSV, human metapneumovirus, parainfluenza, influenza, other respiratory viruses, and rotavirus are circulating in the community, cohorting based on the presenting clinical syndrome is often a priority in facilities that care for infants and young children. For example, during the respiratory virus season, infants may be cohorted based solely on the clinical diagnosis of bronchiolitis due to the logistical difficulties and costs associated with requiring microbiologic confirmation prior to room placement, and the predominance of RSV during most of the season. However, when available, single patient rooms are always preferred since a common clinical presentation (e.g., bronchiolitis), can be caused by more than one infectious agent. Furthermore, the inability of infants and children to contain body fluids and the close physical contact that occurs during their care, increases infection transmission risks for patients and personnel in this setting.

Ambulatory Settings

Patients actively infected with or incubating transmissible infectious diseases are seen frequently in ambulatory settings (e.g., outpatient clinics, physicians' offices,

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and emergency departments) and potentially expose healthcare personnel and other patients, family members and visitors. In response to the global outbreak of SARS in 2003 and in preparation for pandemic influenza, healthcare providers working in outpatient settings are urged to implement source containment measures (e.g., asking coughing patients to wear a surgical mask or cover their coughs with tissues) to prevent transmission of respiratory infections, beginning at the point of initial patient encounter. Signs can be posted at the entrance to facilities or at the reception or registration desk requesting that the patient or individuals accompanying the patient promptly inform the receptionist if there are symptoms of a respiratory infection (e.g., cough, flu-like illness, increased production of respiratory secretions). The presence of diarrhea, skin rash, or known or suspected exposure to a transmissible disease (e.g., measles, pertussis, chickenpox, tuberculosis) also could be added. Placement of potentially infectious patients without delay in an examination room limits the number of exposed individuals, e.g., in the common waiting area.

In waiting areas, maintaining a distance between symptomatic and non-symptomatic patients (e.g., >3 feet), in addition to source control measures, may limit exposures. However, infections transmitted via the airborne route (e.g., *M. tuberculosis*, measles, chickenpox) require additional precautions.

Patients suspected of having such an infection can wear a surgical mask for source containment, if tolerated, and should be placed in an examination room, preferably an AIIR, as soon as possible. If this is not possible, having the patient wear a mask and segregate him/herself from other patients in the waiting area will reduce opportunities to expose others. Since the person(s) accompanying the patient also may be infectious, application of the same infection control precautions may need to be extended to these persons if they are symptomatic. For example, family members accompanying children admitted with suspected *M. tuberculosis* have been found to have unsuspected pulmonary tuberculosis with cavitory lesions, even when asymptomatic.

Patients with underlying conditions that increase their susceptibility to infection (e.g., those who are immunocompromised or have cystic fibrosis) require special efforts to protect them from exposures to infected patients in common waiting areas. By informing the receptionist of their infection risk upon arrival, appropriate steps may be taken to further protect them from infection. In some cystic fibrosis clinics, in order to avoid exposure to other patients who could be colonized with *B. cepacia*, patients have been given beepers upon registration so that they may leave the area and receive notification to return when an examination room becomes available.

Home Care

In home care, the patient placement concerns focus on protecting others in the home from exposure to an infectious household member. For individuals who are especially vulnerable to adverse outcomes associated with certain infections, it

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may be beneficial to either remove them from the home or segregate them within the home. Persons who are not part of the household may need to be prohibited from visiting during the period of infectivity. For example, if a patient with pulmonary tuberculosis is contagious and being cared for at home, very young children (<4 years of age) and immunocompromised persons who have not yet been infected should be removed or excluded from the household.

Transport of Patients

Several principles are used to guide transport of patients requiring Transmission-Based Precautions. In the inpatient and residential settings these include

- 1) Limiting transport of such patients to essential purposes, such as diagnostic and therapeutic procedures that cannot be performed in the patient's room;
- 2) When transport is necessary, using appropriate barriers on the patient (e.g., mask, gown, wrapping in sheets or use of impervious dressings to cover the affected area(s) when infectious skin lesions or drainage are present, consistent with the route and risk of transmission;
- 3) Notifying healthcare personnel in the receiving area of the impending arrival of the patient and of the precautions necessary to prevent transmission; and
- 4) For patients being transported outside the facility, informing the receiving facility and the medi-van or emergency vehicle personnel in advance about the type of Transmission-Based Precautions being used.

For tuberculosis, additional precautions may be needed in a small shared air space such as in an ambulance.

Environmental Measures

Cleaning and disinfecting non-critical surfaces in patient-care areas are part of Standard Precautions. In general, these procedures do not need to be changed for patients on Transmission-Based Precautions. The cleaning and disinfection of all patient-care areas is important for frequently touched surfaces, especially those closest to the patient, that are most likely to be contaminated (e.g., bedrails, bedside tables, commodes, doorknobs, sinks, surfaces and equipment in close proximity to the patient). The frequency or intensity of cleaning may need to change based on the patient's level of hygiene and the degree of environmental contamination and for certain for infectious agents whose reservoir is the intestinal tract. This may be especially true in LTCFs and pediatric facilities where patients with stool and urine incontinence are

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encountered more frequently. Also, increased frequency of cleaning may be needed in a Protective Environment to minimize dust accumulation.

In all healthcare settings, administrative, staffing and scheduling activities should prioritize the proper cleaning and disinfection of surfaces that could be implicated in transmission. During a suspected or proven outbreak where an environmental reservoir is suspected, routine cleaning procedures should be reviewed, and the need for additional trained cleaning staff should be assessed. Adherence should be monitored and reinforced to promote consistent and correct cleaning is performed. EPA-registered disinfectants or detergents/disinfectants that best meet the overall needs of the healthcare facility for routine cleaning and disinfection should be selected. In general, use of the existing facility detergent/disinfectant according to the manufacturer's recommendations for amount, dilution, and contact time is sufficient to remove pathogens from surfaces of rooms where colonized or infected individuals were housed. This includes those pathogens that are resistant to multiple classes of antimicrobial agents (e.g., *C. difficile*, VRE, MRSA, MDR-GNB). Most often, environmental reservoirs of pathogens during outbreaks are related to a failure to follow recommended procedures for cleaning and disinfection rather than the specific cleaning and disinfectant agents used.

Certain pathogens (e.g., rotavirus, noroviruses, *C. difficile*) may be resistant to some routinely used hospital disinfectants. Since *C. difficile* may display increased levels of spore production when exposed to non-chlorine-based cleaning agents, and the spores are more resistant than vegetative cells to commonly used surface disinfectants, some investigators have recommended the use of a 1:10 dilution of 5.25% sodium hypochlorite (household bleach) and water for routine environmental disinfection of rooms of patients with *C. difficile* when there is continued transmission.

Patient Care Equipment

Medical equipment and instruments/devices must be cleaned and maintained according to the manufacturers' instructions to prevent patient-to-patient transmission of infectious agents. Cleaning to remove organic material must always precede high level disinfection and sterilization of critical and semi-critical instruments and devices because residual protein material reduces the effectiveness of the disinfection and sterilization processes.

Non-critical equipment, such as commodes, intravenous pumps, and ventilators, must be thoroughly cleaned and disinfected before use on another patient. All such equipment and devices should be handled in a manner that will prevent HCW and environmental contact with potentially infectious material. It is important to include computers and personal digital assistants (PDAs) used in patient care in policies for cleaning and disinfection of non-critical items. Two reports have linked computer contamination to colonization and infections in patients. Although keyboard covers and washable keyboards that can be easily

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disinfected are in use, the infection control benefit of those items and optimal management have not been determined.

In all healthcare settings, providing patients who are on Transmission-Based Precautions with dedicated non-critical medical equipment (e.g., stethoscope, blood pressure cuff, electronic thermometer), has been beneficial for preventing transmission. When this is not possible, disinfection after use is recommended.

In home care, it is preferable to remove visible blood or body fluids from durable medical equipment before it leaves the home. Equipment can be cleaned on-site using a detergent/disinfectant and, when possible, should be placed in a single plastic bag for transport to the reprocessing location.

Textiles and Laundry

Soiled textiles, including bedding, towels, and patient or resident clothing may be contaminated with pathogenic microorganisms. However, the risk of disease transmission is negligible if they are handled, transported, and laundered in a safe manner. Key principles for handling soiled laundry are

- 1) Avoid shaking the items or handling them in any way that may aerosolize infectious agents;
- 2) Avoid contact of one's body and personal clothing with the soiled items being handled; and
- 3) Contain soiled items in a laundry bag or designated bin.

When laundry chutes are used, they must be maintained to minimize dispersion of aerosols from contaminated items. The methods for handling, transporting, and laundering soiled textiles are determined by organizational policy and any applicable regulations.

Rather than rigid rules and regulations, hygienic and common sense storage and processing of clean textiles is recommended. When laundering occurs outside of a healthcare facility, the clean items must be packaged or completely covered and placed in an enclosed space during transport to prevent contamination with outside air or construction dust that could contain infectious fungal spores that are a risk for immunocompromised patients.

Institutions are required to launder garments used as personal protective equipment and uniforms visibly soiled with blood or infective material. In the home, textiles and laundry from patients with potentially transmissible infectious pathogens do not require special handling or separate laundering, and may be washed with warm water and detergent.

Solid Waste

The management of solid waste emanating from the healthcare environment is subject to federal and state regulations for medical and non-medical waste. No additional precautions are needed for non-medical solid waste that is being removed from rooms of patients on Transmission-Based Precautions. Solid waste may be contained in a single bag (as compared to using two bags) of sufficient strength.

Dishware and Eating Utensils

The combination of hot water and detergents used in dishwashers is sufficient to decontaminate dishware and eating utensils. Therefore, no special precautions are needed for dishware (e.g., dishes, glasses, cups) or eating utensils; reusable dishware and utensils may be used for patients requiring Transmission-Based Precautions. In the home and other communal settings, eating utensils and drinking vessels that are being used should not be shared, consistent with principles of good personal hygiene and for the purpose of preventing transmission of respiratory viruses, *Herpes simplex* virus, and infectious agents that infect the gastrointestinal tract and are transmitted by the fecal/oral route (e.g., hepatitis A virus, noroviruses). If adequate resources for cleaning utensils and dishes are not available, disposable products may be used.

Adjunctive Measures

Important adjunctive measures that are not considered primary components of programs to prevent transmission of infectious agents, but improve the effectiveness of such programs, include

- 1) Antimicrobial management programs;
- 2) Post-exposure chemoprophylaxis with antiviral or antibacterial agents;
- 3) Vaccines used both for pre and post-exposure prevention; and
- 4) Screening and restricting visitors with signs of transmissible infections.

Chemoprophylaxis

Antimicrobial agents and topical antiseptics may be used to prevent infection and potential outbreaks of selected agents. Infections for which post-exposure chemoprophylaxis is recommended under defined conditions include *B. pertussis*, *N. meningitidis*, *B. anthracis* after environmental exposure to aerosolizable material, influenza virus, HIV, and group A streptococcus. Orally administered antimicrobials may also be used under defined circumstances for MRSA decolonization of patients or healthcare personnel.

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Another form of chemoprophylaxis is the use of topical antiseptic agents. For example, triple dye is used routinely on the umbilical cords of term newborns to reduce the risk of colonization, skin infections, and omphalitis caused by *S. aureus*, including MRSA, and group A streptococcus. Topical antiseptics are also used for decolonization of healthcare personnel or selected patients colonized with MRSA, using mupirocin.

Immunoprophylaxis

Certain immunizations recommended for susceptible healthcare personnel have decreased the risk of infection and the potential for transmission in healthcare facilities. The OSHA mandate that requires employers to offer hepatitis B vaccination to HCWs played a substantial role in the sharp decline in incidence of occupational HBV infection. The use of varicella vaccine in healthcare personnel has decreased the need to place susceptible HCWs on administrative leave following exposure to patients with varicella.

Many states have requirements for HCW vaccination for measles and rubella in the absence of evidence of immunity. Annual influenza vaccine campaigns targeted to patients and healthcare personnel in LTCFs and acute-care settings have been instrumental in preventing or limiting institutional outbreaks and increasing attention is being directed toward improving influenza vaccination rates in healthcare personnel.

Transmission of *B. pertussis* in healthcare facilities has been associated with large and costly outbreaks that include both healthcare personnel and patients. HCWs who have close contact with infants with pertussis are at particularly high risk because of waning immunity and, until 2005, the absence of a vaccine that could be used in adults. However, two acellular pertussis vaccines were licensed in the United States in 2005, one for use in individuals aged 11-18 and one for use in ages 10-64 years.

Immunization of children and adults will help prevent the introduction of vaccine preventable diseases into healthcare settings.

Some vaccines are also used for post-exposure prophylaxis of susceptible individuals, including varicella, influenza, hepatitis B, and smallpox vaccines. In the future, administration of a newly developed *S. aureus* conjugate vaccine (still under investigation) to selected patients may provide a novel method of preventing healthcare-associated *S. aureus*, including MRSA, infections in high-risk groups (e.g., hemodialysis patients and candidates for selected surgical procedures).

Immune globulin preparations also are used for post-exposure prophylaxis of certain infectious agents under specified circumstances (e.g., varicella-zoster virus [VZIG], hepatitis B virus [HBIG], rabies [RIG], measles and hepatitis A virus [IG]).

Management of Visitors

Visitors as Sources of Infection

Visitors have been identified as the source of several types of HAIs (e.g., pertussis, *M. tuberculosis*, influenza, SARS, and other respiratory viruses). However, effective methods for visitor screening in healthcare settings have not been studied. Visitor screening is especially important during community outbreaks of infectious diseases and for high risk patient units. Sibling visits are often encouraged in birthing centers, post-partum rooms and in pediatric inpatient units, ICUs, and in residential settings for children; in hospital settings, a child visitor should visit only his or her own sibling. Screening of visiting siblings and other children before they are allowed into clinical areas is necessary to prevent the introduction of childhood illnesses and common respiratory infections.

Screening may be passive through the use of signs to alert family members and visitors with signs and symptoms of communicable diseases not to enter clinical areas. More active screening may include the completion of a screening tool or questionnaire which elicits information related to recent exposures or current symptoms. That information is reviewed by the facility staff and the visitor is either permitted to visit or is excluded.

Family and household members visiting pediatric patients with pertussis and tuberculosis may need to be screened for a history of exposure as well as signs and symptoms of current infection. Potentially infectious visitors are excluded until they receive appropriate medical screening, diagnosis, or treatment. If exclusion is not considered to be in the best interest of the patient or family (i.e., primary family members of critically or terminally ill patients), then the symptomatic visitor must wear a mask while in the healthcare facility and remain in the patient's room, avoiding exposure to others, especially in public waiting areas and the cafeteria.

Visitor screening is used consistently on HSCT units. However, considering the experience during the 2003 SARS outbreaks and the potential for pandemic influenza, developing effective visitor screening systems will be beneficial. Education concerning Respiratory Hygiene/Cough Etiquette is a useful adjunct to visitor screening.

Barrier Precautions by Visitors

The use of gowns, gloves, or masks by visitors in healthcare settings has not been addressed specifically in the scientific literature. Family members or visitors who are providing care or having very close patient contact (e.g., feeding, holding) may have contact with other patients and could contribute to transmission if barrier precautions are not used correctly. Specific recommendations may vary by facility or by unit and should be determined by the level of interaction.

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Precautions for Selected Infectious Agents and Conditions

Actinomycosis

Precautions – Standard

Comments - Not transmitted from person to person

Amebiasis

Precautions – Standard

Comments - Person to person transmission is rare. Use care when handling diapered infants.

Anthrax (cutaneous)

Precautions – Standard

Comments - Transmission through non-intact skin contact with draining lesions possible, therefore use Contact Precautions if large amount of uncontained drainage. Handwashing with soap and water preferable to use of waterless alcohol based antiseptics since alcohol does not have sporicidal activity.

Anthrax (pulmonary)

Precautions – Standard

Comments - Not transmitted from person to person

Ascariasis

Precautions – Standard

Comments - Not transmitted from person to person

Aspergillosis

Precautions – Standard

Comments - Contact Precautions and Airborne Precautions if massive soft tissue infection with copious drainage and repeated irrigations required.

Babesiosis

Precautions – Standard

Comments - Not transmitted from person to person except rarely by transfusion.

Blastomycosis

Precautions – Standard

Comments - Not transmitted from person to person

Bronchiolitis

Precautions – Contact

Comments – Use mask

Brucellosis

Precautions – Standard

Comments - Not transmitted from person to person except rarely via banked spermatozoa and sexual contact.

Chlamydia pneumoniae

Precautions – Standard

Comments – Outbreaks most common in institutionalized populations.

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Cholera (*Vibrio cholerae*)

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Clostridium difficile

Precautions – Contact

Comments - Do not share electronic thermometers; ensure consistent environmental cleaning and disinfection. Hypochlorite solutions may be required for cleaning if transmission continues 847. Handwashing with soap and water preferred because of the absence of sporicidal activity of alcohol in waterless antiseptic handrubs.

Cryptococcosis

Precautions – Standard

Comments - Not transmitted from person to person, except rarely via tissue and corneal transplant.

Cytomegalovirus

Precautions – Standard

Comments - No additional precautions for pregnant HCWs

Diphtheria (Cutaneous)

Precautions – Contact

Comments - Continue precautions until 2 cultures taken 24 hrs. apart negative

Diphtheria (Pharyngeal)

Precautions – Standard

Comments – Continue precautions until 2 cultures taken 24 hrs. apart negative

Ebola

Precautions – Standard/droplet/contact

Comments - Single-patient room preferred. 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. Largest viral load in final stages of illness when hemorrhage may occur; additional PPE, including double gloves, leg and shoe coverings may be used, especially in resource-limited settings where options for cleaning and laundry are limited. Notify public health officials immediately if Ebola is suspected.

***E. coli* (Enteropathogenic O157:H7)**

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks

Enteroviral infections (i.e., Group A and B Coxsackie viruses and Echo viruses)

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent individuals for duration of illness and to control institutional outbreaks

Gangrene

Precautions – Standard

Comments - Not transmitted from person to person

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Giardia lamblia

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Hepatitis A

Precautions – Standard

Comments - Provide hepatitis A vaccine post-exposure as recommended

Hepatitis B

Precautions – Standard

Comments – Special precautions for patients having hemodialysis

Hepatitis C

Precautions – Standard

Comments – Special precautions for patients having hemodialysis

Hepatitis D

Precautions – Standard

Comments – Seen only with Hepatitis B

Hepatitis E

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent individuals for the duration of illness.

Herpes zoster (localized)

Precautions – Standard

Comments - Susceptible HCWs should not provide direct patient care when other immune caregivers are available.

Human immunodeficiency virus (HIV)

Precautions – Standard

Comments - Post-exposure chemoprophylaxis for some blood exposures

Influenza (seasonal)

Precautions – Droplet

Comments - Single patient room when available or cohort; avoid placement with high-risk patients; mask patient when transported out of room; chemoprophylaxis/vaccine to control/prevent outbreaks. Use gown and gloves according to Standard Precautions may be especially important in pediatric settings. Duration of precautions for immunocompromised patients cannot be defined; prolonged duration of viral shedding (i.e. for several weeks) has been observed; implications for transmission are unknown.

***M. tuberculosis* (Extrapulmonary, draining lesion)**

Precautions – Airborne/Contact (AIIR)

Comments - Discontinue precautions only when patient is improving clinically, and drainage has ceased or there are three consecutive negative cultures of continued drainage.

***M. tuberculosis* (Pulmonary or laryngeal disease, confirmed)**

Precautions – Airborne (AIIR)

Comments - Discontinue precautions only when patient on effective therapy is improving clinically and has three consecutive sputum smears negative for acid-fast bacilli collected on separate days.

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***M. tuberculosis* (Pulmonary or laryngeal disease, suspected)**

Precautions – Airborne (AIIR)

Comments - Discontinue precautions only when the likelihood of infectious TB disease is deemed negligible, and either 1) there is another diagnosis that explains the clinical syndrome or 2) the results of three sputum smears for AFB are negative. Each of the three sputum specimens should be collected 8-24 hours apart, and at least one should be an early morning specimen.

Malaria

Precautions – Standard

Comments - Not transmitted from person to person except through transfusion rarely and through a failure to follow Standard Precautions during patient care.

Meningococcal disease

Precautions – Droplet

Comments – Post-exposure chemoprophylaxis for household contacts, HCWs exposed to respiratory secretions; post-exposure vaccine only to control outbreaks.

Mumps (infectious parotitis)

Precautions – Droplet

Comments - After onset of swelling; susceptible HCWs should not provide care if immune caregivers are available. Recent assessment of outbreaks in healthy 18-24 year olds has indicated that salivary viral shedding occurred early in the course of illness and that 5 days of isolation after onset of parotitis may be appropriate in community settings; however the implications for healthcare personnel and high-risk patient populations remain to be clarified.

Noroviruses

Precautions – Standard

Comments - Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks. Persons who clean areas heavily contaminated with feces or vomitus may benefit from wearing masks since virus can be aerosolized from these body substances; ensure consistent environmental cleaning and disinfection with focus on restrooms even when apparently unsoiled. Hypochlorite solutions may be required when there is continued transmission. Alcohol is less active, but there is no evidence that alcohol antiseptic handrubs are not effective for hand decontamination. Cohorting of affected patients to separate airspaces and toilet facilities may help interrupt transmission during outbreaks.

Parainfluenza virus

Precautions – Contact

Comments — Viral shedding may be prolonged in immunosuppressed patients.

Parvovirus B19 (Erythema infectiosum)

Precautions – Droplet

Comments — Maintain precautions for duration of hospitalization when chronic disease occurs in an immunocompromised patient. For patients with transient aplastic crisis or red-cell crisis, maintain precautions for 7 days. Duration of precautions for immunosuppressed patients with persistently positive PCR not defined, but transmission has occurred.

Pediculosis (lice)

Precautions – Contact

Comments — Transmitted person to person through infested clothing. Wear gown

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and gloves when removing clothing.

Pertussis (whooping cough)

Precautions – Droplet

Comments — Single patient room preferred. Cohorting is an option. Post-exposure chemoprophylaxis for household contacts and HCWs with prolonged exposure to respiratory secretions.

Pneumonia (Adenovirus)

Precautions – Droplet/Contact

Comments — Outbreaks in pediatric and institutional settings reported. In immunocompromised hosts, extend duration of Droplet and Contact Precautions due to prolonged shedding of virus.

Pneumonia (*B. cepacia* in patients with CF)

Precautions – Contact

Comments — Avoid exposure to other persons with CF; private room preferred.

Pneumonia (Pneumococcal)

Precautions – Standard

Comments — Use Droplet Precautions if evidence of transmission within a patient care unit or facility.

Respiratory Syncytial Virus (RSV)

Precautions – Contact

Comments – In immunocompromised patients, extend the duration of Contact Precautions due to prolonged shedding.

Rotavirus

Precautions – Standard

Comments — Ensure consistent environmental cleaning and disinfection and frequent removal of soiled diapers. Prolonged shedding may occur in both immunocompetent and immunocompromised children and the elderly.

Rubella

Precautions – Droplet

Comments — Susceptible HCWs should not enter room if immune caregivers are available. No recommendation for wearing face protection (e.g., a surgical mask) if immune. Pregnant women who are not immune should not care for these patients. Administer vaccine within three days of exposure to non-pregnant susceptible individuals. Place exposed susceptible patients on Droplet Precautions; exclude susceptible healthcare personnel from duty from day 5 after first exposure to day 21 after last exposure, regardless of post-exposure vaccine.

Salmonella

Precautions – Standard

Comments — Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Severe Acute Respiratory Syndrome (SARS)

Precautions – Airborne/Droplet/Contact (AIIR)

Comments — Airborne Precautions preferred; Droplet if AIIR unavailable. N95 or higher respiratory protection; surgical mask if N95 unavailable; eye protection (goggles, face shield); aerosol-generating procedures and “supershedders” highest risk for transmission via small droplet nuclei and large droplets. Vigilant environmental disinfection.

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Shigella

Precautions – Standard

Comments — Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Smallpox

Precautions – Airborne/Contact (AIIIR)

Comments — Until all scabs have crusted and separated (3-4 weeks), nonvaccinated HCWs should not provide care when immune HCWs are available; N95 or higher respiratory protection for susceptible and successfully vaccinated individuals; post-exposure vaccine within 4 days of exposure.

Staphylococcal disease (group A streptococcus)

Precautions – Contact/Standard

Comments — Dressing should cover and contain wounds/drainage adequately

Varicella Zoster

Precautions – Airborne/Contact

Comments — Susceptible HCWs should not enter room if immune caregivers are available; no recommendation for face protection of immune HCWs; no recommendation for type of protection, i.e. surgical mask or respirator for susceptible HCWs. In immunocompromised host with varicella pneumonia, prolong duration of precautions for duration of illness. Post-exposure prophylaxis: provide post-exposure vaccine ASAP but within 120 hours; for susceptible exposed persons for whom vaccine is contraindicated (immunocompromised persons, pregnant women, newborns whose mother's varicella onset is <5days before delivery or within 48 hrs after delivery) provide VZIG, when available, within 96 hours; if unavailable, use IVIG, Use Airborne Precautions for exposed susceptible persons and exclude exposed susceptible healthcare workers beginning 8 days after first exposure until 21 days after last exposure or 28 if received VZIG, regardless of postexposure vaccination

Vibrio parahaemolyticus

Precautions – Standard

Comments — Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Yersinia enterocolitica

Precautions – Standard

Comments — Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.

Supplemental Information

[Healthcare Associated Infections: Nuisance in the Modern Medical Epoch](#)

Ikrām, A., & Satti, L. (2012). Healthcare Associated Infections: Nuisance in the Modern Medical Epoch. In C. Sudhakar (Ed.), *Infection Control - Updates*: InTech. CC BY 3.0

[Health Care Associated Infections: Sources and Routes of Transmission](#)

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[Infection Control Practices in Health Care Set-Up](#)

Basak, S., Rajurkar, M. N., Mallick, S. K., & Attal, R. O. (2013). Infection Control Practices in Health Care Set-Up. In S. Basak (Ed.), *Infection Control*: InTech. CC BY 3.0

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[Recent Advances in the Diagnosis and Treatment of Clostridium Difficile Infection](#)

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[Prevention of Device-Related Healthcare-Associated Infections](#)

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[A Review of Management of Clostridium difficile Infection: Primary and Recurrence](#)

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[Fungal Infections in Immunosuppressed Patients](#)

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[Infection in Primary Hip and Knee Arthroplasty](#)

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[Insect/Bacteria Association and Nosocomial Infection](#)

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[Nosocomial Infections through Hospital Waste](#)

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[Guideline for the prevention and control of norovirus gastroenteritis outbreaks in healthcare settings](#)

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Infection Control

Infection Control Post-Test

1. Patients treated in the ICU have the highest risk of healthcare-associated infections. (p. 4)
A. True B. False
2. Which of the following is an element required for the transmission of an infectious agent?
(p. 4)
A. A source of infectious agent
B. A susceptible host with a portal of entry
C. Mode of transmission
D. All of the above
3. A therapist fails to wash her hands after treating a patient infected with VRE. She then inadvertently passes the pathogen onto her next patient. This is an example of _____. (p. 6-7)
A. direct contact transmission
B. indirect contact transmission
C. droplet transmission
D. vectorborne transmission
4. Infection spread via mosquitoes, flies, rats, and other vermin is classified as _____.
transmission. (p. 10)
A. direct
B. indirect
C. zoonotic
D. vectorborne
5. Clostridium difficile is a spore-forming gram negative aerobic virus that is a major cause of healthcare-associated diarrhea. (p. 11) A. True B. False
6. Noroviruses are relatively stable in the environment and can survive freezing and heating.
(p. 13) A. True B. False
7. Which of the following organisms is primarily transmitted via fecal-oral contamination?
(p.14-15)
A. Multidrug-resistant gram-negative bacilli
B. Acinetobacter
C. Hepatitis A
D. Group A streptococcus
8. Most healthy people who come in contact with Group A streptococcus will not develop invasive GAS disease. (p. 16) A. True B. False
9. Standard precautions apply to all patients in all healthcare settings, regardless of infection status. (p. 21) A. True B. False
10. Transmission precautions are used instead of standard precautions whenever patients are known to be colonized with an infectious agent. (p. 24) A. True B. False
11. Multi-patient rooms with individuals under contact precautions should have greater than 3 feet separation between beds. (p. 25) A. True B. False

Infection Control

12. Hydrotherapy of burn patients has been associated with wound and bloodstream infections caused by which of the following pathogens? (p. 29)
 - A. Multidrug-resistant *P. aeruginosa*
 - B. *A. baumannii*
 - C. MRSA
 - D. All of the above
13. Which source represents the greatest transmission risk to home care patients? (p. 33)
 - A. Family members
 - B. Household pets
 - C. Healthcare providers
 - D. Environmental sources
14. Infection caused by _____ has been associated with increased morbidity and mortality in individuals with cystic fibrosis. (p. 34-35)
 - A. *G. lamblia*
 - B. Respiratory Syncytial Virus
 - C. *P. aeruginosa*
 - D. *B. cepacia*
15. Xenotransplantation potentially exposes patients to zoonotic pathogens. (p. 36)
A. True B. False
16. Which of the following is NOT a component for creating a safety culture? (p. 38)
 - A. Worker participation in safety planning.
 - B. Availability of appropriate protective equipment.
 - C. The organization's socialization process for new personnel.
 - D. Defined punitive actions for poor safety performance scores.
17. Standard definitions are an essential element of a surveillance system. (p. 40) A. True B. False
18. Nitrile gloves have a higher failure rate than latex or vinyl gloves. (p. 43) A. True B. False
19. _____ are usually the first piece of PPE to be donned. (p. 44)
 - A. Masks
 - B. Gloves
 - C. Gowns
 - D. Booties
20. Removal of a face shield can be performed safely only after gloves have been removed, and hand hygiene performed. (p. 46) A. True B. False
21. Cleaning to remove organic materials from critical instruments must never precede high level disinfection. (p. 53) A. True B. False
22. Non-medical waste from a hospital is subject to federal and state regulations. (p. 55)
A. True B. False
23. Which of the following is NOT treated with a post-exposure prophylaxis vaccine? (p. 56)
 - A. Cholera
 - B. Varicella
 - C. Hepatitis B
 - D. Smallpox

Infection Control

24. Which of the following requires contact precautions? (p. 58-59)
- A. Anthrax (pulmonary)
 - B. Babesiosis
 - C. Clostridium difficile
 - D. Cytomegalovirus
25. Which of the following infectious agents does NOT require placing a patient in an AIIR? (p. 61-63)
- A. Parvovirus B19
 - B. M. tuberculosis
 - C. SARS-CoV
 - D. Smallpox virus

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