

# DRAFT

## Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings

### Recommendations of the Healthcare Infection Control Practices Advisory Committee

**Disclaimer: This draft document is intended for public comment only. Healthcare personnel should not modify practices or policies based on these preliminary recommendations.**

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## EXECUTIVE SUMMARY

The *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings 2004* updates and expands the *1996 Guideline for Isolation Precautions in Hospitals* (1). The following developments led to revision of the 1996 guideline:

1. The transition of healthcare delivery from primarily acute care hospitals to other healthcare settings (e.g., home care, ambulatory care, free-standing specialty care sites, long-term care) created a need for recommendations that can be applied to all healthcare settings while adhering to common principles of infection control practice. Accordingly, the revised guideline addresses the spectrum of healthcare delivery and the term “nosocomial infections” is replaced by “healthcare-associated infections” (HAIs) to reflect changing patterns in healthcare delivery.
2. The emergence of new pathogens (e.g., severe acute respiratory syndrome [SARS], Avian influenza) and new therapies (e.g., gene therapy) and increasing concern for the threat of bioweapons attacks established a need to address a broader scope of issues than in previous isolation guidelines.
3. Experience with Standard Precautions since it was recommended in the 1996 guideline, has led to a reaffirmation of this approach as the foundation for preventing transmission of infectious agents in all healthcare settings. A new addition to the recommendations for Standard Precautions is Respiratory Hygiene/Cough Etiquette. The need for this recommendation grew out of observations during the SARS epidemic where failure to implement simple source control measures with patients, visitors, and healthcare personnel with respiratory symptoms may have contributed to SARS coronavirus (SARS-CoV) transmission.
4. Accumulated evidence that environmental controls decrease the risk of life-threatening fungal infections in the most severely immunocompromised patients (allogeneic hematopoietic stem cell transplant patients) led to the addition of a new category of isolation precautions, the Protective Environment (PE).

5. Evidence that organizational characteristics (e.g., nurse staffing levels and composition, establishment of a safety culture) and levels of adherence of healthcare workers to recommended infection control practices are important factors in preventing transmission of infectious agents has led to a new emphasis on the importance of administrative involvement in development and support of infection control programs.
6. Continued increase in the incidence of HAIs caused by multidrug-resistant organisms (MDROs) in all healthcare settings and the expanded body of knowledge concerning prevention of transmission of MDROs created a need for more specific recommendations for surveillance and control of these pathogens that would be practical and effective in various types of healthcare settings.
7. There has been an increase in the number of published studies of various practices used to prevent transmission of infectious agents.

This document is intended for use by infection control staff, healthcare epidemiologists, healthcare administrators, and other persons responsible for developing, implementing, and evaluating infection control programs for healthcare settings across the continuum of care. The reader is referred to other guidelines and websites for more detailed information and for recommendations concerning specialized infection control problems.

## **Part I: Review of the Scientific Data Regarding Transmission of Infectious Agents in Healthcare Settings**

This section reviews the relevant scientific literature that supports the recommended prevention and control practices. This section also updates the fundamental elements needed to prevent transmission of infectious agents in healthcare settings. The categories of precautions developed by the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Centers for Disease Control and Prevention (CDC) are described and guidance for application of these precautions in various healthcare settings is provided. A new category, Protective Environment (PE), has been added.

Additionally, there are several tables that include 1) a summary of the evolution of this document; 2) definitions; 3) a summary of infection control recommendations for

category A agents of bioterrorism; 4) components of Standard Precautions and recommendations for their application; 5) components of the Protective Environment; and 6) guidance on using empiric precautions according to clinical syndrome. New in this guideline is a figure that shows the recommended sequence for donning and removing personal protective equipment used for isolation precautions.

## **Part II: Recommendations for Preventing Transmission of Infectious Agents in Healthcare Settings**

This section provides evidence-based recommendations for specific prevention and control practices using the CDC/HICPAC system for ranking the strength of recommendations. Those practices for which there is no recommendation and which are considered unresolved issues are topics in need of further research.

New to this guideline are the detailed recommendations for prevention of transmission of MDROs. Seven categories of interventions to control MDROs are described: administrative measures, education of healthcare personnel, judicious antimicrobial use, surveillance, infection control precautions, environmental measures, and decolonization. Recommendations for each category apply to and are adapted for the various healthcare settings. With the increasing incidence and prevalence of MDROs, all healthcare facilities must identify the prevalent MDROs, implement control measures, and assess the effectiveness of the control program. A set of intensified MDRO prevention interventions is presented to be added for situations where there is evidence of continuing transmission or the prevalence of target MDRO has exceeded institutional goals despite implementation of basic MDRO infection control measures, and when the *first* case(s) of an epidemiologically important MDRO is identified within a healthcare facility. Recommendations for MDRO prevention and control with modifications suggested for settings outside of acute care are summarized in 4 tables that are included in Appendix B.

## **Part III: Performance Measures**

Five practices for the general prevention of transmission of infectious agents in healthcare settings and two practices specifically for prevention of transmission of (MDROs)

are presented as a means for healthcare facilities to monitor implementation of some of the key recommendations in this guideline.

### **Appendix A: Type and Duration of Precautions Recommended for Selected Infections and Conditions**

Appendix A consists of an updated alphabetical list of most infections and clinical conditions for which isolation precautions are recommended. The type and duration of recommended precautions are presented with additional comments concerning the use of adjunctive measures or other relevant considerations to prevent transmission of the specific agent.

### **Appendix B: Management of MDROs in Healthcare Settings**

Appendix B provides a detailed review of the complex and controversial topic of MDRO control in healthcare settings that will allow the reader to place into perspective the MDRO conditions present within a specific healthcare setting. A rationale and institutional requirements for developing an effective MDRO control program are summarized. Although the focus of this guideline is on measures to prevent *transmission* of MDROs in healthcare settings, information concerning the judicious use of antimicrobial agents is presented since such practices are intricately related to the size of the reservoir of MDROs which in turn influences transmission (e.g. colonization pressure). This section elaborates on the principles introduced in earlier HICPAC guidelines and expands their application to address control of current and future MDROs across the spectrum of healthcare settings. Appendix B includes two tables that summarize the characteristics of selected MDRO studies published in the literature and four tables that summarize recommended prevention and control practices.

### **Summary**

This updated guideline responds to changes in healthcare delivery and addresses new concerns about transmission of infectious agents to patients and healthcare workers in the United States and infection control. The primary objective of the guideline is to improve the safety of the nation's healthcare delivery system by reducing the rates of HAIs.

# Part I: Review of Scientific Data Regarding Transmission of Infectious Agents in Healthcare Settings

## I.A. Evolution of the 2004 Document

The *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings 2004* builds upon a series of isolation and infection prevention documents promulgated since 1970. These previous documents are summarized and referenced in Table 1 and in Part I of the *1996 Guideline for Isolation Precautions in Hospitals* (1).

**Objectives and methods.** The objectives of this guideline are to 1) provide infection control recommendations for all components of the healthcare delivery system, including hospitals, long-term care facilities, ambulatory care, and home health; 2) reaffirm Standard Precautions as the foundation for preventing transmission during patient care in all healthcare settings; 3) provide epidemiologically sound and, whenever possible, evidence-based recommendations; and 4) provide a unified infection control approach to MDROs, thus replacing prior pathogen-specific recommendations such as those issued for vancomycin-resistant enterococci (VRE) (2) and *Staphylococcus aureus* with reduced susceptibility to vancomycin (VISA) (3).

The guideline is designed for individuals who are charged with administering infection control programs and healthcare personnel in hospitals and other healthcare settings. All healthcare personnel who need general information about infection control measures to prevent transmission will also find this guideline useful. Terms used in the guideline are defined in the glossary in Table 2. Med-line and Pub Med were used to search for relevant English language studies published primarily since 1996.

Standard Precautions is reaffirmed as the foundation for preventing transmission of infectious agents during healthcare personnel-patient interactions. Consistent observance of Standard Precautions by healthcare personnel offers the greatest potential for preventing transmission of infectious agents in healthcare settings. A new addition to the recommendations for Standard Precautions is Respiratory Hygiene/Cough Etiquette. The need for this recommendation grew out of observations during the SARS epidemic where failure to implement basic source control measures with patients, visitors, and healthcare personnel with signs and symptoms of respiratory tract infection may have contributed to

SARS coronavirus (SARS-CoV) transmission. This concept has been incorporated into CDC planning documents for SARS and pandemic influenza.

**Changes or clarifications in terminology.** This guideline contains 3 changes in terminology from the 1996 guideline:

- The term “Transmission-based Precautions” has been replaced by “Expanded Precautions” to eliminate a contradiction – Standard Precautions is a “transmission-based” approach. The term “Expanded Precautions” was adopted to reflect the need for additional measures to prevent transmission when the route of transmission (e.g., contact, droplet, airborne) is not interrupted completely by Standard Precautions, or when a Protective Environment (PE) is required (e.g., for allogeneic hematopoietic stem cell transplant (HSCT) patients) to prevent acquisition of fungi from the environment.
- “Airborne Precautions” has been replaced with “Airborne Infection Isolation (AII)” to be consistent with the revised *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Healthcare Settings 2004* (MMWR in preparation), the *Guidelines for Environmental Infection Control in Healthcare Facilities* (4), and the American Institute of Architects (AIA) guidelines for design and construction of hospitals(5).
- The term “nosocomial infection,” which refers only to infection acquired in hospitals, has been replaced by “healthcare-associated infection”(HAI) which refers to infections associated with healthcare delivery in any setting.

**Scope.** This guideline, like its predecessors, focuses primarily on interactions between patients and healthcare providers. Several other HICPAC guidelines to prevent transmission of infectious agents associated with healthcare delivery are cited, e.g., *Guideline for Hand Hygiene* (6), *Guideline for Disinfection and Sterilization* (in preparation) (7), *Guideline for Environmental Infection Control* (4), *Guideline for Prevention of Healthcare-Associated Pneumonia* (8), and *Guideline for Infection Control in Healthcare Personnel* (9). In combination, these provide comprehensive guidance on the primary infection control measures for ensuring a safe environment for patients and healthcare personnel.

This guideline also does not discuss in detail specialized infection control issues in defined populations that are addressed elsewhere (e.g., *Recommendations for Preventing Transmission of Infections among Chronic Hemodialysis Patients* (10), *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Facilities, 1994* (11), *Guidelines for Infection Control in Dental Health-Care Settings* (12)). An exception has been made by including abbreviated guidance for a Protective Environment (PE) used for allogeneic HSCT recipients since components of the PE have been more completely defined since publication of the *Guidelines for Preventing Opportunistic Infections Among HSCT Recipients in 2000* (13).

## **I.B. Rationale for Standard and Expanded Precautions in healthcare settings**

Transmission of infection within a healthcare setting requires three elements: a source (or reservoir) of infecting microorganisms, a susceptible host, and a mode of transmission for the microorganism. This section describes the interrelationship of these elements in the epidemiology of healthcare-associated infections.

### **I.B.1. Sources of infectious agents**

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, household members, and visitors (e.g., family, friends). Such 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. In many situations the endogenous flora of patients (e.g., bacteria residing in the respiratory or gastrointestinal tract) are the source of healthcare-associated infections (14).

### **I.B.2. Susceptible hosts**

Individual susceptibility to infection varies. Some persons exposed to pathogenic microorganisms never develop symptomatic disease because of their resistance to colonization or immunity to specific virulence properties of the pathogen. Others may become 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. Host factors such as extremes of age and underlying

disease (e.g., diabetes, HIV/AIDS) enhance 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, immunosuppressive drugs, and others). 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 healthcare-associated infections 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. Some infections associated with invasive procedures are a result of transmission within the healthcare facility; others are acquired from endogenous organisms on the patient's body. High-risk patient populations with noteworthy risk factors for infection are discussed further in subsequent sections of this document.

### **I.B.3. Modes of transmission**

Persons are exposed to human sources of microorganisms in healthcare settings via three primary routes: contact (direct and indirect), respiratory droplets, and airborne droplet nuclei (i.e., respirable particles of  $\leq 5 \mu\text{m}$ ).

**I.B.3.a. Contact transmission**, the most common mode of transmission, is divided into two subgroups: direct contact and indirect contact.

**I.B.3.a.i. Direct contact transmission** occurs when microorganisms are transferred directly from one person to another person. Examples of direct contact transmission in healthcare settings include:

- blood from a patient directly enters a caregiver's body through a cut in the skin;
- scabies mites from a patient are transferred to the skin of a caregiver while he/she is lifting the patient;
- a healthcare provider develops herpetic whitlow on a finger after contact with *Herpes simplex* virus 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 HCW (9).

Direct contact transmission is more efficient than indirect contact transmission but occurs less frequently in healthcare settings than does indirect contact transmission. Transmission

by direct contact occurs more frequently between patients and healthcare personnel than between patients. Disease is more likely to develop following direct contact transmission when the pathogen is highly virulent or has a low infectious dose or the patient or HCW is immunocompromised.

**I.B.3.a.ii. Indirect contact transmission**, the most frequent mode of transmission, involves the transfer of an infectious agent through a contaminated intermediate object or person. Hands of personnel are usually cited as the most important contributors to indirect contact transmission (6). Examples of indirect contact transmission are as follows:

- Hands of healthcare personnel touch an infected or colonized body site on one patient or a contaminated inanimate object, and then subsequently touch another patient without healthcare personnel performing hand hygiene between patient contacts.
- Patient-care devices (e.g., electronic thermometers (15), glucose monitoring devices (16, 17)) contaminated with blood or body fluids are shared between patients without cleaning and disinfecting between patients.
- Shared toys become a vehicle for transmitting respiratory viruses (e.g., respiratory syncytial virus (18) or pathogenic bacteria (e.g., *Pseudomonas aeruginosa* (19)) to pediatric patients.
- Instruments that are inadequately cleaned between patients before disinfection or sterilization (e.g., endoscopes or surgical instruments) (20-24) or that have manufacturing defects that interfere with the effectiveness of reprocessing (25, 26) may transmit bacterial and viral pathogens.

**I.B.3.b. Droplet transmission**, technically, is a form of contact transmission. However, the mechanism of transfer of the pathogen to the host is distinct and additional prevention measures are required. Respiratory droplets are generated when an infected person coughs, sneezes, or talks or during procedures such as suctioning, bronchoscopy, and cough induction by chest physiotherapy. Transmission occurs when droplets propelled short distances (traditionally,  $\leq 3$  feet through the air) are deposited on the conjunctivae, nasal mucosa, or mouth (27-30).

The definition of droplet transmission is of current interest and under discussion. Historically, the area of defined risk has been a distance of  $\leq 3$  feet around the patient and is

based on epidemiologic and simulated studies of selected infections. Using this distance for donning masks has been effective in preventing transmission of infectious agents via the droplet route. However, experimental studies with smallpox (31) and investigations of the global SARS outbreak of 2003 ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)) suggest that droplets from patients with these two infections rarely could reach persons 6 feet or more away from their source. It is possible that the distance droplets travel depends on a number of factors, including the velocity and mechanism by which they are propelled from the source, environmental factors such as temperature and humidity, and the density of respiratory secretions (32). Thus, a distance of  $\leq 3$  feet around the patient is best viewed as an *example* of what is meant by “a short distance from a patient” and not used as a *criterion* for deciding when a mask should be donned to protect from 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; more information is needed.

Droplet size is another subject under discussion. Droplets traditionally have been defined as being  $>5 \mu\text{m}$  in size and droplet nuclei, which are associated with airborne transmission,  $\leq 5 \mu\text{m}$  in size. The behavior of droplets and droplet nuclei affect recommendations for preventing transmission. Because droplets are relatively heavy and do not remain suspended in the air, special air handling and ventilation are not required to prevent droplet transmission. Examples of infectious agents that can be transmitted via the droplet route include *Bordetella pertussis* (33), influenza virus (32), adenovirus (29), rhinovirus (34), *Mycoplasma pneumoniae* (35), SARS-associated coronavirus (SARS-CoV) (30, 36, 37), group A streptococcus (38), and *Neisseria meningitidis* (27, 39, 40). As the subjects of droplets and droplet nuclei and the droplet and airborne routes of transmission are studied and discussed, there may be changes in future recommendations for preventing droplet transmission.

**I.B.3.c. Airborne transmission** occurs by dissemination of airborne droplet nuclei (small-particle residue [ $5 \mu\text{m}$  or smaller in size] of evaporated droplets, sometimes referred to as “small droplets,” that contain infectious microorganisms that remain suspended in the air for long periods of time) or dust particles containing the infectious agent. Microorganisms carried in this manner can be dispersed widely by air currents and may be inhaled by susceptible hosts within the same room or over a longer distance from the source patient

when the air supply is shared (41-43). Special air handling and ventilation as well as respiratory protection with NIOSH approved N-95 or higher respirators are required to prevent airborne transmission. There are only a few microorganisms known to be transmitted by the airborne route: *Mycobacterium tuberculosis* (11, 41, 44), rubeola virus (measles) (43), and varicella-zoster virus (chickenpox) (42). Airborne transmission of smallpox (31, 45) has been documented, but is less frequent than transmission via contact and droplet routes. Airborne transmission of SARS (46) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)), monkeypox ([www.cdc.gov/ncidod/monkeypox](http://www.cdc.gov/ncidod/monkeypox)) and the viral hemorrhagic fever viruses (47) has been reported, though not proven conclusively. Although airborne transmission has been considered in some outbreaks of influenza, droplet spread is the most frequent mode of transmission for influenza in healthcare settings (32).

A new classification of aerosol transmission was proposed when evaluating routes of SARS transmission (48): 1) *obligate*: under natural conditions, disease occurs following transmission of the agent only through small particle aerosols (e.g., tuberculosis); 2) *preferential*: natural infection results from transmission through multiple routes, but small particle aerosols are the predominant route (e.g. measles, varicella); and 3) *opportunistic*: agents that naturally cause disease through other routes, but under certain environmental conditions may be transmitted via fine particle aerosol (e.g., SARS transmission via an aerosol plume that originated from sewage in the Amoy Gardens housing complex in 2003 (46)).

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 and re-aerosolized from contaminated environmental surfaces and inhaled into the respiratory tract (49, 50). Currently, reaerosolization is not known to occur with agents that are transmitted from the respiratory tract. Spores of environmental fungi (e.g., *Aspergillus spp.*) are ubiquitous and may be aerosolized via construction dust, and inhaled by immunosuppressed neutropenic oncology patients. A Protective Environment (PE) decreases the risk of environmental fungal infections in allogeneic HSCT patients (13). Person-to-person transmission of *Aspergillus* sp. generally does not occur, but has been documented in a multibed intensive care unit (ICU) via the airborne route from a source patient who developed an extensive abdominal

wound complicating liver transplant and required deep debridement and frequent dressing changes (51).

**I.B.3.d. Other sources of infection** that do not involve person-to-person transmission include those associated with *common source vehicles*, e.g. contaminated food, water, or medications (e.g. intravenous fluids). *Vectorborne transmission* of infectious agents from mosquitoes, flies, rats, and other vermin also can occur in healthcare settings. However, these route of transmission is of less significance in U.S. healthcare facilities than in other regions of the world and will not be addressed in this document.

### **I.C. Emerging pathogens of special concern to healthcare settings**

Several classes of microorganisms can cause infection, including bacteria, viruses, fungi, parasites, and prions. The routes of transmission vary by type of organism; some are transmitted primarily by the contact route (e.g., *Herpes simplex*, multidrug-resistant bacteria), others by the droplet (e.g., influenza virus, *B. pertussis*) or airborne routes (e.g., *M. tuberculosis*), while others, such as bloodborne viruses (e.g., hepatitis B and C viruses [HBV, HCV] and human immunodeficiency virus [HIV]) are transmitted under limited circumstances via percutaneous or mucous membrane exposure. With some infections, there is a constellation of symptoms that categorize the infection as an “infectious disease.” Importantly, not all infections or infectious diseases are transmitted from person to person. These are distinguished in Appendix A.

Some groups of microorganisms have become established endemically in healthcare settings or have new and/or epidemiologically important implications. Six groups or types of organisms with important infection control implications at the time of publication of this guideline are MDROs, agents of bioterrorism, prions, SARS-CoV, monkeypox and Avian influenza A (H5N1) viruses. Each is discussed in the following section.

#### **I.C.1. Multidrug-Resistant Organisms (MDROs)**

All healthcare settings constitute important environments for the emergence and transmission of antimicrobial resistant microbes, although transmission of MDROs is especially well documented in acute care facilities. MDROs are defined as microorganisms – predominantly bacteria – that are resistant to one or more classes of antimicrobial agents (52). Although the names of certain MDROs suggest resistance to only one agent (e.g.,

methicillin-resistant *Staphylococcus aureus* [MRSA] r vancomycin resistant enterococcus [VRE]), these pathogens are usually resistant to all but one or two commercially available antimicrobial agents (53). This latter feature defines MDROs that deserve special attention in healthcare facilities (53). Other MDROs of current concern include nonsusceptible *Streptococcus pneumoniae* (NSSP) which is resistant to penicillin and other broad-spectrum agents such as macrolides and fluoroquinolones, multidrug-resistant gram-negative bacilli (MDR- GNB), especially those producing extended spectrum beta-lactamases (ESBLs); and strains of *S. aureus* that are intermediate or resistant to vancomycin (i.e., vancomycin intermediate *S. aureus* [VISA], vancomycin resistant *S. aureus* [VRSA]) (3, 54-69). The terminology for *M. tuberculosis* is a special case, where multidrug-resistant strains are defined as those resistant to at least isoniazid and rifampin (the two most important and potent of the first line drugs) with or without resistance to other drugs (11).

MDROs cause concern primarily because they limit treatment options. Until recently, only vancomycin provided effective therapy for life-threatening MRSA infections. During the 1990's, there were virtually no antimicrobial agents to treat infections caused by VRE. Although quinupristin-dalfopristin (Synercid™), linezolid, and daptomycin are now available for treatment of MRSA and VRE infections, their utility may be limited since resistance to quinupristin-dalfopristin and linezolid has emerged in clinical isolates (70-74). Similarly, therapeutic options are limited for ESBL-producing isolates of gram-negative bacilli, strains of *Acinetobacter baumannii* resistant to all antimicrobial agents except imipenem (75-80) and intrinsically resistant *Stenotrophomonas* sp. (81-84). These limitations may drive antibiotic usage patterns in ways that suppress normal flora and create a favorable environment for further transmission of MDROs among patients exposed to other patients colonized or infected with MDROs (i.e., selective advantage) as demonstrated by VRE (85).

Patient-to-patient transmission in healthcare settings, usually via hands of HCWs, has been a major factor accounting for the increase in MDRO incidence and prevalence, especially for MRSA and VRE in acute care facilities (86-88). A detailed discussion of this complex and controversial topic is provided in Appendix B.

### **I.C.2. Agents of bioterrorism**

CDC has designated anthrax, smallpox, plague, tularemia, viral hemorrhagic fevers, and botulism as Category A (high priority) because these agents can be easily disseminated

environmentally and/or transmitted from person to person; can cause high mortality and have the potential for major public health impact; might cause public panic and social disruption; and require special action for public health preparedness. Information relevant to infection control for Category A agents of bioterrorism is summarized in Table 3. Consult [www.bt.cdc.gov](http://www.bt.cdc.gov) for additional, updated Category A agent information as well as information concerning Category B and C agents of bioterrorism and updates.

Healthcare facilities confront a different set of issues when dealing with a suspected bioterrorism event as compared with other communicable diseases. An understanding of the epidemiology, modes of transmission, and clinical course of each disease and carefully drafted plans that provide disease-specific guidance to healthcare, administrative, and support personnel are essential for responding to and managing a bioterrorism event. Among the infection control issues that may need to be addressed are: preventing transmission among patients, healthcare personnel, and visitors; identifying persons who may be infected and exposed; providing treatment or prophylaxis to large numbers of people; protecting the environment; and logistical issues associated with securing sufficient All environments, providing barrier protection, and providing appropriate staffing (e.g., vaccinated healthcare personnel for care of patients with smallpox). The response is likely to differ based on whether exposure is a result of a biological release or person-to-person transmission.

A variety of sources offer guidance for the management of persons exposed to the most likely agents of bioterrorism. Federal agency websites (e.g., [www.usamriid.army.mil/publications/index.html](http://www.usamriid.army.mil/publications/index.html); [www.bt.cdc.gov](http://www.bt.cdc.gov)) and state and county health department web sites should be consulted for the most up-to-date information. Sources of information on specific agents include: anthrax:(89); smallpox:(90); [www.bt.cdc.gov/DocumentsApp/Smallpox/RPG/index.asp](http://www.bt.cdc.gov/DocumentsApp/Smallpox/RPG/index.asp); Smallpox and its Eradication ([www.who.int/emc/diseases/smallpox/Smallpoxeradication.html](http://www.who.int/emc/diseases/smallpox/Smallpoxeradication.html)); plague:(91); botulinum toxin:(92); tularemia: (93); and viral hemorrhagic fevers:(47).

In addition to the agents of bioterrorism, pre-event administration of smallpox (vaccinia) vaccine to healthcare personnel has important infection control implications (94-96). These include the need for meticulous screening for vaccine contraindications in persons who are at increased risk for adverse vaccinia events; containment and monitoring

of the vaccination site to prevent transmission in the healthcare setting and at home; and the management of patients with vaccinia-related adverse events (97, 98). The pre-event U.S. smallpox vaccination program of 2003 is an excellent example of how close monitoring of vaccination sites is an effective measure to prevent vaccinia transmission (99).

Recommendations for pre-event smallpox vaccination of healthcare personnel and vaccinia-related infection control recommendations are published in the MMWR (97, 100) with updates posted on the web site ([www.bt.cdc.gov/smallpox](http://www.bt.cdc.gov/smallpox)).

### **I.C.3. Prions**

Creutzfeldt-Jakob Disease (CJD) is a rapidly progressive, degenerative, neurologic disorder of humans with an incidence in the United States of approximately 1 person/million population/year (101, 102). CJD is caused by a transmissible proteinaceous infectious agent, or prion protein (PrP). The incubation period varies and symptoms may not present for decades after the exposure. However, death typically occurs within 1 year of the onset of symptoms. Approximately 90% of cases are sporadic and 10% are familial. Iatrogenic transmission has occurred. Most iatrogenic cases have resulted from treatment with human cadaveric pituitary-derived hormone (>130 cases) or gonadotropin (4 cases) or from implantation of contaminated dura mater grafts from humans (>110 cases) or corneal transplants (3 cases). Only 6 (<1%) reported cases have been linked to contaminated neurosurgical instruments or stereotactic electroencephalogram electrodes (103).

Six prion diseases in animals have been described, including scrapie in sheep and goats, bovine spongiform encephalopathy (BSE, or “mad cow disease”) in cattle, and chronic wasting disease in deer and elk. BSE, first recognized in the United Kingdom (UK) in 1986, was associated with a major epidemic among cattle that had consumed meat and bone meal prepared from sheep and beef with scrapie.

The first animal-to-human cases of a neurologic prion disease, BSE, termed variant CJD (vCJD) were announced in 1996 and subsequently found to be associated with consumption of beef from infected cattle outside the United States. Less than 300 cases have been reported worldwide at the time of publication of this guideline. Although most cases of vCJD were reported from the UK, a few cases were also reported from France, Italy, and Ireland. The first case of BSE in U.S. cattle was recognized in December 2003, in a single adult cow in Mabton, Washington (104). This animal was part of the same herd as

the first positive cow from Canada in the province of Alberta (105). Although there has been no transmission of vCJD to humans in the United States, these cases have heightened awareness of the possibility that such infections could occur and have led to increased surveillance activities. Updated information may be found on the following website: [www.cdc.gov/ncidod/diseases/cjd/bse\\_washington.htm](http://www.cdc.gov/ncidod/diseases/cjd/bse_washington.htm).

vCJD differs from sporadic CJD in the following aspects: 1) younger mean age at onset: 28 (range 16-48) vs. 65 years; 2) longer duration of illness: mean 13 months vs. 4.5 months; 3) shorter incubation period: 5-10 years vs. decades; 4) increased frequency of sensory and psychiatric symptoms; and 5) detection of PrP tonsillar tissue from vCJD patients prior to the onset of symptoms, but not from sporadic CJD patients (106). Similar to sporadic CJD, there have been no reported cases of direct human-to-human transmission of vCJD by contact, droplet, or airborne routes. Although there is strong evidence that vCJD can be transmitted by blood transfusion, there is no such evidence to date that sporadic CJD or vCJD is transmissible from environmental surfaces (107, 108), but surveillance is ongoing. Potential for transmission of vCJD through blood transfusion is of increasing concern based on animal studies (109) and one case report of highly probable transmission to a British patient (110). Since there is no direct patient-to-patient transmission, Standard Precautions is used when caring for patients with suspected or confirmed CJD or vCJD. Upon the death of a patient with CJD, special precautions are recommended only for conducting an autopsy, embalming, and for contact with a body that has undergone autopsy. Recommendations for reprocessing surgical instruments to prevent transmission of CJD or vCJD in healthcare settings have been published elsewhere (7, 103); [www.who.int/emc-documents/tse/docs/whocdscsraph2003.pdf](http://www.who.int/emc-documents/tse/docs/whocdscsraph2003.pdf)).

#### **1.C.4. Severe Acute Respiratory Syndrome (SARS)**

SARS is a newly discovered respiratory disease that emerged in China late in 2002 and spread globally (111, 112). Mainland China, Hong Kong, Hanoi, Singapore, and Toronto, Canada, were affected significantly by SARS. SARS is caused by SARS CoV, a previously unrecognized member of the coronavirus family (113, 114). The incubation period from exposure to the onset of symptoms is generally between 2 to 7 days but can be as long as 10 days. The illness is initially difficult to distinguish from other common respiratory infections. Signs and symptoms usually include fever  $>38.0^{\circ}\text{C}$  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. Children have been affected only rarely and there are only two reported cases of transmission from children to adults and no reports of child-to-child transmission (112, 115). The case fatality rate is approximately 6.0%; underlying disease and advanced age increase the risk of mortality. Local health departments should be consulted to determine where to perform diagnostic studies (e.g. culture, nucleic acid detection by polymerase chain reaction [PCR], acute and convalescent serology).

Outbreaks in healthcare settings, with transmission to large numbers of healthcare personnel and patients, have been a particularly striking feature of this disease; unidentified infected patients and visitors were an important source of these infections (37, 116). The exact mode(s) of transmission is unknown. However, there is ample evidence for droplet and contact transmission (30, 36), and airborne dissemination and transmission through contaminated fomites cannot be excluded (112, 117, 118). SARS CoV may be considered an opportunistic airborne pathogen that is transmitted through the airborne route only under unusual circumstances (46, 48). Exposure to “super-shedders” during cough-inducing procedures has been associated with transmission of infection to large numbers of healthcare personnel outside of the United States (36). In addition, subtle breaches in recommended laboratory practices have led to SARS-CoV transmission in laboratories where the SARS-CoV was under investigation. The research laboratory was the source of most cases reported after the first series of outbreaks in the winter and spring of 2003 (119) ([www.cdc.gov/ncidod/sars/situation.htm](http://www.cdc.gov/ncidod/sars/situation.htm)). Studies of the SARS outbreaks of 2003 and transmissions that occurred in the laboratory re-affirm the effectiveness of recommended infection control precautions and highlight the importance of consistent adherence to these measures.

Screening for travel to areas experiencing community transmission or contact with SARS patients, followed by prompt placement of a surgical mask over the nose and mouth at the initial point of encounter and segregation of suspected SARS patients from others is essential to prevent transmission in ambulatory settings and the emergency department. When Standard Precautions, including use of hand hygiene and eye protection, Contact Precautions, and All Precautions, including fit-tested NIOSH-approved N95 or higher

respirators, are used, transmission in healthcare settings has been controlled. Updated guidance for infection control precautions in various settings is available at [www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars).

### **I.C.5. Monkeypox**

Monkeypox is a rare viral disease found mostly in the rain forest countries of central and West Africa. The disease, which was first discovered in laboratory monkeys, hence the name “monkeypox,” is caused by an orthopoxvirus and is similar in appearance, though not in severity, to smallpox. Monkeypox was first reported in the United States in June 2003 after several people became ill following contact with sick pet prairie dogs. Infection in the prairie dogs was subsequently traced back to contact with a shipment of animals from Africa, including Giant Gambian Rats. This outbreak illustrated the potential for epizootic disease in the United States with transmission to humans and the need to improve controls on the importation of animals.

Limited data on transmission of monkeypox are available. Transmission from infected animals and humans is believed to occur primarily through direct contact with lesions and respiratory droplets; the possibility of airborne transmission cannot be excluded. Transmission of monkeypox within hospitals has been reported in Africa, albeit rarely. To date in the United States, there has been no evidence of person-to-person transmission of monkeypox, and no new cases of monkeypox have been identified since the initial outbreak in June 2003. Smallpox vaccine is protective (120) and may be administered to individuals who have been exposed to patients or animals with monkeypox since there is an associated case fatality rate of <10% (121). For the most current information on monkeypox, see [www.cdc.gov/ncidod/monkeypox/clinicians.htm](http://www.cdc.gov/ncidod/monkeypox/clinicians.htm).

### **I.C.6. Avian influenza A**

In 2003-2004, transmission of avian influenza A (H5N1) among domestic poultry resulted in highly contagious, rapidly fatal disease, and severe epidemics in  $\geq 9$  countries in Asia ([www.cdc.gov/flu/avian/index.htm](http://www.cdc.gov/flu/avian/index.htm); [www.who.int/csr/disease/avian\\_influenza/en](http://www.who.int/csr/disease/avian_influenza/en)). Avian influenza A (H7N2) was also identified in 2004 among poultry in the states of Delaware, New Jersey, and Texas. This strain is known to circulate in live bird markets in the New York City area and has been associated with only one possible case of disease in humans. This virus is distinct from the Asian H5N1 strain. In humans, laboratory-confirmed cases of

avian influenza A (H5N1) with high mortality have occurred (122). During the 2003-2004 outbreak in Asia, at least 34 cases with 23 deaths (68% case fatality rate) (as of March 31, 2004) in two countries, Viet Nam and Thailand, were reported by the World Health Organization (WHO). Viruses from these patients contained only avian genes with no human influenza virus genes. Most patients were children and all but two are reported to have had direct contact with infected birds or surfaces or materials contaminated with excretions from infected birds in areas experiencing severe influenza outbreaks among poultry and birds. Thus, to date, human-to-human transmission of H5N1 is inefficient and rare. Preliminary testing of some of the recent H5N1 viruses found resistance to amantidine/rimantadine, but susceptibility to oseltamivir (123).

Instances of various avian influenza strains and subtypes affecting humans (e.g., H7N7, H9N2, and H5N1) have been reported sporadically since 1997. Of these subtypes, only H5N1 infection was associated with high mortality and none were associated with efficient transmission from person-to-person (124-126). The influenza A virus subtype H5N1 is of particular concern because of its high virulence and its ability to directly infect humans. The avian viruses that can infect humans may change over time, either through point mutations or reassortment with a human influenza virus, and acquire the ability to transmit readily from human-to-human, with high morbidity and mortality and rapid global spread. Thus, prompt detection and control of H5N1 are critical. Control among birds has focused on 1) culling of flocks of birds; 2) use of avian vaccines; 3) surveillance; and 4) biosecurity measures such as quarantine and isolation of farms. Measures recommended for the care of humans with suspected or confirmed H5N1 disease include vaccination of healthcare personnel with the appropriate seasonal human influenza vaccine and the combined use of Standard Precautions, All, Contact Precautions, and eye protection ([www.cdc.gov/flu/han020302.htm](http://www.cdc.gov/flu/han020302.htm)). Although human influenza viruses are transmitted most frequently by the droplet route, because of the potential for emergence of a pandemic influenza strain, additional precautions are recommended for avian influenza infections until the human epidemiology of infection with avian strains is defined.

#### **I.D. Transmission risks associated with specific types 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 and intensity of interaction between patients/residents with each other and with HCWs. These factors, as well as organizational priorities, goals, and resources, influence how the different healthcare settings adapt transmission prevention guidelines to meet their specific needs. Infection control management decisions should be informed by information and data regarding institutional experience/epidemiology, trends in community and institutional HAIs, local and regional epidemiology as well as national trends and emerging risks.

### **I.D.1. Hospitals**

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

**I.D.1.a. 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 account for >20% of all healthcare-associated infections (127). This patient population exhibits high infection rates and susceptibility to colonization and infection, especially with MDROs, because of their underlying diseases and conditions, the invasive medical devices and technology used in their care, the frequency of their contact with healthcare personnel, and the prolonged duration of exposure to antimicrobial agents (128-130). 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.

**I.D.1.b. Burn Units.** Exposed burn tissues provide optimal conditions for colonization, infection, and transmission; therefore, infection acquired by burn patients is a frequent cause of morbidity and mortality. The risk of invasive burn wound infections is particularly high for patients with a burn injury involving  $\geq 30\%$  of the total body surface area (TBSA)(131, 132). Infections that occur in patients with  $< 30\%$  TBSA are usually associated with the use of invasive devices. In recent years, there has been a shift in the predominant organisms causing infections in burn unit patients from gram-negative to gram-positive bacteria and fungi. Methicillin-susceptible *Staphylococcus aureus* and enterococci, including VRE (133), are prevalent and outbreaks of MRSA are reported frequently in burn units (134, 135). Gram-negative bacteremia is associated with a 50% increase in predicted mortality.

Hydrotherapy equipment is an important environmental reservoir of gram-negative organisms and its use is discouraged based on investigations that used molecular typing techniques to demonstrate an association between hydrotherapy and wound infection or colonization with multidrug-resistant *P. aeruginosa* (136) and *A. baumannii* BSI (137); 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 feeds, have led to decreased infectious complications. Others have included prophylactic antibiotic 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 (138).

There is no consensus on the most effective infection control practices (e.g., single-bed rooms (139), laminar flow and high efficiency particulate air filtration [HEPA]) 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 care of burn patients. One retrospective study (140) demonstrated the efficacy and cost effectiveness of a simplified barrier isolation protocol on wound colonization. This protocol emphasized handwashing and use of gloves, caps, masks and plastic impermeable aprons (rather than isolation gowns) for direct patient contact. However, none of the studies have determined definitively the most effective combination of infection control precautions for use in burn settings. Prospective studies in this area are needed.

**I.D.1.c. Pediatrics.** Studies of the epidemiology of HAIs in children have identified unique infection control issues in this population (141). Pediatric and neonatal intensive care units (PICU and NICU) monitored in the National Nosocomial Infection Surveillance (NNIS) system have higher rates of central venous catheter-associated bloodstream infections than adult ICUs (142-144). 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 in pediatric healthcare settings, especially during seasonal epidemics (e.g., pertussis; respiratory infections including those caused by respiratory syncytial, influenza, parainfluenza, and adeno viruses; rubeola [measles], varicella [chickenpox], and rotavirus infection) (18, 33, 145, 146).

Close physical contact between healthcare personnel and infants and young children including cuddling, feeding, playing, changing soiled diapers, and cleaning copious uncontrolled respiratory secretions, provides abundant opportunities for transmission of infectious agents. The congregation of children in play areas where toys and bodily secretions may be shared, and family rooming-in further enhance the risk of transmission. There is one report, for example, of contaminated bath toys that were implicated in an outbreak of multidrug-resistant *P. aeruginosa* on a pediatric oncology unit (19). The innovative practices of co-bedding (147) and kangaroo care (148) in the NICU for the purpose of improving developmental outcomes increase the potential for skin-to-skin exposure of multiple gestation infants to each other and to their mothers. In addition, several patient factors increase the likelihood that infection will result from these close contacts (e.g., immaturity of the neonatal immune system, lack of previous natural infection and resulting immunity, use of life saving invasive devices in the NICU and PICU, and prevalence of patients with congenital or acquired immune deficiencies and congenital anatomic anomalies).

### **I.D.2. Nonacute healthcare settings**

Healthcare is provided in various settings outside of hospitals including residential facilities, such as long-term care facilities (e.g. nursing homes), homes for the developmentally disabled, settings where behavioral health services are provided, rehabilitation centers, hospices, and others. In addition, healthcare may be provided in

nonhealthcare settings such as factories with occupational health clinics, adult day care centers, assisted living facilities, homeless shelters, and 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. While this Guideline does not discuss each specific type of setting, the principles and strategies provided should be reviewed, adapted, and applied as appropriate to the setting and its population.

**I.D.2.a. Long-term care.** The term “long-term care 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 (149, 150). Nursing homes for the elderly predominate numerically and frequently represent the group. Approximately 1.8 million Americans reside in the nation’s 16,500 nursing homes (151). HAI rates of 1.8 to 13.5 per 1000 resident-care days have been reported with estimates in the range of 3 to 7 per 1000 resident-care days in the more rigorous studies (149, 152-154).

LCTFs 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. Able residents interact freely with each other. Controlling transmission in this setting is challenging. Residents who are colonized or infected with certain microorganisms may, in some cases, be restricted to their room environment. Such actions, if not fully justified, may be perceived as infringing on patient rights and quality of care.

Risk factors for infection abound in LTCF residents (149). Age-related declines in immunity may affect responses to immunizations for influenza and other infectious agents or increase susceptibility to tuberculosis. Immobility, incontinence, dysphagia and age-related skin changes increase susceptibility to urinary, respiratory and cutaneous and soft tissue infections while malnutrition impairs wound healing. Medications that affect level of consciousness, immune function, and gastric acid secretions, and normal flora heighten susceptibility to infection. Antibiotic therapy, invasive devices, and feeding tubes also contribute to infection risks in LTCF residents. Finally, total dependence on healthcare

personnel for activities of daily living has been identified as an independent risk factor for colonization with MRSA (155-157) and ESBL-producing *K. pneumoniae* (158). Several position papers have been published that provide guidance on various aspects of infection control and antimicrobial resistance in LTCFs (159-165).

Because residents of LTCFs are hospitalized frequently, they can serve as conduits for transmission of infectious agents between the healthcare facilities in which they receive care (166-168). Pediatric chronic care facilities also were the source of imported colonization with extended -spectrum cephalosporin-resistant Gram-negative bacilli in one PICU (169, 170). Children from child care centers (171, 172) and pediatric rehabilitation units (173) may also contribute to the reservoir of community-onset MRSA infections in pediatrics (174-178).

**I.D.2.b. 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 centers, and many others. In 2000, there were 83 million visits to hospital outpatient clinics (179) and more than 823 million visits to physician offices (180). A characteristic of these settings that presents unique challenges for adapting transmission prevention guidelines is that care is often episodic, patients remain in common areas for prolonged periods of time waiting to be seen by a healthcare provider or awaiting admission to the hospital, examination or treatment rooms are turned around quickly with minimal cleaning, and infectious patients may not be recognized immediately. Furthermore, immunocompromised patients often receive chemotherapy in infusion rooms where they are maintained for extended periods of time among other patients receiving similar treatment.

There are few data on the risk of HAIs in ambulatory care settings, with the exception of hemodialysis centers (10, 181, 182). However, infections are transmitted in these settings and one review noted 53 outbreaks or clusters of infections (183). Twenty-nine of the episodes were related to a common source exposure, usually a contaminated medical device, multi-dose vial, or solution. Fourteen reports involved person-to-person transmission, and 10 were due to airborne or droplet transmission. Several reports have

involved transmission of bloodborne pathogens, primarily hepatitis B and C viruses from healthcare personnel to patients. Others have reported similar findings (184, 185). Transmission of hepatitis B and C viruses among patients continues to occur in these settings due to failure to adhere to recommended practices (186).

*M. tuberculosis* is the most frequently reported airborne infection transmitted in ambulatory settings (183, 185); measles virus also has been transmitted in physician offices and outpatient settings in an era when immunization rates were low and measles outbreaks were occurring regularly (43, 185, 187). Of interest, there are no published reports of outbreaks of varicella in the outpatient setting. Droplet transmission of rubella and *Herpes simplex* viruses from HCWs has caused outbreaks in ambulatory settings, and adenovirus type 8 epidemic keratoconjunctivitis has been reported as a result of HCW-to-patient transmission or via incompletely disinfected medical equipment used by ophthalmologists (9, 183, 185).

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 virus, rubeola (measles), is critical during the initial patient encounter. When identified, prompt separation of potentially infectious patients and implementation of respiratory hygiene/cough etiquette precautions and appropriate isolation precautions based on the suspected infection decreases transmission risks (11).

**I.D.2.c. Home Care.** Home care in the United States is delivered by over 20,000 provider agencies that include home health agencies, home care aide organizations, hospices, home health pharmacies and providers of medical equipment for use in the home. 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 postoperative wounds, infusion therapy, and chronic ambulatory peritoneal dialysis (CAPD).

The incidence of infection in home care patients, other than those associated with infusion therapy (188-193), is not well studied. Data collection and calculation of infection rates have been accomplished for central venous catheter-associated bloodstream infections in patients receiving home infusion therapy (192) and for the risk of blood contact through percutaneous or mucosal exposures (194), suggesting that, while difficult,

surveillance can be performed in this setting. However, 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 become exposed to an infectious patient during home visits. Since home care interactions usually involve a limited number of home care staff who are not concurrently interacting with other patients, the potential reservoir of pathogens from other patients in the same setting is eliminated.

Infection risks to home care providers that could pose a risk to other home care patients if the provider becomes infected include infections transmitted by the airborne or droplet routes (e.g., chickenpox, tuberculosis, influenza) and skin infestations (e.g., scabies, lice, impetigo) occurring in home care patients or family members. There are no published data on indirect transmission of MDROs from one home care patient to another, although this is theoretically possible if equipment is used by and transported from an infected or colonized patient to a non-colonized or infected patient. Investigation of the first case of VISA in homecare (61) and the first 2 reported cases of VRSA (63, 64, 66) found no evidence of transmission of VISA or VRSA to contacts in the home setting.

Although most home care agencies have implemented policies and procedures to prevent transmission of organisms, the current approach is based on the adaptation of the *1996 Guideline for Isolation Precautions in Hospitals* (1) as well as other recommendations to prevent transmission of MDROs (195). This issue has been very challenging in the home care industry and practice has been inconsistent and frequently not evidence-based. For example, many home health agencies continue to observe “nursing bag technique,” a practice that prescribes the use of barriers between the nursing bag and environmental surfaces in the home (196). While the home environment may not always appear clean, the use of barriers between two non-critical surfaces is not supported scientifically.

**I.D.2.d. Other sites of healthcare delivery.** Facilities that are not primarily healthcare settings, but in which healthcare is delivered, include correctional facilities and shelters. Both of these settings are often crowded and poorly ventilated. Many economically disadvantaged individuals with healthcare problems related to alcoholism, injection drug use, poor nutrition, and inadequate shelter are housed under these suboptimal conditions and receive their primary healthcare at these sites. Also, there is a conspicuous absence of

hand hygiene materials. A high index of suspicion for tuberculosis and MRSA in these populations is needed, as outbreaks in these settings have been reported (197-200). Residence in these types of facilities provides an opportunity to deliver recommended immunizations and screen for *M. tuberculosis* infection in addition to diagnosing and treating acute illnesses. Infection control measures in areas designated for healthcare are the same as for other ambulatory care settings and these areas must be equipped to observe Standard and Expanded Precautions as recommended for ambulatory clinics (201).

### **I.E. Transmission risks associated with special patient populations**

As new treatments emerge for complicated diseases, unique infection control challenges associated with special patient populations receiving these treatments are identified. Important lessons may be learned from studying the epidemiology and prevention of infection in these populations.

**I.E.1. Immunocompromised patients.** Patients who have congenital primary immune deficiencies or acquired disease- or treatment-induced immune deficiencies are at increased risk for numerous types of infections while receiving healthcare. 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 highly transmissible infections such as influenza and other respiratory viruses or easily transmitted bacteria. Application of transmission prevention guidelines to this population needs to address two aspects of patient placement: 1) determining when to avoid placing other patients in the same room with an immunocompromised patient and 2) when to place immunocompromised patients in a PE to minimize the patient's risk of acquiring environmental fungal infections. Other patients with active infections, especially viral respiratory tract infections (202), or patients colonized with MDROs pose a risk to immunocompromised patients if they are in the same room. Published data provide evidence to support environmental protection for allogeneic HSCT patients (13, 203). Three other published guidelines address the special requirements of immunocompromised patients, including use of antimicrobial prophylaxis and engineering controls to create a PE for the prevention of infections caused by

*Aspergillus* spp. and other environmental fungi (4, 8, 13). As more intense chemotherapy regimens associated with prolonged periods of graft versus host disease are implemented, the period of risk and duration of environmental protection may need to be prolonged beyond the traditional 100 days.

**I.E.2. Cystic fibrosis patients.** Patients with cystic fibrosis (CF) require special consideration when developing infection control guidelines. In addition to the usual pathogens that are a threat to all patients and healthcare personnel (e.g., MRSA and respiratory viruses), CF patients require additional protection to prevent transmission from contaminated respiratory therapy equipment (204-208) as well as patient-to-patient transmission of infectious agents that have unique clinical and prognostic significance for CF patients (e.g., *Burkholderia cepacia* complex and *P. aeruginosa* (209)). *B. cepacia* infection has been associated with increased morbidity and mortality in CF patients (210, 211) while delayed acquisition of chronic *P. aeruginosa* infection may be associated with an improved long-term clinical outcome in CF patients (212). *B. cepacia* complex and *P. aeruginosa* may be transmitted by direct contact with patients and their secretions, by contact with a contaminated environment, and by the droplet route; the natural environment (e.g. soil or water) is an unlikely source of *B. cepacia* for CF patients.

Person-to-person transmission of *B. cepacia* complex has been demonstrated among children (211) and adults (213) with CF in healthcare settings and during various social contacts (214), most notably attendance at camps for patients with CF (215), and among siblings with CF (216). Successful infection control measures used to prevent transmission of these infections include containment of respiratory secretions (e.g., by observing respiratory hygiene/cough etiquette), 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 (217-220). The Cystic Fibrosis Foundation published a consensus document with evidence-based recommendations for infection control practices for CF patients (221). It is important to note that *B. cepacia* has also been implicated in many outbreaks and pseudo-outbreaks of HAI associated with contamination of antiseptics, distilled water, and respiratory therapy equipment that are unrelated to cystic fibrosis patients (221, 222).

## **I.F. New therapies associated with potentially transmissible infectious agents**

**I.F.1. Gene therapy.** Gene therapy has progressed at a brisk rate within the last several years. As of May 2000, 425 gene therapy protocols had enrolled 3,476 patients worldwide (223). These trials use a number of different viral vectors, including nonreplicating retroviruses, adenoviruses, adeno-associated viruses, and replication-competent strains of poxviruses. Monitoring for unexpected adverse events has been incorporated into all 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 “superbug.” Greatest concern attends the use of replication-competent viruses, especially vaccinia. As of the time of publication of this guideline, no reports have described transmission of a vector virus from the recipient to another individual, but surveillance is ongoing. Rigorous protocols and recommendations to monitor infection control issues throughout the course of gene therapy trials have been published (223-225).

**I.F.2. Xenotransplantation and tissue allografts.** The potential hazards of xenotransplantation and human tissue allografts have become an infection control concern within the last decade. Reported infections arising from transplanted allografts of human origin include cytomegalovirus infection, Creutzfeldt-Jacob disease, hepatitis C virus, *Clostridium spp.*, group A streptococcus (226, 227). The transplantation of nonhuman cells, tissues, and organs into man potentially expose patients to infectious agents of animal origin. Transmission of known zoonotic infections, (e.g., trichinosis from porcine tissue), constitutes one concern, but of greater concern is the possibility that transplantation of nonhuman cells, tissues, and organs may transmit previously unknown zoonotic infections (xenozoonoses) to immunosuppressed human recipients. Potential infections that might accompany transplantation of porcine organs have been described (228). Recently published guidelines from the U.S. Public Health Service address the many infectious diseases and infection control issues that surround the developing field of xenotransplantation (229); work in this area is ongoing.

## **I.G. Healthcare system components that influence the effectiveness of precautions to prevent transmission**

Three interdependent factors, institutional climate, individual worker behavior, and the work environment may affect the transmission of infectious agents during patient care. Improvements in nurse staffing levels and monitoring of healthcare personnel adherence to recommended infection control practices can be incorporated into the organization's patient safety goals (230-233)

**I.G.1. 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 (234, 235) ([www.patientsafety/vision.html](http://www.patientsafety/vision.html)). The authors of the recent Institute of Medicine Report, *To Err is Human* (230), acknowledge that causes of medical error are multifaceted but emphasize repeatedly the pivotal roles of system failures and a safety culture. A safety culture is created through 1) the actions management takes to improve patient and worker safety; 2) worker participation in safety planning; 3) the 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 organizational characteristics within patient care units as demonstrated by studies of surgical ICUs (236, 237). Each of these perception factors has a direct bearing on the application of and adherence to transmission prevention recommendations. Measurements of an institutional culture of safety is useful for designing improvements in healthcare (238). One hospital-based study linked measures of safety culture with both employee adherence to safe practices and reduced exposures to blood and body fluids (239) and another study of hand hygiene practices concluded that improved adherence requires integration of infection control into the organization's safety culture (240).

**I.G.2. Nurse staffing.** There is increasing evidence that levels of nurse staffing influence the quality of patient care (241, 242). If there is adequate nursing staff, it is more likely that infection control practices, including hand hygiene and Standard and Expanded Precautions, will be given appropriate attention and be applied correctly and consistently (243). A national multicenter study reported recently strong and consistent inverse

relationships between nurse staffing variables and five outcomes in medical patients, two of which were HAIs: urinary tract infections and pneumonia (241). The association of nursing staff shortages with increased rates of HAIs also has been demonstrated in several outbreaks in hospitals and long term care settings (244-258). In two studies (254, 258), the composition of the nursing staff (“pool” or “float” vs. regular staff nurses) influenced the rate of primary bloodstream infections with an increased infection rate occurring when the proportion of pool nurses increased. In most cases, when staffing improved as part of a comprehensive control intervention, the outbreak ended or the HAI rate declined.

**1.G.3. Adherence of healthcare personnel to recommended guidelines.** Adherence to recommended infection control practices decreases disease transmission (259, 260). Several observational studies of healthcare personnel adherence to recommended practices have been published (6, 260-277). Observed adherence to universal precautions ranged from 43% to 89% (261, 262, 269, 271, 272). However, the degree of adherence depended frequently on the barrier that was assessed and, for gloves, the circumstance in which they were used. Appropriate glove use overall has ranged from a low of 15% (265) to a high of 82% (270) while 92% and 98% adherence has been reported during arterial blood gas collection and resuscitation, respectively, procedures where there may be considerable blood contact (263, 276). Differences in observed adherence have been reported among occupational groups in the same healthcare facility (261) and between experienced and nonexperienced professionals (265). 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 (277). Among nurses and physicians, years of experience is a negative predictor of adherence (265, 271). Education to improve adherence is the primary intervention that has been studied. While positive changes in knowledge and attitude have been demonstrated, (260, 278) there often has been limited or no accompanying change in behavior (262, 264). Self-reported adherence is higher in groups that have received an educational intervention (279, 280). Educational interventions that incorporated videotaping and performance feedback were successful in improving adherence (274). The use of videotape also served to identify system problems

(e.g., communication, access to personal protective equipment) that otherwise may not have been understood.

Improving adherence to infection control practices requires a multifaceted approach that incorporates continuous assessment of both the individual and the work environment (6, 240). Using several behavioral theories, Kretzer and Larson (281) concluded that a single intervention (e.g., a handwashing 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 (240).

**I.G.4. Clinical microbiology laboratory support.** The critical role of the microbiology laboratory in infection control and healthcare epidemiology has been well described (282-284) and is supported by the Infectious Disease Society of America policy statement on consolidation of clinical microbiology laboratories published in 2001(284). The clinical laboratory contributes to preventing the transmission of infectious agents in healthcare settings by promptly detecting and reporting epidemiologically important organisms, identifying emerging patterns of antimicrobial resistance, and assessing the effectiveness of recommended precautions in limiting transmission during outbreaks. Healthcare facilities need to ensure that the recommended scope and quality of laboratory services are available and that systems to rapidly communicate epidemiologically important results are in place. As concerns about emerging pathogens and bioterrorism grow, the role of the clinical laboratory takes on even greater importance. For healthcare organizations that outsource microbiology laboratory services (e.g., ambulatory care, home care, LTCFs, smaller acute care hospitals), it is important to specify by contract the types of services, (e.g. periodic institution-specific aggregate susceptibility reports) needed for infection control purposes.

Several key functions of the clinical laboratory apply to this guideline:

- Adherence to current guidelines for antimicrobial susceptibility testing and interpretive criteria developed by the National Committee for Clinical Laboratory Standards (NCCLS) for the detection of emerging resistance patterns(285, 286).
- Support for performing surveillance cultures as needed to assess healthcare facility transmission risks.

- Capacity to perform on site or to outsource molecular typing to investigate and control healthcare-associated outbreaks (287).
- Capacity to employ rapid diagnostic testing techniques in situations where there is an immediate need for clinical information for decisions regarding patient treatment, room placement, and implementation of control measures including barrier precautions and use of vaccine or chemoprophylaxis agents (e.g., influenza (8, 288, 289), *B. pertussis* (290), respiratory syncytial virus (RSV) (291, 292), and enterovirus (293)). At the same time, the microbiologist provides guidance in limiting rapid testing to those clinical situations in which test results influence early patient management decisions and oversight of point-of-care testing performed by non-laboratory healthcare workers (294).
- A quality control program that ensures appropriate testing services for the population served and stringent evaluation of new products for sensitivity, specificity, applicability, and feasibility. With an understanding of testing availability, limitations, and proper specimen collection, the clinical team can utilize the microbiology laboratory resources more efficiently.
- A collaborative effort by microbiology, pharmacy, infection control, and infectious diseases representatives to develop and maintain an effective institutional program for the judicious use of antimicrobial agents.

## **Part II. Fundamental elements to prevent transmission of infectious agents in healthcare settings**

### **II.A. 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 (230-232, 295). An infrastructure to guide, support, and monitor adherence to Standard and Expanded Precautions (162, 296, 297) will help carry out the organization's mission. Policies and procedures that explain how Standard and Expanded Precautions will be 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.

Key administrative measures include adherence monitoring, assessment and correction of system failures that contribute to transmission, and providing feedback to healthcare personnel and senior administrators. The positive influence of institutional leadership has been demonstrated repeatedly in studies of HCW adherence to recommended hand hygiene practices (6, 52, 53, 240, 296-301). Thus, healthcare administrator involvement in infection control processes can improve understanding of the rationale and resource requirements for following recommended infection control practices.

## **II.B. Education of HCWs, patients, and families**

Education and training of healthcare personnel are a prerequisite for ensuring that policies and procedures for Standard (e.g., hand hygiene, use of gowns and gloves, etc.) and Expanded Precautions are understood and practiced. An explanation of the scientific rationale for the precautions will assist HCWs to apply the procedures as well as inform necessary judgments to safely modify precautions based on changing requirements, resources, or adaptation in a different healthcare setting (275, 302-306).

Education on the principles and practices for preventing transmission of infectious agents during healthcare begins ideally during training in the health professions and is 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, and occupational, radiology and cardiology technicians; phlebotomists; housekeeping and maintenance staff; and students). In health care facilities, education and training on Standard and Expanded Precautions are typically provided at the time of orientation and 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 publication of new recommendations. Education and training materials appropriate to the HCW's level of responsibility and individual learning level and language needs improve understanding (6, 307-311). Periodic assessment of the HCWs knowledge and adherence to recommended practices with feedback is another important component of all educational programs (6, 299, 312-314).

Patients and family members can be partners in preventing transmission of infections in healthcare settings. Information about Standard Precautions, especially hand hygiene and respiratory hygiene/cough etiquette, 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 Expanded 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 family members and visitors, room assignment for Expanded Precautions purposes, explanation about the use of personal protective equipment by HCWs and visitors, and directions for use of such attire by family members and visitors. Such information may be particularly helpful in the home environment where family members often have primary responsibility for adherence to recommended infection control practices for preventing transmission. Healthcare personnel must be available and prepared to explain this material and answer questions as needed.

### **II.C. Hand hygiene**

Hand hygiene is the single most important practice to reduce the transmission of infectious agents in healthcare settings (6) and is an essential element of Standard Precautions. The term “hand hygiene” includes both handwashing with either plain or antiseptic-containing soap and water and use of alcohol-based products (gels, rinses, foams) containing an emollient 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 water because of their superior microbiocidal activity, reduced drying of the skin, and convenience (6). Improved hand hygiene practices have been associated with a sustained decrease in the incidence of MRSA and VRE infections in the ICU (240, 299, 315-318). The scientific rationale, indications, methods, and products for hand hygiene are summarized in other publications (6, 318).

The quality of performing hand hygiene can be affected by the type and length of fingernails and wearing jewelry. Artificial fingernails and extenders are discouraged for healthcare personnel who have contact with high-risk patients (e.g., those in the ICU, OR, or NICU) due to their association with outbreaks of gram-negative bacillus and candidal infections (319-323). Whether there is a 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 or cystic fibrosis patients) (221), has not been determined. At this time such decisions are at the discretion of an individual facility's infection control department. There is less evidence that jewelry affects the quality of hand hygiene practices. Although hand contamination with potential healthcare-associated pathogens is increased with ring-wearing (6, 324), no studies have related this practice to HCW-to-patient or patient-to-patient transmission of pathogens.

## **II.D Personal protective equipment (PPE)**

PPE refers to a variety of barriers and respirators used alone or in combination to protect mucous membranes, 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. Guidance on the use of PPE should be discussed in Section III. A suggested procedure for donning and removing PPE that will prevent skin or clothing contamination is presented in the Figure. The following sections highlight the primary uses and methods for selecting this equipment.

**II.D.1. Gloves.** Gloves prevent contamination of healthcare personnel hands when direct contact with blood or body fluids, mucous membranes, and nonintact skin is anticipated; when having direct contact with patients; and when handling or touching visibly or potentially contaminated patient care equipment and environmental surfaces (6). Gloves protect both patients and healthcare personnel from exposure to infectious agents that may be carried on the hands of HCWs (6, 325, 326). Although gloves may reduce the volume of blood on the external surface of a sharp by 46-86% (327), the residual blood in the lumen of a hollowbore needle would not be affected; therefore, the effect on transmission risk is unknown.

Nonsterile disposable gloves made of a variety of materials (e.g., latex, vinyl, nitrile) may be used for routine patient care (328). A single pair of gloves generally provides adequate barrier protection. Nonlatex gloves are required for healthcare personnel who are sensitive to latex and/or who are caring for patients with latex hypersensitivity (9, 329, 330). Gloves that fit the healthcare personnel hands and are appropriate for the task to be performed are preferred. For example, gloves that fit loosely around the wrist may be appropriate for patient care activities that involve limited touching of a contaminated body site. However, gloves that fit snugly are needed when a large amount of blood or body

fluids is present, or the procedure requires greater dexterity or tactile sensitivity. Heavier, reusable utility gloves are indicated for non-patient care activities, e.g., handling or cleaning contaminated equipment or surfaces (4, 8, 313).

During patient care, opportunities for spreading contamination, and therefore increasing opportunities for transmission, 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, especially if an MDRO is present (2, 6). Discarding gloves between patients further reduces opportunities for transmission. 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 (331-334).

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 (Figure). Hand hygiene following glove removal further ensures that the hands will not carry potentially infectious agents that could penetrate through micro-tears (6, 326, 331). Procedures for PPE use specify removal and disposal of gloves before removing other PPE.

**II.D.2. Isolation gowns and other protective apparel.** Isolation gowns and other protective apparel (e.g., aprons) are used to protect the HCW’s arms and exposed body areas and prevent contamination of clothing from blood and body fluid contact and from contamination with transmissible infectious agents (e.g., RSV, MDROs, *C. difficile*) (18, 335-338) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)), as specified by Standard and Expanded Precautions. Selection of protective apparel is based on the nature of the patient interaction and the anticipated degree of body contact with infectious material and level of needed protection from fluid penetration. The wearing of gowns and other protective apparel as PPE to reduce the risk of exposure to bloodborne pathogens is mandated by the OSHA Bloodborne Pathogens Standard (313). Clinical and laboratory coats or jackets worn over personal clothing are not considered PPE.

In most instances, gowns are worn only if contact with blood and body fluid is likely. However, when Contact Precautions are used to prevent transmission of an MDRO, donning of both gown and gloves prior to room entry, regardless of the anticipated level of contact, may reduce unanticipated contact with an MDRO in the environment. The practice of routine gowning upon entrance into an intensive care or other high-risk area does not prevent colonization or infection of patients (140, 339-342). Therefore, CDC recommendations for this practice have been rescinded (13).

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 upper and lower torso (mid-thigh to the knees) and arms will ensure clothing and exposed upper body areas are covered. Most isolation gowns are affixed (e.g., tied, taped) at the back of the neck and waist. Regardless of gown type, there should be a contiguous barrier over the front torso and arms. Several gown sizes may be needed in a healthcare facility. If a single gown does not fit a given individual, two gowns may be needed; the first to cover the back and the second, worn over the first, to cover the front of the body. Removal of isolation gowns before leaving the patient care area is advised to prevent opportunities for possible contamination outside the patient's room. Isolation gowns can be removed in a manner that prevents contamination of clothing or skin. When the outer, "contaminated" side of the gown is turned inward and rolled into a ball, and then discarded into a designated container for waste or linen, contamination is contained (Figure).

**II.D.3. Mouth, nose, eye, and face protection.** The mucous membranes of the mouth, nose, and eyes are particularly vulnerable to infection as is facial skin if skin integrity is compromised (e.g. by acne, dermatitis). Therefore, face protection is an important component of Standard Precautions. Masks are used as PPE for healthcare personnel as part of Standard and Droplet Precautions, and for prevention of transmission of infectious agents from the HCW to the patient when performing a procedure that requires sterile technique (309). A mask placed on a coughing patient with a respiratory infection for source containment decreases the quantity of infectious droplets transmitted from the respiratory tract to the surrounding environment (343-345). **Masks protect mucosal surfaces against large droplets and splashes or sprays and should not be confused with particulate**

***respirators that are recommended for protection from small particles (< 5 μm) containing infectious agents transmitted via the airborne route as described below.***

Various types of masks, goggles, and face shields are available for use alone or in combination to provide barrier protection. The selection of PPE for face, nose and/or eye protection is determined by the nature of the patient interaction and the extent of blood and body fluid contact from spray and splatter that can be anticipated. Procedures that generate splashes or sprays of blood, body fluids, secretions, or excretions (e.g., endotracheal suctioning, bronchoscopy) generally require either a face shield or mask and goggles (30, 36, 39, 40, 313) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). The wearing of masks, eye protection, and face shields in specified circumstances when exposures are likely to occur is mandated by the OSHA Bloodborne Pathogens Standard (313).

Two mask types are available for use in healthcare settings: surgical masks that are regulated by the FDA and required to have fluid-resistant properties, and procedure or isolation masks ([www.fda.gov/cdrh/ode/guidance/094.html#4](http://www.fda.gov/cdrh/ode/guidance/094.html#4)). 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 several different types of PPE are needed to best meet healthcare personnel needs; fit, comfort, and durability for the purpose they will be used are important criteria for mask selection. There are no data to suggest that any one mask provides better protection than another.

Removal of a face shield, goggles, and mask can be performed safely after the gloves have been removed. The pieces of this equipment that are considered “clean” , and therefore safe to touch with the bare hands, are the ties, ear pieces, or headband; the front of a mask, goggles and face shield are considered contaminated (Figure). Designated containers for disposable and reusable equipment need to be placed in a location convenient to the site of removal. Hand hygiene is performed as the final step of PPE removal.

**II.D.4. Respiratory protection.** PPE for respiratory protection is intended to prevent inhalation of respirable particles that can cause harm. The term “respiratory protection” has a regulatory context that includes components of a program required by OSHA to protect workers in all employment settings from inhalation of toxic materials. OSHA program components include medical clearance to wear a respirator, provision and use of

appropriate NIOSH-approved fit-tested and fit-checked respirators, and education on respirator use. In selecting respirators, models shown to have inherently good fitting characteristics (i.e., expected to provide protection factors of 10 or more to 95% of wearers) are preferred (346). Information on various types of respirators may be found at [www.cdc.gov/niosh/npptl/respirators/respsars.html](http://www.cdc.gov/niosh/npptl/respirators/respsars.html) and in published studies (346-348).

Respiratory protection (i.e., use of a NIOSH-approved N-95 or higher level respirator) is required to prevent healthcare personnel exposure to *M. tuberculosis* (11). Although there is limited information on the efficacy of respirators or masks in preventing transmission, particulate respirators have been shown to have greater filtration efficiency and better facial fit qualities than surgical masks (349). Also, the incremental benefit of respirators, in addition to administrative and engineering controls, for preventing transmission of airborne infectious agents has not been assessed. Some studies have shown control of tuberculosis transmission in hospitals that used surgical masks rather than respirators in conjunction with other administrative and engineering controls (350-352), but respirators now are required by OSHA for protection of healthcare personnel from tuberculosis (11).

Respiratory protection is recommended for other diseases that could be transmitted through the airborne route, including SARS ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)), smallpox (45), and hemorrhagic fevers (47). Although All and PPE for mouth and nose protection are recommended for protection from measles and chickenpox, there are no data upon which to base a recommendation for surgical masks or respirators for protection against these two infections. However, for purposes of consistency and simplicity, some facilities require the use of respirators for entry into all All rooms, regardless of the specific infectious agent. Removal of respirators outside an All room, in an anteroom, or just outside the door is advised to limit opportunities for exposure to airborne contaminants. Procedures for safe removal, touching only the “clean” elastic are provided (Figure). In some healthcare settings, particulate respirators used to provide care for patients with tuberculosis in All are reused by the same HCW. This is an acceptable practice providing the respirator is not damaged or soiled, and the fit is not compromised by change in shape. Reuse of respirators that are likely to have been contaminated with blood or respiratory secretions is not advised.

## **II.E. Safe work practices to prevent HCW exposure to bloodborne pathogens**

**II.E.1. Prevention of needlesticks and other sharps-related injuries.** Injuries due to needles and other sharps have been associated with transmission of HBV, HCV and HIV to HCWs (353, 354). Therefore, included in Standard Precautions are measures to handle needles and other sharp devices in a manner that will prevent injury to the user and to others who may encounter the device during or after a procedure. Additional guidance on a sharps injury prevention program may be found at [www.cdc.gov/sharpsafety/](http://www.cdc.gov/sharpsafety/).

**II.E.2. Prevention of mucous membrane contact.** Use of safe work practices to protect mucous membranes whether or not PPE is used will help protect from exposure to a variety of pathogens. Keeping gloved and ungloved hands that are contaminated from touching the mouth, nose, eyes, and/or face will prevent exposing healthcare personnel to various pathogens. Careful placement of PPE before patient contact will help avoid the need to make adjustments during use.

Mouthpieces, pocket resuscitation masks with one-way valves, and other ventilation devices are an alternative to mouth-to-mouth resuscitation methods in areas where resuscitation is predictable and will avoid exposing the nose and mouth to oral and respiratory fluids during such procedures.

## **II.F. Patient placement**

**II.F.1. Hospitals and long-term care settings.** There are 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 isolation rooms (e.g., tuberculosis, SARS, chickenpox), the risk of transmission of infectious agents is often overlooked. However, appropriate patient placement is an important Standard and Expanded Precautions infection control strategy.

From an infection control perspective, it would be preferable to have only single-patient rooms in healthcare facilities. However, this rarely occurs. When there are only a limited number of single-patient rooms, they will need to be prioritized for those patients who have conditions that facilitate transmission of infectious agents 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) (13, 18, 146, 158, 355, 356).

Single-patient rooms are always indicated for patients placed in All and in a Protective Environment. For patients who require Contact or Droplet Precautions, single patient rooms are preferred (18, 32, 163, 357, 358). 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 or when single-patient rooms are not available, 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 are maintained. Results of several studies to determine the benefit of a single-patient room to prevent transmission of *Clostridium difficile* are inconclusive (359). However, for children, the risk of healthcare-associated diarrhea was increased with the increased number of patients per room (360). 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 patients with the same infection or colonization with the same MDRO together to confine their care to one area and prevent contact with other patients. This is not a primary prevention strategy due to the logistical difficulties encountered and the frequent lack of microbiologic data to determine infection or colonization status, especially in LTCFs. Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology, and mode of transmission of the infectious agent. Criteria for including a patient in a cohort include 1) the patient is not infected with other potentially transmissible microorganisms; 2) the likelihood of reinfection with the same organism is minimal; and 3) the patient is not severely immunocompromised. Assigning or cohorting healthcare personnel to care only for patients infected or colonized with a single target pathogen limits further transmission of infectious agents to uninfected

patients (361) but is difficult to achieve in the face of current staffing shortages in hospitals (241) and in non-hospital healthcare sites ([www.cdc.gov/nciod/hip/Aresist/aresist.htm](http://www.cdc.gov/nciod/hip/Aresist/aresist.htm)).

During the seasons when RSV, 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 (362). 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. The inability of infants and children to contain body fluids plus the close physical contact that occurs during routine care increases infection transmission risks for this population considerably (18, 356).

**II.F.2. Ambulatory settings.** Patients actively infected with or incubating transmissible infectious diseases are seen frequently in ambulatory settings (e.g., outpatient clinics, physicians' offices, emergency departments) and potentially expose healthcare personnel and other patients, family members and visitors (37, 44, 112, 187, 363). In response to the global SARS outbreak of 2003 and in preparation for pandemic influenza, outpatient settings are being urged to implement source containment measures to prevent transmission of agents causing respiratory infections, beginning at the point of initial patient encounter ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)) as described below in section III.A.1. Signs posted at the entrance to facilities or at the reception or registration desk may request that the receptionist promptly be informed if the patient or individuals accompanying the patient has symptoms of a respiratory infection, e.g., cough, flu-like illness, increased production of respiratory secretions. The presence of diarrhea, skin rash, or known exposure to a transmissible disease (e.g., measles, pertussis, chickenpox, tuberculosis, SARS) also could be added. Whenever possible, placement without delay in an examination room limits the number of exposed individuals 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, should limit most exposures. However, infections transmitted via the airborne route (e.g., tuberculosis, measles, chickenpox) will require additional precautions (11, 364, 365). Patients suspected of having an airborne infection may be asked to wear a surgical mask, if tolerated, for source

containment and placed in an All room 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. HCWs should wear NIOSH-approved respirators (N95 or higher) when entering the All room (9, 11). The person accompanying the patient also should be considered potentially infectious and instructed to follow the same infection control instructions given to the patient. For example, family members accompanying children admitted for the suspicion of tuberculosis and who have been diagnosed subsequently with tuberculosis, frequently have been found to have unsuspected pulmonary tuberculosis with cavitory lesions (366, 367).

Patients with underlying conditions (e.g., those who are immunocompromised (146, 368) or have cystic fibrosis (221)), require special efforts to protect them from exposures to infected patients in common waiting areas. These patients should inform the receptionist of their risk for infection upon arrival so that appropriate steps may be taken to further protect them from infection. In cystic fibrosis clinics, 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 in order to avoid exposure to other patients who could be colonized with *B. cepacia* (369).

**II.F.3. Home care.** In home care, the HCW should identify high-risk persons who would benefit from being removed from the home or who should be prohibited from visiting as long as the patient is infectious. For example, if a patient with pulmonary tuberculosis is contagious and being cared for at home, the removal of small children (370) or immunocompromised persons who have not been infected may be protective. During the SARS outbreak of 2003, segregation of infected persons during the communicable phase of the illness was beneficial for prevention of household transmission.

## **II.G. Transport of patients**

In the inpatient setting, the transport of patients on Expanded Precautions should be limited to essential purposes such as diagnostic and therapeutic procedures that cannot be performed in the patient's room. When transport is necessary, the patient should use appropriate barriers (e.g., mask, gown, wrapping in sheets or use of impervious dressings when infectious skin lesions or drainage are present), consistent with the route and risk for transmission. Healthcare personnel in the receiving area should be notified of the impending

arrival of the patient and of the precautions necessary to prevent transmission.

## **II.H. Environmental measures**

As part of Standard Precautions, recommended practices for cleaning and disinfecting non-critical surfaces in patient-care areas should be followed (4). These procedures remain the same for patients on Expanded Precautions. Cleaning and disinfection of all patient-care areas should especially focus on frequently touched surfaces and those most likely to be contaminated with blood and body fluids (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. This may be especially true in LTCFs where patients with stool and urine incontinence are encountered more frequently. Also, increased frequency of cleaning may be needed in a PE to minimize dust accumulation. Special recommendations for cleaning and disinfecting environmental surfaces in dialysis centers have been published (10). In all healthcare settings, cleaning and disinfection of surfaces that could be implicated in transmission should take priority in administrative staffing and scheduling activities. During a suspected or proven outbreak, an environmental reservoir is a consideration and routine cleaning procedures should be reviewed and the need for proper technique re-enforced.

Healthcare facilities should select disinfectant agents that best meet their overall needs. Consistently following the routine recommendations for the amount, dilution, and contact time of disinfectants, rather than changing agents or procedures, will generally suffice for cleaning of rooms of patients colonized or infected with microorganisms associated with environmental contamination and those that are resistant to multiple classes of antimicrobial agents (e.g., *C. difficile*, VRE, MRSA, MDR-GNB (4, 18, 163, 337, 338, 357, 371)). Most often, it is the failure to follow recommended procedures rather than the failure of the procedures that contributes to the role of an environmental reservoir of pathogens during outbreaks.

Certain infectious agents (e.g., rotavirus, *C. difficile*, prions) may be resistant to some routinely used hospital disinfectants (372-375). The role of specific disinfectants in limiting transmission of rotavirus has been demonstrated experimentally (372). Also, 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 (7, 374). The need to change disinfectants based on the presence of these organisms should be decided after consultation with infection control (4). For detailed recommendations for disinfection and sterilization of surfaces and medical equipment that have been in contact with prion-containing tissue or high risk body fluids, and for cleaning of blood and body substance spills, consult the Guideline for Disinfection and Sterilization in Healthcare Settings 2004 (in preparation) (7) and the Guidelines for Environmental Infection Control in Healthcare Facilities (4).

### **II.I. Patient care equipment**

Medical equipment must be cleaned and maintained according to the manufacturers' instructions. Noncritical items, such as commodes, intravenous pumps, and ventilators, must be thoroughly cleaned and disinfected prior to 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.

In all healthcare settings, patients known or suspected to be colonized or infected with multidrug-resistant or epidemiologically important organisms requiring Expanded Precautions should be provided with dedicated noncritical medical equipment (e.g., stethoscope, blood pressure cuff, electronic thermometer) (2, 15, 376). When this is not possible, cleaning with a low-level disinfectant after use is recommended. Other guidelines should be consulted for detailed guidance in developing specific protocols for cleaning and reprocessing medical equipment and patient care items in both routine and special circumstances (2, 8, 10).

In home care, durable medical equipment that is taken out of the home should be visibly inspected prior to leaving the home. Visible soiling or contaminated material should be removed using an appropriate cleaning/disinfectant agent (221, 313). The equipment then should be placed in a single plastic bag for transport to the reprocessing location.

## **II.J. 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 it is handled, transported, and laundered in a safe manner (4, 377, 378). Key principles for handling soiled laundry are 1) not to shake the items or handle in any way that may aerosolize infectious agents; 2) to avoid contact of the body and personal clothing with the laundry; and 3) to contain it 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 of soiled textiles are determined by organizational policy and any applicable regulations; guidance is provided in the Guidelines for Environmental Infection Control (4). Rather than rigid rules and regulations, hygienic and common sense storage and processing of clean and soiled textiles are recommended (4, 313) ([www.jcaho.org](http://www.jcaho.org)). When laundering occurs outside of a healthcare facility, the clean items must be packaged to prevent contamination with outside air or construction dust that could contain infectious fungal spores that are a risk for immunocompromised patients (4).

Institutions are required to launder garments used as personal protective equipment and uniforms visibly soiled with blood or infective material. There are few data to determine the safety of home laundering of HCW uniforms, but there was no increase in infection rates in the one published study (4, 379). In the home, textiles and laundry from patients with potentially transmissible infectious agents do not require special handling or separate laundering, but should be washed with hot water and soap (4, 379).

## **II.K. Dishware and eating utensils**

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 Expanded Precautions. The combination of hot water and detergents used in dishwashers is sufficient to decontaminate dishware and eating utensils. In the home and other communal settings, all individuals should be taught and encouraged not to share eating utensils and drinking vessels as part of good personal hygiene and for the purpose of preventing transmission of respiratory viruses, *Herpes simplex* virus, and agents that infect

the gastrointestinal tract and are transmitted by the fecal/oral route (e.g., hepatitis A virus, noroviruses). If hot water or adequate conditions for cleaning utensils and dishes are not available, disposable products should be used.

## **II.L. Adjunctive measures**

Important adjunctive measures that are not considered primary components of programs to prevent transmission of infectious agents, but that improve effectiveness of such programs, include 1) antimicrobial management programs; 2) postexposure chemoprophylaxis with antiviral or antibacterial agents; and 3) vaccines used both for pre and postexposure prevention. Detailed discussion of judicious use of antimicrobial agents is beyond the scope of this document. However, implementation of effective programs to limit use of selected antibiotics has been shown to decrease the reservoir of MDROs for which Contact Precautions is required in high-risk units and is one component of recommended MDRO control measures discussed in Appendix B of this guideline (128, 380-405).

**II.L.1. Chemoprophylaxis.** Antimicrobial agents and topical antiseptics may be used to prevent outbreaks of selected agents. Infectious agents for which post-exposure chemoprophylaxis is recommended under defined conditions include: *B. pertussis* (9), *N. meningitidis* (406), *B. anthracis* (407), influenza virus (408), HIV (353), and group A streptococcus (409).

Another form of chemoprophylaxis is the use of topical antiseptic agents. Triple dye is one of the agents 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 (410, 411). Extension of the use of triple dye to low birth weight infants in the NICU was one component of a program that finally controlled a longstanding MRSA outbreak (248). Chemoprophylaxis for decolonization of healthcare personnel or patients colonized with MRSA using either orally administered antimicrobials or topical mupirocin is discussed in the section on MDROs in Appendix B.

**II.L.2. Immunization.** Certain immunizations are recommended for susceptible healthcare personnel to decrease the risk of infection and the potential for transmission within the healthcare facility (9, 412). The OSHA mandate that employers offer hepatitis B vaccination to HCWs played a substantial role in the sharp decline in incidence of healthcare-associated HBV (353). Similarly, reports of healthcare-associated transmission of rubella in obstetrical

clinics (413, 414) and measles in acute care settings (187) demonstrate the importance of immunization of susceptible healthcare personnel against childhood diseases. 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 (415). Many states have requirements for HCW vaccination in the absence of evidence of immunity.

Transmission of *B. pertussis* in healthcare facilities has been associated with large outbreaks that include both healthcare personnel and patients (9, 33, 304, 363, 416). HCWs are at particularly high risk because of prolonged close contact with infants with pertussis, waning immunity, and the absence of a vaccine that can be used in adults. Licensure of an adult acellular pertussis vaccine in the United States is anticipated within the next 2-3 years. When licensed, it is likely that healthcare personnel in facilities that care for young infants and children will be amongst the highest priority groups to receive this vaccine (417).

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 (408, 418-420). Anthrax (407) and smallpox (100) vaccines are two additional vaccines that are likely to be used in HCWs if widespread immunization should become necessary due to the ongoing threat of bioterrorist attacks.

Immunization of children according to the recommended schedule published annually in a January issue of the *Morbidity Mortality Weekly Report* (421) and the January issue of *Pediatrics* (422) and with interim updates as needed will further decrease the burden of transmissible viruses that could be introduced into the healthcare environment by both patients and visitors. Varicella (423), influenza (408), hepatitis B (353), smallpox (100), and anthrax (407) vaccines are also recommended for post-exposure prophylaxis of susceptible individuals (9, 412). Finally, administration of a newly developed *S. aureus* conjugate vaccine that is still under investigation to selected patients provides 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) (425, 426).

### **Part III. HICPAC/CDC Precautions to Prevent Transmission of Infectious Agents**

There are two tiers of HICPAC/CDC transmission precautions, Standard Precautions and Expanded Precautions. Standard Precautions is 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 successful prevention of healthcare-associated transmission of infectious agents among patients and healthcare personnel.** Expanded Precautions are for patients who are known or suspected to be infected with epidemiologically important pathogens that require additional control measures to prevent transmission. Expanded Precautions also include recommendations for creating a PE for allogeneic HSCT patients.

#### **III.A. Standard Precautions**

Standard Precautions synthesizes the major features of Universal Precautions (427, 428) and Body Substance Isolation (260) and includes infection control practices and use of PPE recommended for healthcare personnel when having contact with all patients wherever healthcare is delivered, regardless of patient diagnoses or presumed infection status. Standard Precautions is designed to protect HCWs and patients from contact with infectious agents in recognized and unrecognized sources of infection. Standard Precautions applies to 1) blood; 2) all body fluids, secretions, and excretions except sweat, regardless of whether they contain visible blood; 3) nonintact skin; and 4) mucous membranes. The fundamental elements for transmission prevention discussed in Section II above apply to Standard Precautions. The same PPE for protection against blood exposure are also used to prevent healthcare personnel from contacting the various infectious agents and then carrying them to other patients (18, 335-338, 376) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)).

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 contact. For some interactions, only gloves may be needed; in others gloves, gowns, and face shields may be required. Education and training on the principles and rationale for recommended practices are critical elements of Standard Precautions because they facilitate appropriate decisions when HCWs are faced with new circumstances.

Recommendations for the application of Standard Precautions are described below in IV and summarized in Table 4. Guidance on donning and removing gloves, gowns and other barriers is presented in the Figure.

### **III.A.1. New Standard Precautions for patients: Respiratory Hygiene/Cough Etiquette.**

The global outbreak of SARS in 2003 identified several opportunities to improve infection control practice in all healthcare settings. One such opportunity is implementing controls to prevent transmission of respiratory infections at the first point of contact 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 one component of Standard Precautions

([www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm](http://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm)). The term *cough etiquette* is derived from recommended source control measures for *M. tuberculosis* (11).

SARS is but one of a number of respiratory agents that can be transmitted via large respiratory droplets. Others include influenza virus (32), adenovirus (29), *B. pertussis* (363) and *Mycoplasma pneumoniae* (35). During the SARS outbreak, several instances of SARS transmission in outpatient settings were reported (37, 116, 429). In one case, the infected wife of a suspect SARS patient transmitted SARS-CoV to 13 individuals in a hospital emergency department, including five persons sitting with her in the waiting area (37). These transmissions highlighted the need for vigilance in detecting possible infection in patients and accompanying family members or friends and implementing infection control measures promptly in these healthcare settings.

The elements of Respiratory Hygiene/Cough Etiquette include 1) education of healthcare facility staff, patients, and visitors; 2) posted signs in language 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 disposing of used tissues, using surgical masks on the coughing person when tolerated and appropriate); 4) hand hygiene after contact with respiratory secretions; and 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 droplets into the air (343-345). Physical proximity of <3 feet has been associated with an increased risk for transmission of infections via the droplet route (e.g., *N. meningitidis* (27) and group A streptococcus (38)) and therefore supports the practice of distancing infected persons from others who are not infected. Finally, the effectiveness of good hygiene, especially hand hygiene, practices in preventing transmission of viruses and reducing the incidence of respiratory infections both within and outside (430-432) healthcare settings is summarized in several reviews (6, 318, 433).

These measures are targeted to patients and accompanying family members or friends but applies to any person (33, 145, 146) with signs of a cold or other respiratory infection (e.g., cough, congestion, rhinorrhea, increased production of respiratory secretions) who enters any healthcare facility. Although fever will be present in many respiratory infections, patients with pertussis and colds 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. Although these patients are not infectious, cough etiquette measures also apply.

Healthcare personnel are advised to observe Droplet Precautions (i.e., wear a surgical 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 patient contact when they are actively coughing and producing respiratory secretions.

### **III.B. Expanded Precautions**

There are four categories of Expanded Precautions: Contact Precautions, Droplet Precautions, Airborne Infection Isolation (AII), and Protective Environment (PE). More than one category may be used for diseases that have multiple routes of transmission (e.g., SARS). When used either singularly or in combination, they are always to be used in addition to Standard Precautions. (See Appendix A for recommended precautions for specific infections.) PE differs from the other categories in that the goal of placing a high-risk patient in a PE to prevent the patient from acquiring fungal infections from the environment,

whereas the goals of the other categories are to protect HCWs, visitors, and other patients from acquiring infectious agents from infected patients.

**III.B.1. Contact Precautions** are intended to reduce the risk of transmission of epidemiologically important microorganisms by direct or indirect contact with the patient or the patient's environment as described in I.B.3.a. With Contact Precautions, greater spatial separation of the infected/colonized patient is preferred (e.g., single-patient room or  $\geq 3$  feet between beds in multipatient rooms) and healthcare personnel and visitors wear gown and gloves for all interactions that may involve contact with the patient or the patient's environment. Contact Precautions apply where the presence of excessive wound drainage, fecal incontinence, or other discharges from the body suggest an increased transmission risk. In addition, Contact Precautions may apply to patients known or suspected to be infected or colonized (as locally defined) with epidemiologically important microorganisms that can be transmitted by direct or indirect contact, e.g. MDROs, as described in Appendix B. For pathogens that are likely to be associated with extensive environmental contamination (e.g., VRE), PPE should be donned before room entry and discarded before exiting the patient's room. When Contact Precautions is indicated, efforts must be made to counteract the adverse effects on patients that have been reported in the literature in order to improve acceptance by the patients and adherence by HCWs (233, 434-437).

**III.B.2. Droplet Precautions** is intended to reduce the risk of droplet transmission of infectious agents from close respiratory or mucous membrane contact (e.g.,  $\leq 3$  feet) with large-particle droplets (larger than 5  $\mu\text{m}$  in size) as described in I.B.3.b. Because droplets do not remain suspended in the air, special air handling and ventilation are not required to prevent droplet transmission. However, masks (respirators are not necessary) are needed for close contact with the patient. Indirect evidence suggests that masks are effective in preventing transmission of *B. pertussis* (33), *N. meningitidis* (39, 40), SARS (30), and influenza virus (32). Masks should be changed when they become wet and should be considered contaminated and therefore disposed after use. Droplet Precautions apply to patients known or suspected to be infected with epidemiologically important pathogens that can be transmitted by infectious droplets (e.g., *B. pertussis* (33), influenza virus (32),

adenovirus (29), SARS-CoV (30), rhinovirus (34), *N. meningitidis* (39), and group A streptococcus (38) [for the first 24 hours of antimicrobial therapy]).

**III.B.3. Airborne Infection Isolation (All) Precautions** is intended to reduce the risk of airborne transmission of infectious agents (e.g., rubeola virus [measles], varicella virus, *M. tuberculosis*) as described in I.B.3.c. and in Table 2. An All room 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 All rooms (i.e., monitored negative pressure relative to the surrounding area, 2 air exchanges per hour (6 air exchanges per hour for existing facilities), air exhausted directly to the outside or recirculated through HEPA filtration). Some state regulations require the availability of such rooms in hospitals, emergency departments, and nursing homes for care of patients with tuberculosis. In settings where All cannot be implemented due to limited engineering resources, physical separation, masking the patient, and providing respiratory protection for healthcare personnel will reduce the likelihood of airborne transmission until the patient can be transferred to a facility with All. Persons who enter an All room or area must wear respiratory protection (e.g., NIOSH-approved N-95 or higher respirator), depending on the disease-specific recommendations (Respiratory Protection II.D.4 and Appendix A). Non-immune HCWs should not care for patients with vaccine preventable airborne diseases (e.g., measles, chickenpox, and smallpox), regardless of use of personal protective equipment. However, immune persons should also wear masks or NIOSH-approved N-95 respirators for complete protection, due to errors in ascertaining immunity, and for consistency in the practice of All.

**III.B.4. Protective Environment** is designed for allogeneic HSCT patients to minimize fungal spore counts in the air (see Table 6 for specifications) (4, 5, 8, 13). The need for such controls has been demonstrated in studies of outbreaks of aspergillosis associated with construction and in molecular typing studies that have found identical strains of *Aspergillus terreus* in patients with hematologic malignancies and in potted plants in the vicinity of the patients (4, 8, 13, 203). Air quality for HSCT patients is improved through a combination of environmental controls that include 1) HEPA filtration of incoming air, 2) directed room air flow, 3) positive room air pressure relative to the corridor, 4) well-sealed rooms (including sealed walls, floors, ceilings, windows, electrical outlets) to prevent infiltration of air from the

outside, 5) ventilation to provide  $\geq 12$  air changes per hour, 6) strategies to lower dust (e.g., scrubbable surfaces rather than carpet and upholstery) and routinely cleaning crevices and sprinkler heads, and 7) prohibiting dried and fresh flowers and potted plants and fresh flowers in the rooms of HSCT patient. The desired quality of air may be achieved without the inconvenience or expense of laminar airflow (13, 203). To prevent inhalation of respirable particles and reaerosolization of exhaled particles in the presence of construction, placement of an N95 respirator on the patient is advised when patients leave the PE for diagnostic studies or treatments elsewhere in the facility (438). However, the use of respirators outside of the protective environment for prevention of environmental fungal infections in the absence of construction has not been evaluated. A PE does not include the use of barrier precautions beyond those indicated for Standard and Expanded Precautions when applicable. No published reports support the benefit of placing solid organ transplants or other immunocompromised patients in a PE.

### **III.C. Syndromic or empiric application of Expanded Precautions**

Diagnosis of many infections requires laboratory confirmation. Since laboratory confirmation tests, especially those that depend on culture techniques, often require two or more days for completion, reliance on confirmed diagnoses to implement preventive measures allows additional exposures while test results are pending. Use of precautions at the time patients develop symptoms and signs of transmissible infections or present to medical attention reduce exposure opportunities. In particular, the routine use of Standard Precautions for all patient interactions reduces greatly the risk of exposure for conditions other than those requiring Contact or Droplet Precautions or All. While it is not possible to prospectively identify all patients needing Expanded Precautions, certain clinical syndromes and conditions carry a sufficiently high risk to warrant their use on an empirical basis while confirmatory tests are pending (Table 6).

Table 6 lists some of the most worrisome infectious agents that require Expanded Precautions in addition to Standard Precautions. The relevant Expanded Precautions category should be applied until either a definitive etiologic diagnosis is established or a role for the worrisome pathogen is excluded. Infection control professionals are encouraged to modify or adapt this table according to local conditions. For example, in acute care facilities using Contact Precautions to manage all patients harboring MDROs, these precautions

would be applied empirically for all new admissions with a history of prior infection or colonization with MDROs. They would also be applied empirically to all patients who present with skin, wound, or urinary tract infections and who have a history of recent hospitalization or residence in facilities where MDROs are prevalent. Contact Precautions could be discontinued once admission surveillance cultures are reported to be negative for the target MDRO. Implementation of Expanded Precautions on an empirical basis requires education and training of front-line HCWs and competency assessment.

### **III.D. Discontinuation of Expanded Precautions**

Standard Precautions apply to all patients, at all times. In general, Expanded Precautions remain in effect for limited periods, i.e., while the risk for transmission of the infectious agent persists or for the duration of the illness (Appendix A). For most diseases this duration reflects known patterns of microbial persistence and shedding associated with the natural history of the infectious process and its treatment. For some diseases, e.g., pharyngeal or cutaneous diphtheria, Expanded Precautions remain in effect until culture results document eradication of the pathogen. For other diseases, state laws and regulations may dictate the duration of Expanded Precaution use. See Appendix B for discussion of criteria to discontinue Contact Precautions for patients colonized or infected with MDROs.

### **III.E. Application of Expanded Precautions in ambulatory and home care settings**

Although Expanded Precautions generally apply in all healthcare settings, exceptions exist. For example, in home care, engineered Air rooms are not available. Furthermore, family members already exposed to diseases such as varicella and tuberculosis would usually not use masks or respiratory protection, though visiting HCWs would. Similarly, management of patients colonized or infected with MDROs may necessitate Contact Precautions in acute care hospitals, but in ambulatory care and home care, consistent use of Standard Precautions usually suffices (160).

For healthcare settings using Contact Precautions for patients who are colonized or infected with MDROs, the duration of these precautions remains undefined. Although guidelines for VRE suggested discontinuation of Contact Precautions after three stool cultures, obtained at weekly intervals, proved negative (2), subsequent experiences have indicated that such screening may fail to detect colonization that may persist for >1 year

(439-442). Likewise, 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 (443, 444). Available data indicate that colonization with VRE, MRSA (445), and, probably, 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. Selection of the best strategy awaits the results of additional studies.

## Part IV: Recommendations

These recommendations are designed to prevent transmission of infectious agents among patients and healthcare personnel in all settings where healthcare is delivered unless otherwise stated. As in other CDC/HICPAC guidelines, each recommendation is categorized on the basis of existing scientific data, theoretical rationale, applicability, and when possible, economic impact. The CDC/HICPAC system for categorizing recommendations is as follows:

**Category IA.** Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.

**Category IB.** Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and a strong theoretical rationale.

**Category IC.** Required for implementation, as mandated by federal and/or state regulation or standard.

**Category II.** Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale.

**No recommendation;** unresolved issue. Practices for which insufficient evidence or no consensus regarding efficacy exists.

### I. Administrative Responsibilities

- A. Incorporate preventing transmission of infectious agents into the objectives of the organization's patient and occupational safety programs (230-232, 234, 295).

*Category II*

- B. Make preventing transmission of infectious agents a priority for the healthcare organization. Provide administrative support, including fiscal and human resources for maintaining infection control programs (6, 162, 240, 243, 281, 296, 297, 299, 446). *Category IB*

1. Assure that individuals with training in infection control are employed by or are available by contract to all healthcare organizations, with at least 1 infection control professional per 250 occupied acute care beds (162, 297, 446, 447).

*Category IB*

- a. Add infection control professionals based on the scope of the infection

control program, the complexity of the healthcare facility or system, the characteristics of the patient population and the unique or urgent needs of the facility and community (447).

*Category II*

2. Include prevention of healthcare-associated infections (HAI) as one determinant of bedside nurse staffing levels and composition, especially in high risk units (162, 241, 254, 255, 257, 258, 297, 299). *Category IB*

3. Involve infection control personnel in decisions on facility construction and design, determination of Airborne Infection Isolation (All) and Protective Environment (PE) capacity needs, and selection of medical equipment and supplies (4, 5, 448-450).

*Category IB/IC*

4. Ensure availability of clinical laboratory support appropriate to the healthcare setting for monitoring transmission of microorganisms and conducting epidemiologic investigations. Include resources for surveillance cultures, rapid diagnostic testing for viral and other selected pathogens, preparation of antimicrobial susceptibility reports, trend analysis, and molecular typing of clustered isolates performed either on site or in a reference laboratory (162, 284, 287-289, 297). *Category IB*

5. Provide human and fiscal resources to meet occupational health needs related to infection control, e.g., healthcare worker immunization, post-exposure evaluation and care, evaluation and management of healthcare personnel with communicable infections (9, 11, 313, 353, 412, 416, 451) ([www.cdc.gov/ncid/sars](http://www.cdc.gov/ncid/sars)). *Category IB/IC*

6. Provide supplies and equipment required for the consistent observance of Standard and Expanded Precautions (Contact, Droplet, All, PE) including hand hygiene products and protective barriers (e.g., gloves, gowns, face and eye protection)(6, 313). *Category IB/IC*.

7. Provide ventilation systems required for a sufficient number of All rooms and a PE in facilities that provide care to patients for whom such rooms are indicated according to published recommendations (4, 11, 13, 313). *Category IA/IC*

8. Develop and implement policies and procedures to ensure that reusable patient care equipment is cleaned and reprocessed appropriately before use on another patient (4, 7, 313). *Category IA/IC*
- C. Develop and implement a process to ensure oversight of infection control activities appropriate to the healthcare setting.
1. Assign responsibility for oversight of infection control activities to an individual or group within the healthcare organization that is knowledgeable about infection control (162, 297). *Category II*
  2. Delegate authority to infection control personnel or their designees (e.g., patient care unit charge nurses) for making infection control decisions concerning patient placement and the use of Expanded Isolation Precautions (162, 297) ([www.jcaho.org](http://www.jcaho.org)). *Category IC*
  3. Develop and implement systems for early detection and management, (e.g. initiation of appropriate isolation precautions) of potentially infectious persons at initial points of patient encounter in outpatient areas (e.g., triage areas, emergency departments, outpatient clinics, physician offices) and at the time of admission to hospitals and long term care facilities (37, 43, 363, 452); [www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars). *Category IB*
  4. Develop and implement policies that limit patient visitation by persons with signs or symptoms of a communicable infection. Screen visitors to high-risk patient care areas (e.g., oncology units, hematopoietic stem cell transplant [HSCT] units, intensive care units [ICU]) for signs and symptoms of communicable infections, high risk pediatric units (18, 33, 146, 408). *Category IB.*
  5. Develop indicators to monitor the effectiveness of facility-specific measures to prevent transmission of infectious agents and provide feedback to staff members (6, 299, 312-314). *Category IB*
  6. Monitor recommended performance indicators for adherence to recommended practices for hand hygiene and Standard and Expanded Precautions and provide feedback to staff (6, 259, 299). *Category IA.*

## II. Education and Training

- A. Provide education and training on preventing transmission of infectious agents associated with healthcare during orientation to the healthcare facility; update information periodically during staff development programs. Target all healthcare personnel for education and training, including but not limited to medical, nursing, and laboratory staff; property service (housekeeping), laundry, maintenance, and dietary workers; and students, contract staff, and volunteers. Enhance training by applying principles of adult learning and using appropriate reading level and language for target audience (6, 11, 307-311, 453). *Category IB.*
- B. Provide instructional materials for patients and visitors on recommended hand hygiene practices and application of Expanded Precautions (18, 146). *Category II*

## III. Surveillance

Conduct ongoing monitoring of sentinel populations (e.g., ICU, post-operative, hematology-oncology, transplant patients), procedures and device use (e.g., central venous-catheter associated bloodstream infections (BSI), ventilator-associated pneumonia (VAP), urinary tract infection associated with indwelling catheters, surgical site infections (SSI)), and highly transmissible infections (e.g. *Clostridium difficile*, rotavirus-associated diarrhea; viral respiratory infections, especially influenza, RSV, and SARS; environmental fungal infections, tuberculosis) for evidence of contamination of devices or new or ongoing transmission in the healthcare facility (309, 446, 453-459). *Category IA*

- A. Use the following principles of infection control surveillance (454, 455) *Category IB:*
- Use standardized definitions of infection
  - Use laboratory-based data for surveillance (when available)
  - Specify location and/or clinical service in hospitals and other large multi-unit facilities
  - Use established risk stratification when available, e.g. surgical wound class, device days, birthweight (neonatal intensive care unit [NICU])
  - Monitor results and identify trends that may indicate increased rates of transmission within the facility.

- Provide information on trends in incidence and prevalence of healthcare-associated infections, probable risk factors and prevention strategies and their impact to the appropriate healthcare providers and institutional administrators
- B. Obtain consultation from persons knowledgeable in infection control and healthcare epidemiology when indicated by presence of continued transmission despite implementation of basic infection control measures (446). *Category IB*
- C. Periodically review information on local trends in incidence and prevalence of pathogens acquired in the community (including in other healthcare facilities in the community) that may impact rates of HAI, e.g. influenza, RSV, multidrug-resistant organisms [MDRO] (e.g., MRSA, VRE) (459). *Category II*

### III. Standard Precautions

Assume that every person is potentially infected or colonized with an organism that could be transmitted in the healthcare setting and apply the following infection control practices during delivery of health care:

- A. Indications for handwashing and hand antisepsis:
1. When hands are visibly dirty or contaminated with proteinaceous material or visibly soiled with blood or other body fluids, wash hands with either a nonantimicrobial soap and water or an antimicrobial soap and water (6, 460). *Category IA*
  2. If hands are not visibly soiled, use an alcohol-based handrub for routinely decontaminating hands in all other clinical situations described below and in the Guideline for Hand Hygiene in Health-Care Settings (6, 461-463). *Category IA*. Alternatively, wash hands with an antimicrobial soap and water (6, 464). *Category IB*
  3. Decontaminate hands in the following circumstances, whether or not gloves are worn (6) :
    - a. Before having direct contact with patients (465, 466). *Category IB*
    - b. After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings(466). *Category IA*

- c. After contact with a patient's intact skin (e.g. when taking a pulse or blood pressure or lifting a patient) (461, 465, 467, 468). *Category IB*
  - d. If hands will be moving from a contaminated-body site to a clean-body site (461, 465, 467-469). *Category II*
  - e. After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient (338, 469, 470). *Category II*
  - f. After removing gloves (326, 331, 333). *Category IB*
4. Wash hands with non-antimicrobial soap and water or with antimicrobial soap and water if contact with spores (e.g., *Bacillus* spp. or *C. difficile*) is anticipated. The physical action of washing and rinsing hands under such circumstances is recommended because alcohols, chlorhexidine, iodophors, and other antiseptic agents have poor activity against spores (6, 7, 471). *Category II*
  5. Do not wear artificial fingernails or extenders when having direct contact with patients at high risk for infection (e.g., those in ICUs or operating rooms) (6, 319-323). *Category IA*

## B. Personal Protective Equipment (see Figure 1)

1. Observe the following principles of use:
  - a. Wear personal protective equipment (PPE) when the nature of the anticipated patient interaction indicates that contact with blood or body fluids may occur (313, 427, 428). *Category IB/IC*
  - b. During the delivery of healthcare, avoid touching surfaces in close proximity to the patient (10, 313, 472, 473). *Category IB/IC*
  - c. Prevent contamination of clothing and skin during the process of removing PPE ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category II*
  - d. Before leaving the patient's room or cubicle, remove and discard gowns and gloves (10, 313). *Category IB/IC*
2. Gloves
  - a. Wear gloves when it can be reasonably anticipated that contact with blood or other potentially infectious materials, mucous membranes, nonintact skin, or potentially colonized intact skin (e.g., of a patient with diarrhea), could occur (10, 313, 326, 331, 428, 474). *Category IB/IC*

- b. Wear gloves with fit and durability appropriate to the task (6, 313, 328, 329, 475, 476). *Category IB*
    - i. Wear disposable medical examination gloves for providing direct patient care.
    - ii. Wear disposable medical examination gloves or reusable utility gloves for cleaning the environment or medical equipment.
  - c. Remove gloves after contact with a patient and/or the surrounding environment (including medical equipment), using proper technique to prevent hand contamination. Do not wear the same pair of gloves for the care of more than one patient. Do not wash gloves for reuse with different patients (6, 326, 331-334). *Category IB*
  - d. Change gloves during patient care if the hands will move from a contaminated body site (e.g., perineal area) to a clean body site (e.g., face) (6, 325, 326).  
*Category II*
3. Gowns and other PPE attire
- a. Wear a gown, apron, or other PPE attire, that is appropriate to the task, to protect skin and prevent soiling of clothing during procedures and patient-care activities when contact with blood, body fluids, secretions, or excretions is anticipated (313). *Category IC*
    - i. Wear a gown for direct patient contact if the patient has uncontained secretions or excretions (18, 313, 338, 371, 376). *Category IB/IC*
    - ii. Remove gown, apron, or other PPE attire and perform hand hygiene before leaving the patient's environment (18, 313, 338, 371, 376).  
*Category IB/IC*
  - b. No recommendation for re-use of gowns for the same patient by the same or multiple healthcare personnel. *Unresolved issue*
4. Mouth, nose, eye protection
- a. Use PPE to protect the mucous membranes of the eyes, nose and mouth during procedures and patient - care activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions. Masks,

goggles, face shields, and combinations of each should be selected according to the task performed (30, 313). *Category IB*

- b. During procedures that generate sprays of respiratory secretions (e.g., bronchoscopy, suctioning, and intubation), wear gloves, gown, and either a face shield that fully covers the front and sides of the face, or a mask and goggles. Use an N95 or higher respirator instead of a surgical mask if the patient has a suspected or proven infection that is likely to be transmitted by the airborne route (11, 30, 36, 39, 313) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category IB/IC*

### C. Respiratory Hygiene/Cough Etiquette

1. Educate staff on the importance of source control measures to contain respiratory secretions and prevent droplet and fomite transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections (e.g., Severe Acute Respiratory Syndrome (SARS), influenza, RSV, adenovirus, parainfluenza (8, 18, 305, 408) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category IB*
2. Implement the following measures to contain the source of respiratory secretions in patients and accompanying individuals who have signs and symptoms of respiratory tract infection, beginning at the point of initial encounter in a healthcare setting (e.g., triage, reception and waiting areas in emergency departments, ambulatory clinics, healthcare provider offices):
  - a. Post signs in ambulatory and inpatient settings with instructions to patients and other persons with symptoms of a respiratory infection entering the facility to cover their mouths/noses when coughing or sneezing, use and dispose of tissues, and perform hand hygiene after hands have been in contact with respiratory secretions. *Category II*
  - b. Provide tissues and no-touch receptacles (i.e., ideally by foot pedal-operated lid or open waste baskets) for disposal of used tissues (18, 28, 221, 345, 431). *Category IB*
  - c. Provide resources and instructions for performing hand hygiene in or near waiting areas in ambulatory and inpatient settings; provide conveniently located dispensers of alcohol-based hand rubs and, where sinks are

available, supplies for handwashing (6, 430, 431, 432). *Category IA*

- d. During periods of increased rates of respiratory infections in the community (e.g., as indicated by increased school absenteeism), offer masks to coughing patients and other persons (e.g., symptomatic persons who accompany ill patients) with suspected respiratory tract infection upon entry into common waiting areas (11, 343, 344) and encourage them to maintain spatial separation, ideally a distance of at least 3 feet, from others in common waiting areas (27, 29, 32, 38, 221) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)).

*Category IB*

Some facilities may find it logistically easier to institute this recommendation year-round as a standard practice. *Category II*

#### D. Patient placement

1. Include the potential for transmission of infectious agents in patient-placement decisions. Place patients who pose a risk for transmission to others (e.g., uncontained secretions, excretions or wound drainage or infants with suspected viral respiratory tract or gastrointestinal tract infections) in a single-patient room when available (18, 158, 163, 357, 358, 478). *Category IB*
2. Determine patient placement based on the following principles (*Category II*):
  - Route(s) of transmission of the infectious agent
  - Risk factors for transmission in the infected patient
  - Risk factors for adverse outcomes resulting from healthcare-associated infection in other patients in the area
  - Availability of single-patient rooms
  - Patient options for room sharing (e.g., cohorting patients with the same infection)

#### E. Patient care equipment (7)

1. Establish policies and procedures for containing, transporting, and handling patient care equipment that may be contaminated with blood or body fluids (10, 313, 472). *Category IB/IC*

2. Wear appropriate PPE when handling patient care equipment that may have been in contact with or is visibly soiled with blood or body fluids (10, 313, 472).

*Category IB/IC*

#### F. Care of the environment (4)

1. Establish policies and procedures for cleaning and maintaining environmental surfaces as appropriate for the level of patient contact and degree of soiling (4).

*Category II*

2. Clean and disinfect surfaces that are in close proximity to the patient and those that may be contaminated with potential pathogens (e.g., doorknobs, bed rails, surfaces in and surrounding toilets in patients' rooms) on a more frequent schedule compared to that for minimal touch surfaces (e.g., horizontal surfaces in waiting rooms) (2, 4, 337, 479, 480). *Category IB*

3. Use EPA-approved disinfectants that have microbicidal (i.e., killing) activity against the pathogens most likely to contaminate the patient care environment. Review the efficacy of in-use disinfectants when there is evidence of transmission of infectious agents that may indicate resistance to the in-use product (e.g., rotavirus, *C. difficile*) and change to a more effective disinfectant as indicated (7, 372-374). *Category II*

#### G. Textiles and laundry

1. Handle used textiles and fabrics with minimum agitation to avoid contamination of air, surfaces, and persons (313, 481-483). *Category IB/IC*
2. If laundry chutes are used, ensure that they are properly designed, maintained, and used in a manner to minimize dispersion of aerosols from contaminated laundry (4, 5, 484, 485). *Category IB/ IC*

H. Workers' safety: Adhere to federal and state requirements for protection of healthcare personnel from exposure to bloodborne pathogens (313). *Category IC*

### **IV. Expanded Precautions**

#### **A. General principles**

In addition to Standard Precautions, use Expanded Precautions for patients with documented or suspected infection or colonization with highly transmissible or

epidemiologically important pathogens for which additional precautions are needed to prevent transmission (see Appendix A) (4, 8, 11, 18, 478). *Category IA*

## **B. Contact Precautions**

1. Use Contact Precautions as recommended in Appendix A for patients with known or suspected infections or evidence of syndromes that represent an increased risk for contact transmission, including colonization or infection with MDROs according to recommendations below (V.A.5.c, V.B.6.b.c). *Category IB*
2. Patient placement
  - a. In *acute care settings*, place patients who may require Contact Precautions in a single patient room (18, 75, 78, 357, 358, 371, 459, 486, 487). *Category IB*  
Apply the following hierarchy of alternatives when single-patient rooms are in short supply (*Category II*):
    - i. Prioritize patients with conditions that may facilitate transmission (e.g., uncontained drainage, stool incontinence) for single-patient room placement.
    - ii. Place together (cohort) in the same room patients who are infected or colonized with the same pathogen and are suitable roommates (e.g., at low risk for acquiring an infection or for an adverse outcome should transmission occur).
      - a) Ensure that patients are physically separated (i.e., >3 feet) from each other. Draw the privacy curtain between beds to minimize opportunity for direct contact.
      - b) Change protective attire and perform hand hygiene between patients.
    - iii. Avoid placing patients on Contact Precautions in the same room with patients who have conditions that may increase the risk of adverse outcome from infection or that may facilitate transmission (e.g., those who are immunocompromised, have open wounds, or have anticipated prolonged lengths of stay).
  - b. In *long term care settings*, make decisions regarding patient placement on a case-by-case basis, balancing infection risks to other patients in the room and

the potential adverse psychosocial impact on the infected or colonized patient (436, 437). *Category II*

- c. In *ambulatory settings*, place patients who require Contact Precautions in an examination room or cubicle as soon as possible (221). *Category II*
3. Hand hygiene and gloves: Observe hand hygiene practices and wear gloves according to Standard Precautions and whenever touching the patient's intact skin (6, 18, 335, 337, 338, 376) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)) (*Category IB*) or surfaces and articles in close proximity to the patient (e.g., medical equipment or bed rails). *Category II*
4. Gowns
  - a. Wear a gown whenever anticipating that clothing will have direct contact with the patient or potentially contaminated environmental surfaces or items in the patient's room. Remove the gown and observe hand hygiene before leaving the patient's environment (18, 335-338);[www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars). *Category IB*
  - b. After gown removal, ensure that clothing and skin do not contact potentially contaminated environmental surfaces to avoid transfer of microorganisms to other patients or environmental surfaces. *Category II*
5. Patient transport
  - a. Limit transport and movement of patients outside of the room to medically necessary purposes. When transport is required, ensure that infected or colonized areas of the patient are contained and covered. *Category II*
  - b. Remove contaminated PPE and perform hand hygiene prior to transporting patient on Contact Precautions. *Category II*
  - d. Don clean PPE to handle the patient when the transport destination has been reached. *Category II*
6. Patient care equipment
  - a. Manage patient care equipment according to Standard Precautions (7, 313). *Category IB/IC*
  - b. Use disposable patient care items (e.g. blood pressure cuffs) wherever possible or implement patient-dedicated use of noncritical equipment to avoid

sharing between patients. If use of common equipment or items is unavoidable, clean and disinfect them before use on another patient (18, 163, 335, 338, 357, 488). *Category IB*

In *home care settings*,

- a) Limit the amount of patient-care equipment brought into the home of patients on Contact Precautions. When possible, leave patient-care equipment in the home until discharge from home care services.
- b) If noncritical patient care equipment (e.g. stethoscopes) cannot remain in the home, clean and disinfect items before taking them from the home, using a low- to intermediate- level disinfectant, or place reusable items in a plastic bag for transport and subsequent cleaning and disinfection.

*Category II*

#### 7. Environmental measures

Ensure that rooms of patients on Contact Precautions are given cleaning priority with a focus on frequent (e.g., at least daily) cleaning and disinfection of high touch surfaces (e.g., bed rails, bedside commodes, faucet handles, doorknobs, carts, charts) and equipment in the immediate vicinity of the patient (4, 18, 163, 337, 338, 357, 371). *Category IB*

8. Discontinue Contact Precautions after signs and symptoms have resolved or according to pathogen-specific recommendations in Appendix A. *Category IB.*

### **C. Droplet precautions**

1. Use Droplet Precautions as recommended in Appendix A for patients known or suspected to be infected with microorganisms transmitted by respiratory droplets (large-particle droplets [ $>5\ \mu\text{m}$  in size] that can be generated by the patient during coughing, sneezing, talking, or the performance of cough-inducing procedures) (8, 27-29, 32, 33, 35, 39, 363, 489). *Category IB*

#### 2. Patient placement

- a. In *acute care settings*, place patients who require Droplet Precautions in a single patient room (8, 28, 29, 32, 490) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category IB*

Apply the following hierarchy of alternatives when single patient rooms are in short supply (*Category II*):

- i. Prioritize patients with conditions that may facilitate transmission (e.g., uncontained drainage, stool incontinence) for single patient room placement.
  - ii. Place together (cohort) in the same room patients who are infected or colonized with the same organism and are suitable roommates (e.g., low risk for acquiring an infection or at low risk for an adverse outcome should transmission occur).
    - a) Ensure that patients are physically separated (i.e., >3 feet) from each other. Draw the privacy curtain between beds to minimize opportunity for transmission or sharing of items.
    - b) Change PPE and perform hand hygiene between patients.
  - iii. Avoid placing patients on Droplet Precautions in the same room with patients who are at increased risk for infection (e.g., immunocompromised or have an anticipated prolonged length of stay).
- b. In *residential care settings*, make decisions regarding patient placement on a case-by-case basis, balancing infection risks to other patients in the room (490) and the potential adverse psychosocial impact on the infected or colonized patient (436, 437). *Category II*
  - c. In *ambulatory settings*, place patients who may require Droplet Precautions in an examination room or cubicle as soon as possible. Instruct patients and accompanying individuals to follow recommendations for Respiratory Hygiene/Cough Etiquette (184, 185) ([www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm](http://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm)). *Category II*
3. Mask and eye protection for healthcare personnel
- a. Wear a surgical mask for close patient contact (e.g., within 3 feet) (8, 27, 29, 30, 32, 33, 40, 363). *Category IB*
  - b. No recommendation for wearing eye protection in addition to a surgical mask for close contact with patients who require droplet precautions for conditions

other than SARS or avian influenza and as recommended for Standard Precautions. *Unresolved issue.*

- c. For patients with suspected SARS (36) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)) (*Category IB*) or Avian influenza ([www.cdc.gov/flu/han020302.htm](http://www.cdc.gov/flu/han020302.htm)) (*Category II*), wear both eye protection (e.g., goggles or face shield) and respiratory protection (e.g., NIOSH-approved N95 or higher).

#### 4. Patient transport

- a. Limit movement and transport of the patient outside of the room to medically necessary purposes. *Category II*
  - b. Instruct patient to wear a surgical mask and follow Respiratory Hygiene/Cough Etiquette during transport (11, 343, 344). *Category II*
  - c. No mask is required for person handling transport. *Category II*
5. Discontinue Droplet Precautions after signs and symptoms have resolved or according to pathogen-specific recommendations in Appendix A. *Category IB*

### **D. Airborne Infection Isolation (All) Precautions**

1. Use All as recommended in Appendix A for patients known or suspected to be infected with infectious agents transmitted person-to-person by the airborne route e.g., tuberculosis (11), measles (43, 187, 492), chickenpox (42), smallpox (45), viral hemorrhagic fevers (47), and SARS (111, 493) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category IA/IC*
2. Patient placement
  - a. In *acute care hospitals or residential settings*, place the patient in an All that should be a single patient room equipped with the following (4, 5, 11) (*Category IA/IC*):
    - i. Continuous, monitored negative air pressure (2.5 Pa [0.01 inch water gauge]) in relation to the air pressure in the corridor. Monitor air pressure daily with visual indicators (e.g., smoke tubes, flutter strips) placed in the room with the door closed (494).
    - ii. At least six (existing facility) or 12 (new construction) air changes per hour.
    - iii. Direct exhaust of air to the outside. If it is not possible to exhaust the air from an All room directly to the outside, the air may be returned through

HEPA filters to the air-handling system serving exclusively the isolation room.

- iv. Keep the room door closed when not required for entry and exit.
- v. When a private room is not available or in the event of an outbreak or exposure where large numbers of patients require All precautions , consult infection control professionals before patient placement to determine the safety of alternative rooms that do not meet engineering requirements for All and/or cohorting patients together based on clinical diagnosis in areas with the lowest risk of airborne transmission.

b. In *ambulatory settings*:

- i. Develop systems (e.g., triage, signs) to identify and segregate patients with known or suspected infections that require All precautions as soon as possible after entry into a healthcare setting, including emergency departments (11, 44, 116, 187) ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category IA/IC*
- ii. Place a surgical mask on the patient immediately and maintain until the patient has been placed in an All room (11, 343-345). *Category IB/IC*
- iii. Place patients in appropriately ventilated All rooms when available. If such rooms are not available, place these patients in an examination room at the farthest distance from other patient rooms, preferably one that is at the end of the ventilation circuit and place a portable HEPA filter in the room. Once the patient leaves, the room should remain vacant for the appropriate time according to the number of air changes per hour, usually one hour, to allow for a full exchange of air (4, 11, 43). *Category IB/IC*
- iv. When hospital admission is indicated, place patients with confirmed or suspected airborne-transmitted infections in All rooms. If All rooms are not available, transfer to another facility that has All rooms (11, 44, 185, 187). *Category IB/IC*

3. Use of personal protective equipment

- a. Restrict susceptible health-care personnel from entering the rooms of patients known or suspected to have measles (rubeola), varicella (chickenpox), or

smallpox if other immune health-care personnel are available (9, 100, 187, 415). *Category IB*

- b. Wear fit tested NIOSH-approved respiratory protection (N95 respirator or higher) when entering the room or home of a patient when the following diseases are suspected or confirmed:
  - i. Infectious pulmonary or laryngeal tuberculosis or draining tuberculous skin lesions (11, 495, 496). *Category IB/IC*
  - ii. Smallpox (vaccinated and unvaccinated) (45), viral hemorrhagic fevers (47), SARS ([www.cdc.gov/ncidod/sars](http://www.cdc.gov/ncidod/sars)). *Category II*
    - a) Respiratory protection is recommended even for all health-care personnel, even with a documented “take” after smallpox vaccination due to the risk of a genetically engineered virus against which the vaccine may not provide protection, or of exposure to a very large viral load (e.g., from high-risk aerosol-generating procedures, immunocompromised patients, hemorrhagic or flat smallpox) (31).  
*Category II*
- c. Wear nose/mouth protection upon entering the room or home of a patient known or suspected of having measles (rubeola), varicella, or disseminated zoster (immune and susceptible) for consistency and because of the difficulties in establishing definite immunity in all health-care personnel.  
*Category II*
  - i. No recommendation for the type of protection to use (e.g., N95 respirator or surgical mask) for exposure to measles and varicella viruses.  
*Unresolved Issue*
- d. Immunize susceptible persons as soon as possible following contact with a patient with smallpox, measles, or varicella as follows: *Category IA*
  - i. Administer smallpox vaccine to exposed susceptible persons within 4 days after exposure (31, 100, 497).
  - ii. Administer measles vaccine to exposed susceptible persons within 72 hours or administer immunoglobulin within 6 days after exposure (9, 412).

- iii. Administer varicella vaccine to exposed susceptible persons within 120 hours after exposure or administer varicella immune globulin (VZIG) within 96 hours for high risk persons in whom vaccine is contraindicated (e.g., immunocompromised patients, pregnant women, newborns whose mother's varicella onset was <5 days before delivery or within 48 h after delivery). (370, 423).
4. Patient transport
    - a. Limit the movement and transport of patients who require All precautions to medically necessary purposes. *Category II*
    - b. If transport or movement outside an All room is necessary, place a surgical mask on the patient. For patients with skin lesions associated with varicella or smallpox or draining skin lesions caused by *M. tuberculosis*, cover the patient to prevent aerosolization or contact with the infectious agent present in skin lesions. *Category II*
    - c. Wear respiratory protection when transporting patients who require All precautions.
  5. Discontinue All precautions after signs and symptoms have resolved or according to pathogen-specific recommendations in Appendix A. *Category IB*
  6. For additional precautions for preventing transmission of tuberculosis in health-care settings, consult CDC's "Guidelines for Preventing the Transmission of Tuberculosis in Health-Care Facilities" (11) and the most recent update (in preparation), and the "Guideline for Environmental Infection Control in Health-Care Facilities" (4).

#### **E. Protective Environment (PE) (Table 5)**

1. Place allogeneic hematopoietic stem cell transplant (HSCT) patients in a PE as defined in the "Guideline to Prevent Opportunistic Infections in HSCT Patients"(13), the "Guideline for Environmental Infection Control in Health-Care Facilities"(4), and the "Guidelines for Preventing Health-Care-Associated Pneumonia, 2003" (8) to reduce exposure to environmental fungi, (e.g. *Aspergillus* sp) (203, 498). *Category IB*
2. No recommendation for placing other patients identified in a facility as being

- at increased risk for environmental fungal infections, (e.g., aspergillosis) in a PE (4, 221). *Unresolved issue*
3. For patients who require a PE, implement the following components (Table 5): (4, 8, 13)
    - a. Filtered incoming air using central or point-of-use high efficiency particulate air (HEPA) filters capable of removing 99.7% of particles 0.3  $\mu\text{m}$  in diameter (the most penetrating particle size) (5). *Category IB/IC*
    - b. Directed room airflow with supply on one side of the room across the patient and out through exhaust on the other side of the room (5). *Category IB/IC*
    - c. Positive air pressure in room relative to the corridor (pressure differential of  $\geq 2.5$  Pa [0.01-inch water gauge]) (5). *Category IB/IC*
    - d. Well-sealed rooms to prevent infiltration of air from the outside (5). *Category IB/IC*
    - e. At least 12 air changes per hour (5). *Category IC*
    - f. Lowered dust levels by using smooth surfaces and finishes that can be scrubbed rather than textured materials, (i.e. carpet (499) [*Category IB*], upholstery, cloth), wet dusting of horizontal surfaces, and routinely cleaning crevices and sprinkler heads (500). *Category II*
    - g. Avoidance of carpeting in hallways and patient rooms in areas housing immunocompromised patients (499). *Category IB*
    - h. Use of vacuum cleaner equipped with HEPA filters (501, 502). *Category IB*
    - i. Prohibition of dried and fresh flowers and potted plants (503-505). *Category II*
  4. Minimize the length of time that patients who require a PE are outside their rooms for diagnostic procedures and other activities (4, 438, 498). *Category IB*
    - a. During periods of construction, to prevent inhalation of respirable particles that could contain infectious spores, provide respiratory protection (e.g., N95 respirator) to patients who are medically fit to tolerate a respirator when they are required to leave the PE (438). Ensure that patients are instructed on respirator use. *Category II*
    - b. No recommendation on fit testing of patients who are using respirators. *Unresolved issue*

- c. In the absence of construction, no recommendation for use of particulate respirators when leaving the PE. *Unresolved issue*
- 4. Take measures to protect patients who require a PE room and who also have an airborne infectious disease (e.g. tuberculosis, acute varicella-zoster).
  - a. Ensure that the patient's room is designed to maintain positive pressure (5). *Category IC*
  - b. Use an anteroom to ensure appropriate air-balance relationships and provide independent exhaust of contaminated air to the outside or place a HEPA filter in the exhaust duct if the return air must be recirculated (5, 506). *Category IC*
  - c. If an anteroom is not available, place the patient in an All room and use portable, industrial-grade HEPA filters to enhance filtration of spores in the room (507). *Category II*
- 5. Use PPE (e.g., gloves, gown, and mask) according to Standard Precautions. Use Expanded Precautions only if the patient has a suspected or proven infection for which Expanded Precautions is indicated. *Category II*

## **V. Prevention of transmission of MDROs (Tables B.3-6, Appendix B)**

### **A. General recommendations for all healthcare settings independent of the frequency of MDRO transmission or the population served.**

#### **1. Administrative measures**

- a. Designate MDRO prevention and control an organizational patient safety priority (53, 196, 240, 296-301). *Category IB*
- b. Provide administrative support and fiscal and human resources for MDRO prevention activities (53, 162, 240, 296-301). *Category IB*
- c. Implement systems to communicate information about reportable MDROs (e.g., VRSA) to administrative personnel and state and/or local health authorities according to individual state regulations (64). *Category II/IC*
- d. Implement a multidisciplinary program designed to monitor and improve as necessary adherence of healthcare personnel to recommended practices for Standard and Expanded Precautions (6, 240, 299, 301). *Category IB*

- e. Implement communication systems that will ensure that receiving HCWs are notified prior to inter- and intra-facility transfer of patients who have been identified recently or previously known to be colonized or infected with MDROs so that recommended infection control precautions may be initiated promptly (300, 358, 398, 401, 508-513). *Category IB*

## **2. Education and training of healthcare personnel**

- a. Include MDRO education (e.g., clinical impact, epidemiology, and prevention strategies) in the required curriculum of all healthcare professional training programs (e.g., medical and nursing schools) (78, 382, 512, 514-521).  
*Category II*
- b. Provide education and training on risks and prevention of MDRO transmission during orientation and periodic educational updates for healthcare personnel who have patient care responsibilities and who are responsible for care of equipment and supplies. Include information on organizational experience, priorities, and goals (248, 312, 392, 508, 521-524). *Category IB*

## **3. Judicious use of antimicrobial agents**

- a. In all healthcare organizations, implement a system to prompt prescribers to verify that antimicrobial agents used for treatment of infection are active against the patient's clinical isolate(s) (53, 160, 283, 380-387, 389-394, 397, 398, 400, 404, 525, 526). *Category IB*
- b. Avoid use of antimicrobials to treat colonization (e.g., for isolates from tracheal aspirates without evidence of clinical disease) (527-530)  
([www.cdc.gov/drugresistance/healthcare/default.htm](http://www.cdc.gov/drugresistance/healthcare/default.htm)). *Category II*
- c. In all healthcare organizations, ensure that a multidisciplinary process is in place to review antimicrobial utilization, local susceptibility patterns, and antimicrobial agents included in the formulary to foster appropriate antimicrobial use (53, 151, 300, 358, 380-387, 390, 392, 395, 401-403, 531-533). *Category IB/IC*

## **4. Surveillance**

- a. Establish systems between the healthcare organization and its laboratories (on-site or commercial laboratories that receive outsourced work) for detecting

and communicating to designated personnel (e.g., infection control) evidence of MDRO emergence in clinical isolates (284, 317, 371, 394, 395, 400, 512, 518, 521, 531, 534-540). *Category IB*

- b. In all healthcare organizations, promptly notify infection control staff or a medical director designee when a novel resistance pattern for that facility (e.g., VISA, VRSA, ESBL-producing GNB) is detected. Notify health departments according to state and local regulations (11, 64). *Category IB/IC*
- c. Prepare facility-specific summary antimicrobial susceptibility reports as recommended by the National Committee on Clinical Laboratory Standards (NCCLS). Monitor for evidence of changing resistance patterns (160, 161, 285, 358, 382, 384, 385, 390, 531, 535, 536, 541-548). *Category IA*
  - i. In hospitals and LTCFs with specialized units to for the care of high-risk patients (e.g., ventilator-dependent, ICU, oncology patients), develop unit-specific antimicrobial susceptibility reports and monitor for changes in susceptibility that may predict emergence and transmission of an MDRO (53, 454, 455, 549). *Category IB*
  - ii. Determine frequency (e.g., quarterly, semi-annually, annually) of summary reports based on volume of clinical isolates. *Category II*
  - iii. Consult with hospital and/or commercial laboratories on methods for developing and interpreting aggregate susceptibility data (283, 284, 550). *Category IB*
  - iv. Provide clinicians responsible for care of affected patient populations with summary susceptibility reports and analysis of trends to guide antimicrobial prescribing practices (52, 53) ([www.cdc.gov/drugresistance/healthcare/default.htm](http://www.cdc.gov/drugresistance/healthcare/default.htm)). *Category IB*
- d. In healthcare organizations that outsource microbiology laboratory services (e.g., ambulatory care, home care, LTCFs, smaller acute care hospitals), specify by contract that the laboratory provide either facility-specific susceptibility data or local or regional aggregate susceptibility data in order to identify prevalent MDROs and trends in the geographic area served (550). *Category II*

- e. Develop local or regional coalitions to share information on changing patterns of resistance; collaborate with local and state health departments and area health facilities (459, 486, 551-554). *Category II*
- f. Identify specific MDROs (e.g., MRSA, VISA, VRSA, VRE, MDR-GNB, ESBLs, nonsusceptible *S. pneumoniae*) for ongoing systematic monitoring of susceptibility trends to detect changes in susceptibility due to antibiotic pressure, emergence of an environmentally significant organism, and/or transmission within the healthcare setting (23, 56, 61, 63, 64, 75, 76, 78, 129, 155, 166, 168, 169, 173, 317, 358, 380-382, 385, 394, 395, 404, 450, 486, 510, 518, 522, 537, 538, 541, 543, 545, 555-569). *Category IB*
  - i. Specify location and clinical service in MDRO monitoring protocols in hospitals and other large multi-unit facilities with high-risk patients (53, 75, 78, 248, 300, 395, 454, 455, 518, 539). *Category IB*
- g. Determine the baseline prevalence of targeted MDRO infection/colonization by reviewing results of clinical cultures and performing baseline point prevalence studies of colonization in high risk units; when possible, distinguish colonization from infection (248, 358, 384, 387, 454, 510, 520, 537, 539, 548, 570-574). *Category IB*
- h. Define an incidence or frequency of targeted MDROs that would trigger implementation of additional control interventions. Base decisions on frequency of isolation of targeted MDROs, institutional priorities, whether the patient population has conditions that would facilitate transmission or is at increased risk of adverse outcomes following acquisition of infection, and whether there is suspected or proven transmission within the facility, as described under **V.B.** (160, 335, 387, 440, 521, 546, 547, 562, 574-577). *Category IB*

## **5. Infection control precautions to prevent transmission of MDROs**

- a. Observe Standard Precautions during all patient encounters in all settings where healthcare is delivered under the assumption that any patient could be colonized or infected with an MDRO (169, 315, 382, 385, 441, 548, 578, 579). *Category IB*

- b. Patient placement in hospitals and LTCFs
  - i. When single-patient rooms are available, prioritize patients with known or suspected MDROs for single-patient room placement. Give additional priority to those patients who have conditions that may facilitate transmission (e.g., uncontained drainage, stool incontinence, infants/toddlers) or those who are at increased risk of adverse outcomes following acquisition of infection (e.g., severely immunocompromised) (75, 78, 335, 459, 486, 487). *Category IB*
  - ii. When single-patient rooms are not available, cohort patients with the same MDRO in the same room, bay, or patient care unit (75, 78, 248, 335, 459, 486, 487). *Category IB*
  - iii. When cohorting patients with the same MDRO is not possible, place MDRO patients in rooms with patients who are at low risk for acquisition of MDROs and associated adverse outcomes and are likely to have short lengths of stay. *Category II*
  - iv. In the absence of draining wounds or diarrhea, determine degree of permitted ambulation, socialization, and use of common areas for patients with known or suspected MDROs based on the risk to other patients and on the ability of the MDRO-infected patient to observe proper hand hygiene and other recommended precautions to contain secretions (221, 459, 555, 580). *Category II*
- c. Contact Precautions
  - i. In *acute care settings*, implement Contact Precautions for all patients known to be infected or colonized with target MDROs (75, 78, 79, 335, 387, 395, 459, 486, 487, 510, 518, 520, 546). *Category IB*
  - ii. In LTCFs, implement on a case-by-case basis Contact Precautions for patients known to be infected or colonized with target MDROs when the nature of the HCW-patient interaction and/or the risk to other patients within the facility indicates a need to intensify use of barriers to prevent transmission (e.g., MDRO patient has uncontrolled secretions, draining

- wounds, stool incontinence, ostomy tubes/bags, total dependence on HCWs for all activities of daily living) (160, 555, 559, 560). *Category IB*
- iii. In *ambulatory settings*, implement on a case-by-case basis Contact Precautions for patients known to be infected or colonized with target MDROs when the nature of the HCW-patient interaction or the risk of acquisition and associated adverse outcomes to other patients in the area indicates a need to intensify use of barriers to prevent transmission (e.g., MDRO patient has uncontrolled secretions, stool incontinence, ostomy tubes/bags) or immunocompromised patients are in the same clinic area. *Category II*
- iv. In *home care settings*,
- a) Implement Contact Precautions on a case-by-case basis for patients known to be infected or colonized with target MDROs when the nature of the patient HCW-interaction or the risk of transmission to others indicates a need to intensify use of barriers to prevent transmission (e.g., MDRO patients has uncontrolled secretions, stool incontinence, ostomy tubes/bags) (196). *Category II*
- b) Limit the amount of patient care equipment brought into the home of patients infected or colonized with MDROs. When possible, leave patient care equipment in the home until discharge from home care services (196). *Category II*
- c) If noncritical patient care equipment (e.g., stethoscopes) cannot remain in the home, clean and disinfect items before removing them from the home, using a low to intermediate level disinfectant, or place reusable items in a plastic bag for transport and subsequent cleaning and disinfection (7, 196). *Category II*
- v. No recommendation for routine use of gloves and/or gowns to prevent MDRO transmission in ambulatory or home care settings. *Unresolved issue*

- vi. In *hemodialysis units*, follow the “Recommendations to Prevent Transmission of Infections in Chronic Hemodialysis Patients” (10).

*Category IA*

d. Discontinuation of Contact Precautions.

- i. In acute care settings, no recommendation for criteria to discontinue Contact Precautions for patients who are no longer infected but may remain colonized with an MDRO in acute care settings due to the intermittent and prolonged duration of colonization (442, 445, 511, 581, 582). *Unresolved issue*
- ii. Outside of acute care settings, discontinuation of Contact Precautions for a patient colonized or infected with MDROs may be considered on a case-by-case basis if the following criteria are met:
  - a) Surveillance cultures for the target MDRO are repeatedly negative in a patient who has not received antimicrobial therapy for several weeks.
  - b) Absence of an active infection or draining wound.
  - c) No evidence that the patient has been implicated in patient-to-patient transmission of the target MDRO within the facility.
  - d) Patient remains colonized but risk factors for transmission are no longer present. *Category II*

**6. Environmental measures**

Follow recommended routine cleaning, sterilization and disinfection procedures for maintaining patient care areas and critical and noncritical devices and equipment (4, 7). *Category IB*

**B. Intensified interventions to prevent MDRO transmission**

The interventions presented below have been evaluated as part of many multicomponent quasi-experimental design studies reported in the literature. Therefore, the effectiveness of a single or specific combination of interventions in preventing transmission cannot be assessed (722, 723). However, combinations of interventions have successfully controlled outbreaks of MDROs in healthcare facilities.

## 1. Indications for intensified MDRO prevention and control strategies:

- a. Evidence of continued transmission despite implementation of routine control measures (248, 335, 358, 520, 573, 574).
- b. The incidence and prevalence of the target MDRO have increased beyond the accepted institutional level despite implementation of routine infection control measures (134, 387, 539, 583).
- c. When the *first* case of an epidemiologically important MDRO (e.g., VRE, VISA, VRSA) is identified within a healthcare facility (63, 64, 66, 160, 300, 387, 440, 521, 546, 547, 562, 574-577). *Category IB*

## 2. Administrative measures

- a. Obtain expert consultation. Identify persons with experience in infection control and the epidemiology of MDROs either in-house or through outside consultation for assessment of the local MDRO problem and for the design, implementation, and evaluation of appropriate control measures (162, 163, 240, 248, 297, 300, 358, 371, 387, 446, 459, 518, 537, 539, 546, 573, 574). *Category IB*
- b. Evaluate the following healthcare system factors for their role in creating or perpetuating an environment conducive to transmission of MDROs: staffing levels, education and training, availability of consumable and durable resources, communication processes, policies and procedures, barriers to adherence to recommended infection control measures (e.g., hand hygiene and Standard or Contact Precautions). Develop, implement, and monitor action plans to correct system failures (6, 75, 78, 230, 236, 237, 239, 240, 246, 248, 249, 252-255, 257, 394, 395, 486, 518, 519, 577, 584-588). *Category IB*
- c. Provide feedback to health-care providers and administrators on facility and patient-care unit trends in MDRO infections. Include information on changes in prevalence and rates of infection and colonization, results of assessments for system failures, and action plans to improve adherence to recommended infection control practices to prevent MDRO transmission (53, 248, 300, 387, 455, 508, 512, 518, 540, 548, 574, 589). *Category IB*

### **3. Educational interventions**

Implement MDRO educational programs for healthcare personnel who have patient care responsibilities facility-wide and/or in high-risk units targeted for intensified interventions. Include relevant information on clinical risks for acquisition and transmission, MDRO trends, results of adherence monitoring observations, identified system failures (e.g., inadequate staffing, communication, adherence to recommended practices, availability of PPE), and action plans for reducing transmission of a targeted MDRO. Provide individual or unit-specific feedback when available (78, 240, 248, 299, 312, 358, 382, 384, 393, 508, 510-512, 518, 520, 521, 537, 548, 562, 589). *Category IB*

### **4. Judicious use of antimicrobial agents**

Review antimicrobial use and impose limitations on the use of antimicrobial agents associated with increased prevalence of target MDROs e.g., vancomycin, third-generation cephalosporins, and anti-anaerobic agents for VRE (128, 388, 395, 396, 399); third generation cephalosporins for ESBLs (380, 384, 385); and quinolones and carbapenems (381-383, 386, 387, 389-394, 397, 398, 400-404).

- a. Utilize strategies of proven effectiveness in influencing patterns of antimicrobial use (e.g., formulary restriction, drug approval programs, computer assisted management programs) (403, 590-594). *Category IB*
- b. No recommendation for the use of antimicrobial cycling (595). *Unresolved issue*

### **5. Surveillance**

- a. Calculate and analyze prevalence and incidence rates of targeted MDRO infection/colonization in at-risk populations; when possible, distinguish colonization from infection (248, 358, 384, 387, 454, 510, 520, 537, 539, 548, 570-574). *Category IB*
  - i. Use single isolates from each patient (542). *Category IB*
  - ii. Increase frequency of compiling and monitoring antimicrobial susceptibility summary reports, as indicated by rate of increase in incidence of target MDROs. *Category II*
- b. Implement laboratory protocols for storing isolates of selected MDROs for molecular typing when there is a need to confirm transmission or a desire to

monitor for epidemiologic purposes in a healthcare setting (75, 78, 287, 336, 395, 518, 537, 539, 547, 588, 596, 597). *Category IB*

- c. Develop and implement protocols to obtain surveillance cultures for target MDROs from patients in at-risk populations (e.g., patients in intensive care, burn, HSCT and oncology units; transfers from LTCFs and hemodialysis centers), as defined within the local institution (75, 78, 248, 336, 358, 371, 387, 395, 459, 486, 510, 518, 520, 537, 539, 546, 560, 568, 574, 598-601).  
*Category IB*
  - i. Obtain surveillance cultures from areas of skin breakdown and draining wounds. In addition, include the following sites according to target MDROs.  
*Category IB:*
    - a) For MRSA: anterior nares; throat and perirectal or perineal may be added to increase the yield (172, 600, 602-604).
    - b) For VRE, MDR-GNB: stool, rectal, or perirectal (441, 599, 605, 606).
  - ii. Obtain surveillance cultures at the time of admission to a high-risk area (e.g., ICU); especially culture patients previously known to be infected or colonized with the target MDRO or patients arriving from units or facilities with high endemic rates of the target MDRO (75, 384, 387, 459, 508, 511, 518, 574, 588, 589, 607). *Category IB*
- d. Conduct culture surveys to assess the efficacy of the enhanced MDRO control interventions.
  - i. Conduct unit-specific point prevalence culture surveys of the target MDRO to determine if transmission has decreased or ceased (87, 371, 393, 394, 401, 486, 560, 574). *Category IB*
  - ii. Repeat point-prevalence culture surveys at routine intervals (e.g., weekly, biweekly, or monthly) and at time of patient discharge or transfer until transmission has ceased (75, 87, 248, 384, 387, 393, 518, 537, 539, 543, 598, 608). *Category IB*
  - iii. Ensure that culture data provide colonization status of roommates and other patients with substantial exposure to patients with known MDRO infection/colonization (358, 388, 395, 546, 560, 609). *Category IB*

- e. Obtain cultures of healthcare personnel for target MDROs only when there is epidemiologic evidence implicating the healthcare staff member as a source of ongoing transmission(78, 248, 371, 390, 518, 539, 573, 575).

*Category IB*

- f. Implement systems to monitor changes in MDRO incidence and prevalence after reducing the intensity of MDRO control efforts.

*Category II*

## **6. Enhanced infection control precautions**

- a. Patient placement: Implement interim policies for patient admissions, placement and staffing as needed to prevent transmission of a problem MDRO (358, 371, 387, 401, 510, 520, 574, 610). *Category IB*
  - i. Place MDRO patients in single-patient rooms when available (336, 371, 397, 459, 513, 522, 533, 544, 547, 562, 588, 611-614).
  - ii. Cohort patients with the same MDRO in segregated areas (e.g., rooms, bays, patient care areas (75, 248, 385, 387, 395, 400, 401, 486, 513, 520, 524, 525, 561, 574, 587-589).
  - iii. When transmission continues despite cohorting patients, assign dedicated nursing staff (and other staff where possible) to the care of MDRO patients only (361,387,395,574).
  - iv. Close unit or facility to new admissions if transmission continues despite the implementation of the intensified infection control measures described above (76, 78, 394, 401, 525, 540, 548, 587, 589, 598, 615-617).
- b. Implement Contact Precautions routinely for all patients colonized or infected with target MDROs. Don gowns and gloves *before or upon entry* to the patient's room or cubicle due to possible contamination of environmental surfaces and medical equipment, especially those in close proximity to the patient (78, 248, 336, 338, 358, 371, 387, 395, 401, 459, 510, 518, 520, 539, 540, 546, 574, 589, 618). *Category IA*
- c. When active surveillance cultures are obtained as part of an MDRO control program, implement Contact Precautions until the surveillance culture

obtained on admission is reported negative for the target MDRO (87, 341, 486, 511, 512, 539, 546, 619, 620). *Category IB*

- d. No recommendation for universal glove and/or gown use in high-risk units in acute care hospitals(341, 512, 539, 619, 620, 621). *Unresolved issue*
- e. Masks are not recommended for routine use upon room entry by HCWs to prevent transmission of MDROs from patient to healthcare worker and resulting nasal colonization. Use masks to prevent transmission of MRSA, VISA, and VRSA when aerosol-generating procedures (e.g., wound irrigation, oral suctioning, intubation, nebulizer respiratory therapy treatments, bronchoscopy) are performed and in circumstances where there is evidence of transmission from aerosolization from heavily colonized sources (e.g., burn wounds) (1,10, 64, 522, 539, 546, 622, 623). *Category IB*
- f. Discontinuation of Contact Precautions
  - i. No recommendation for criteria to discontinue Contact Precautions for a patient who is no longer infected but may remain colonized with an MDRO and is part of a unit-specific or facility-wide application of Contact Precautions due to the intermittent and prolonged duration of colonization (442, 445, 581, 582, 624). *Unresolved issue.*
  - ii. Consult experts in infection control and healthcare epidemiology to determine whether an intensified MDRO control program has been successful in decreasing transmission of MDROs, for criteria for discontinuing Contact Precautions for patients previously identified as colonized or infected with the target MDRO, and for criteria to discontinue active surveillance cultures (446). *Category II*

## **7. Enhanced environmental measures**

- a. Implement patient-dedicated use of noncritical equipment (e.g., blood pressure cuff, stethoscope) (15, 78, 317, 383, 391, 395, 459, 523, 544, 545, 555, 559, 561, 589). *Category IB*
- b. Assign dedicated staff who have been trained in the role of the environment in transmission of MDROs to targeted patient care areas to enhance consistency of proper environmental cleaning and disinfection services (78, 358, 394, 395,

401, 518, 543, 548, 561, 564, 577, 586, 588, 589, 609, 615, 625-627).

*Category II*

- c. Implement procedures that ensure consistent cleaning and disinfection of surfaces in close proximity to the patient and likely to be touched by the patient and HCWs (e.g., bedrails, carts, bedside commodes, doorknobs, faucet handles) (2, 4, 7, 479, 480, 628). *Category IB*
- d. Obtain cultures from environmental sources (e.g., surfaces, shared medical equipment) only when there is epidemiologic evidence suggesting an environmental source associated with ongoing transmission of the targeted MDRO (4, 15, 23, 25, 26, 78, 222, 401, 518, 588, 629). *Category IB*
- e. Vacate units for environmental assessment and intensive cleaning when previous efforts to eliminate environmental reservoirs have failed (394, 401, 540, 548, 615). *Category II*

## **8. Decolonization**

- a. Consult with physicians with expertise in infectious diseases/healthcare epidemiology on a case-by-case basis regarding the appropriate use of decolonization therapy for a limited period of time as a component of an MRSA control program (487, 630-632). *Category II*
- b. When decolonization is used, perform susceptibility testing of the decolonizing agent against the target organism in the individual being treated and/or the MDRO strain epidemiologically implicated in transmission. Monitor susceptibility to detect emergence of resistance to the decolonizing agent (87, 630, 633, 637). *Category IB*
- c. Do not use topical mupirocin *routinely* for MRSA decolonization of patients as a component of MRSA control programs in any healthcare setting due to risk of emergence of mupirocin-resistant strains and difficulty in eradicating MRSA when multiple body sites are colonized (444, 630, 631, 633-637). *Category IB*
- d. No recommendation for decolonizing patients with VRE or MDR-GNB. Regimens and efficacy of decolonization protocols for VRE and MDR-GNB have not been established (442, 445, 581, 582, 624). *Unresolved issue*

- e. Decolonize HCWs found to be colonized with MRSA only when implicated epidemiologically in transmission to patients (486, 520, 539, 598, 630).

*Category IA*

## **Part IV. Performance indicators**

### **A. General**

1. Monitor appropriateness of Expanded Precautions initiated at the time of admission based on clinical diagnosis (e.g., bronchiolitis, pertussis, influenza) and appropriateness of time of discontinuation.
2. Periodically audit the use of PPE by HCWs when caring for patients on Expanded Precautions.
3. Periodically assess the appropriate use of single-patient rooms to meet infection control needs. Use this information for future facility planning.
4. Include assessment of staffing levels when ongoing transmission of epidemiologically important pathogens is evaluated.
5. Assess adequacy of supplies of PPE for adherence to recommended Standard and Expanded Precautions.

### **B. Prevention of MDRO transmission**

1. Develop and implement a plan for periodically monitoring adherence to selected performance indicators (e.g., hand hygiene, proper use of barrier precautions) for MDRO prevention. Provide feedback to personnel regarding their performance (387, 540, 574, 638).
2. When increased incidence of a target MDRO is observed, monitor selected indicators to identify contributing factors. Implement corrective actions based on findings and monitor results (387, 540, 574, 638).

**TABLE 1. HISTORY OF GUIDELINES FOR ISOLATION PRECAUTIONS IN HOSPITALS\***

<b>YEAR (Ref)</b>	<b>DOCUMENT ISSUED</b>	<b>COMMENT</b>
1970 (639)	Isolation Techniques for Use in Hospitals, 1 <sup>st</sup> ed.	<ul style="list-style-type: none"> <li>- Introduced seven isolation precaution categories with color-coded cards: Strict, Respiratory, Protective, Enteric, Wound and Skin, Discharge, and Blood</li> <li>- No user decision-making required</li> <li>- Simplicity a strength; overisolation prescribed for some infections</li> </ul>
1975 (640)	Isolation Techniques for Use in Hospitals, 2 <sup>nd</sup> ed.	<ul style="list-style-type: none"> <li>- Same conceptual framework as 1<sup>st</sup> edition</li> </ul>
1983 (641)	CDC Guideline for Isolation Precautions in Hospitals	<ul style="list-style-type: none"> <li>- Provided two systems for isolation: category-specific and disease-specific</li> <li>- Protective Isolation eliminated; Blood Precautions expanded to include Body Fluids</li> <li>- Categories included Strict, Contact, Respiratory, AFB, Enteric, Drainage/Secretion, Blood and Body Fluids</li> <li>- Emphasized decision-making by users</li> </ul>
1985-88 (427, 428)	Universal Precautions	<ul style="list-style-type: none"> <li>- Developed in response to HIV/AIDS epidemic</li> <li>- Dictated application of Blood and Body Fluid precautions to all patients, regardless of infection status</li> <li>- Did not apply to feces, nasal secretions, sputum, sweat, tears, urine, or vomitus unless contaminated by visible blood</li> <li>- Added personal protective equipment to protect HCWs from mucous membrane exposures</li> <li>- Handwashing recommended immediately after glove removal</li> <li>- Added specific recommendations for handling needles and other sharp devices; concept became integral to OSHA's 1991 rule on occupational exposure to blood-borne pathogens in healthcare settings</li> </ul>

1987 (642)	Body Substance Isolation	<ul style="list-style-type: none"> <li>- Emphasized avoiding contact with all moist and potentially infectious body substances except sweat even if blood not present</li> <li>- Shared some features with Universal Precautions</li> <li>- Weak on infections transmitted by large droplets or by contact with dry surfaces</li> <li>- Did not emphasize need for special ventilation to contain airborne infections</li> <li>- Handwashing after glove removal not specified in the absence of visible soiling</li> </ul>
1996 (1)	Guideline for Isolation Precautions in Hospitals	<ul style="list-style-type: none"> <li>- Prepared by the Healthcare Infection Control Practices Advisory Committee (HICPAC)</li> <li>- Melded major features of Universal Precautions and Body Substance Isolation into Standard Precautions to be used with all patients at all times</li> <li>- Included three transmission-based precaution categories: airborne, droplet, and contact</li> <li>- Listed clinical syndromes that should dictate use of empiric isolation until an etiological diagnosis is established</li> </ul>

\* Derived from Garner ICHE 1996

## TABLE 2. DEFINITIONS

**American Institute of Architects (AIA).** A professional organization that develops and updates “Guidelines for Design and Construction of Hospital and Health Care Facilities”. AIA recommendations for building ventilation are the primary source of guidance for creating airborne infection isolation and protective environments ([www.aia.org/aah](http://www.aia.org/aah)).

**Ambulatory care settings.** Facilities that provide health care to patients who do not remain overnight e.g., hospital-based outpatient clinics, nonhospital-based clinics and physician offices, urgent care centers, surgicenters, free-standing dialysis centers, public health clinics, imaging centers, ambulatory behavioral health and substance abuse clinics, physical therapy and rehabilitation centers, and dental practices.

**Caregivers.** Persons who provide care to a patient. This term includes both healthcare workers (HCWs) (see below) who have technical or professional training and are employed for the purpose of providing care and persons who are not employees of an organization, are not paid, and provide or assist in providing healthcare to a patient (e.g., family member, friend) and acquire technical training as needed based on the tasks that must be performed.

**Droplet nuclei.** Small particle residue of evaporated droplets that are < 5 µm in size and are produced when a person coughs, sneezes, shouts, or sings. These particles can remain suspended in the air for prolonged periods of time and can be carried on normal air currents within a room or travel long distances outside the room.

**Epidemiologically important infectious agents.** Infectious agents that have one or more of the following characteristics: 1) are readily transmissible; 2) have a proclivity toward causing outbreaks; 3) may be associated with a severe outcome; or 4) are difficult to treat, such as *Acinetobacter*, *Aspergillus* sp., *Burkholderia cepacia*, *Clostridium difficile*, *Klebsiella* or *Enterobacter* spP., methicillin-resistant *Staphylococcus aureus* [MRSA], *Pseudomonas aeruginosa*, vancomycin-resistant enterococci [VRE], influenza virus, respiratory syncytial virus, and rotavirus).

**Expanded Precautions.** A term that has replaced “Transmission-based Precautions” to reflect infection control measures, in addition to Standard Precautions that are needed to prevent transmission of highly transmissible or epidemiologically important infectious agents. The following categories of precautions are included in Expanded Precautions: Contact Precautions, Droplet Precautions, Airborne Infection Isolation, and Protective Environment (see text for descriptions).

**Hand hygiene.** A general term that applies to any one of the following: 1) handwashing with plain (nonantimicrobial) soap and water); 2) antiseptic handwash (soap containing antiseptic agents and water); 3) antiseptic handrub (waterless antiseptic product, most often alcohol-based, rubbed on all surfaces of hands); or 4) surgical hand antisepsis (antiseptic handwash or antiseptic handrub performed preoperatively by surgical personnel to eliminate transient and reduce resident hand flora)(6).

**Healthcare-associated infection (HAI).** An infection that develops in a patient who is cared for in any setting where healthcare is delivered (e.g., acute care hospital, chronic care facility, ambulatory clinic, dialysis center, surgicenter, home) and is related to receiving health care (i.e., was not incubating or present at the time healthcare was provided). In ambulatory and home settings, HAI would apply to any infection that is associated with a medical or surgical intervention. Since the geographic location of infection acquisition is often uncertain, the infection is considered to be *healthcare-associated* rather than *healthcare-acquired*.

**Healthcare epidemiologist.** A person whose primary training is medical (M.D., D.O.) or doctorate-level epidemiology who has received advanced training in infectious diseases or healthcare epidemiology. Typically these professionals direct or provide consultation to an infection control program in a hospital, long term care facility (LTCF), or healthcare delivery system (also see infection control professional).

**Healthcare personnel, healthcare worker (HCW).** All paid and unpaid persons who work in a healthcare setting (e.g. any person who has professional or technical training in a healthcare-related field and provides patient care in a healthcare setting or any person who provides services that support the delivery of healthcare such as dietary, housekeeping, engineering, maintenance personnel).

**Hematopoietic stem cell transplantation (HSCT).** Any transplantation of blood- or marrow-derived hematopoietic stem cells, regardless of transplant type (e.g., allogeneic or autologous) or cell source (e.g., bone marrow, peripheral blood, or placental/umbilical cord blood); associated with periods of severe immunosuppression that vary with the source of the cells, the intensity of chemotherapy required, and the presence of graft versus host disease (13).

**High-efficiency particulate air (HEPA) filter.** An air filter that removes >99.97% of particles 0.3µm (the most penetrating particle size) at a specified flow rate of air. HEPA filters may be integrated into the central air handling systems, installed at the point of use above the ceiling of a room, or used as portable units (4).

**Home health care.** A wide-range of medical, nursing, rehabilitation and social services delivered to patients in their place of residence (e.g., private residence, senior living center, assisted living facility). Home health-care services include care provided by home health aides and skilled nurses; provision of durable medical equipment; home infusion therapy; and physical, speech, and occupational therapy.

**Immunocompromised.** A condition in which the immune system is not functioning normally, leaving the patient in a permanent or temporary state of increased susceptibility to infection. *Immunocompromised* is the broader term, and *immunosuppression* refers to restricted states with iatrogenic causes, including causes that result from therapy for another condition. Susceptibility to various infections is determined by severity of immunosuppression and the components of the immune system that are most severely affected. Conditions associated with immunocompromise may be congenital or acquired

(e.g., genetically determined primary immune deficiencies, human immunodeficiency virus infection, immunosuppressive chemotherapy for a primary disease state such as oncologic or rheumatologic disorders and HSCT or solid organ transplants). Patients undergoing allogeneic HSCT and those with chronic graft versus host disease are considered the most vulnerable to healthcare-associated infections. Immunocompromised states also make it more difficult to diagnose certain infections (e.g., tuberculosis) and are associated with more severe clinical disease states than those seen in persons with a normal immune system.

***Infection control professional (ICP).*** A person whose primary training is in either nursing, medical technology, microbiology, or epidemiology and who has acquired specialized training in infection control. Responsibilities may include collection and analysis of infection data; consultation on infection risk assessment, prevention and control strategies; performance of education and training activities; implementation of evidence-based infection control practices or those mandated by regulatory and licensing agencies; application of epidemiologic principles to improve patient outcomes; participation in planning renovation and construction projects (e.g., to ensure appropriate containment of construction dust); evaluation of new products or procedures on patient outcomes; and participation in research. Certification in infection control (CIC) is available through the Certification Board of Infection Control and Epidemiology.

***Infection control program.*** A multidisciplinary program that includes a group of activities to ensure that recommended practices for the prevention of healthcare-associated infections are implemented and followed by HCWs, making the healthcare setting safe from infection for patients and healthcare personnel. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires the following five components of an infection control program for accreditation: 1) *surveillance*: monitoring patients and healthcare personnel for acquisition of infection and/or colonization; 2) *investigation*: identification and analysis of infection problems or undesirable trends; 3) *prevention*: implementation of measures to prevent transmission of infectious agents and to reduce risks for device- and procedure-related infections; 4) *control*: evaluation and management of outbreaks; and 5) *reporting*: provision of information to external agencies as required by state and federal law and

regulation ([www.jcaho.org](http://www.jcaho.org)). The infection control program staff has the ultimate authority to determine infection control policies for a healthcare organization with the approval of the organization's governing body.

**Long-term care facility (LTCF).** An array of residential and outpatient facilities designed to meet the biopsychosocial needs of persons with sustained self-care deficits. These include skilled nursing facilities, chronic disease hospitals, nursing homes, foster and group homes, institutions for the developmentally disabled, residential care facilities, assisted living facilities, retirement homes, adult day health care facilities, rehabilitation centers, and long-term psychiatric hospitals.

**Multidrug-resistant organisms.** In general, bacteria (excluding *M. tuberculosis*) that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents (e.g., MRSA, VRE, extended spectrum beta-lactamase [ESBL]-producing or intrinsically resistant gram-negative bacilli) (52).

**Nosocomial infection.** Derived from two Greek words “nosos” (disease) and “komeion” (to take care of). Refers to any infection that develops during or as a result of an admission to an acute care facility (hospital) and was not incubating at the time of admission.

**Personal protective equipment (PPE).** A variety of barriers used alone or in combination to protect mucous membranes, skin, and clothing from contact with infectious agents. PPE includes gloves, masks, respirators, goggles, face shields, and gowns/aprons.

**Residential care setting.** A facility in which people live, minimal medical care is delivered, and the psychosocial needs of the residents are provided for.

**Respirator.** A personal protective device worn by healthcare personnel over the nose and mouth to protect them from acquiring airborne infectious diseases due to inhalation of infectious airborne particles that are < 5 µm in size. These include infectious droplet nuclei

from patients with *M. tuberculosis*, variola virus [smallpox], SARS-CoV), and dust particles that contain infectious particles, such as spores of environmental fungi(e.g., *Aspergillus* sp.). The CDC's National Institute for Occupational Safety and Health (NIOSH) certifies respirators used in healthcare settings (<http://www.cdc.gov/niosh/topics/respirators/>). The N-95 disposable particulate, air purifying, respirator is the type used most commonly by HCWs. Other respirators used include N-99 and N-100 particulate respirators, powered air-purifying respirators (PAPRS) with high efficiency filters; and non-powered full-facepiece elastomeric negative pressure respirators. A listing of NIOSH- approved respirators can be found at [www.cdc.gov/niosh/npptl/respirators/disp\\_part/particlist.html](http://www.cdc.gov/niosh/npptl/respirators/disp_part/particlist.html). Respirators must be used in conjunction with a complete Respiratory Protection Program, as required by the Occupational Safety and Health Administration (OSHA),that includes fit testing, training, proper selection of respirators, medical clearance and respirator maintenance.

**Respiratory Hygiene/ Cough Etiquette.** A combination of measures designed to minimize the transmission of respiratory pathogens via droplet or airborne routes in healthcare settings. The components of respiratory hygiene/cough etiquette are 1) covering the mouth and nose during coughing and sneezing, 2) using tissues to contain respiratory secretions with prompt disposal into a no-touch receptacle, 3) offering a surgical mask to persons who are coughing to decrease contamination of the surrounding environment, and 4) turning the head away from others and maintaining spatial separation, ideally >3 feet, when coughing. These measures are targeted to all patients with symptoms of respiratory infection and their accompanying family members or friends beginning at the point of initial encounter with a healthcare setting (e.g., reception/triage in emergency departments, ambulatory clinics, healthcare provider offices) (11) ([www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm](http://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm)).

**Safety culture.** Shared perceptions of workers and management regarding the level of safety in the work environment. A hospital safety climate includes the following six organizational components: 1) senior management support for safety programs; 2) absence of workplace barriers to safe work practices; 3) cleanliness and orderliness of the worksite; 4) minimal conflict and good communication among staff members; 5) frequent safety-

related feedback/training by supervisors; and 6) availability of PPE and engineering controls (234).

**Standard Precautions.** A group of infection prevention practices that apply to all patients, regardless of diagnosis or presumed infection status. Standard Precautions is a combination and expansion of Universal Precautions (428) and Body Substance Isolation (1, 642). Standard Precautions is based on the principle that all blood, body fluids, secretions, excretions except sweat, nonintact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions includes hand hygiene, and depending on the anticipated exposure, use of gloves, gown, mask, eye protection, or face shield. Also, equipment or items in the patient environment likely to have been contaminated with infectious fluids must be handled in a manner to prevent transmission of infectious agents, e.g. wear gloves for handling, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient.

**Surgical mask.** A device worn over the mouth and nose by operating room personnel during surgical procedures to protect both surgical patients and operating room personnel from transfer of microorganisms and body fluids. Surgical masks also are used to protect HCWs from contact with large infectious droplets (>5-10  $\mu\text{m}$  in size). According to draft guidance issued by the Food and Drug Administration on May 15, 2003, surgical masks are evaluated using standardized testing procedures for fluid resistance, bacterial filtration efficiency, differential pressure (air exchange), and flammability in order to mitigate the risks to health associated with the use of surgical masks. These specifications apply to any masks that are labeled surgical, laser, isolation, or dental or medical procedure ([www.fda.gov/cdrh/ode/guidance/094.html#4](http://www.fda.gov/cdrh/ode/guidance/094.html#4)). Surgical masks do not protect against inhalation of small particles and should not be confused with particulate respirators that are recommended for protection against airborne infectious particles.

**TABLE 3. INFECTION CONTROL CONSIDERATIONS FOR HIGH-PRIORITY (CDC CATEGORY A) DISEASES THAT HAVE RESULTED FROM BIOTERRORIST ATTACKS OR CONSIDERED TO BE BIOTERRORIST THREATS** (www.bt.cdc.gov)<sup>a</sup> (643)

Agent	Site (Means of Transmission); Incubation Period	Clinical Features	Diagnosis	Infectivity	Recommended Precautions
<p><b>Anthrax</b></p> <p>Cutaneous and inhalation disease have occurred in past bioterrorist incidents.</p>	<p><b>Sites:</b> Skin (contact with spores), RT (inhalation of spores), GIT (ingestion of spores - rare)</p> <p><b>Incubation period:</b> Usually 1 to 7 days but up to 60-90 days possible for RT.</p> <p><b>Comment:</b> Spores 1-2 <math>\mu</math> or spore clusters of up to 5 <math>\mu</math> in size; infectious dose estimated to be 8,000 to 15,000 but probably lower.</p>	<p><b>Skin:</b> Painless, reddish papule, which becomes edematous in 1-2 days; over next 3-7 days lesion becomes pustular and then necrotic with black eschar.</p> <p><b>RT:</b> initial flu-like illness for 1-3 days with headache, fever, malaise, cough; by day 4 severe dyspnea and shock; meningitis in 50%.</p>	<p><b>Skin:</b> Culture of swab or punch biopsy;</p> <p><b>RT:</b> CXR demonstrating wide mediastinum or chest CT showing hypodense hilar and mediastinal nodes and mediastinal edema may suggest clinical diagnosis; hemorrhagic pleural effusion; cultures, PCR of blood, pleural fluids and CSF for etiologic diagnosis.</p>	<p><b>Skin:</b> Person-to-person transmission from contact with lesion of untreated patient possible, but extremely rare;</p> <p><b>RT:</b> Person-to-person transmission does not occur.</p>	<p><b>Cutaneous:</b> Standard Precautions; Contact Precautions if uncontained copious drainage.</p> <p><b>Inhalation:</b> Standard Precautions.</p> <p><b>Aerosolized powder, environmental exposures:</b> Respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them (644)</p> <p><b>Hand hygiene:</b> Handwashing with soap and water after spore contact (alcohol handrubs inactive against spores).</p> <p><b>Post-exposure chemoprophylaxis:</b> Offer post-exposure vaccine under IND</p>
<p><b>Smallpox</b></p> <p>If used as a biological</p>	<p><b>RT</b> Inhalation of droplet or, rarely, aerosols and skin</p>	<p>Fever, malaise, backache, headache, and</p>	<p>Electron microscopy of vesicular fluid or culture of vesicular</p>	<p>Secondary attack rates up to 50% in unvaccinated</p>	<p>Combined use of Standard, Contact, Precautions and</p>

Agent	Site (Means of Transmission); Incubation Period	Clinical Features	Diagnosis	Infectivity	Recommended Precautions
<p>weapon, natural disease, which has not occurred since 1977, will likely result.</p>	<p>lesions (contact with virus). <b>Incubation period:</b> 7 to 19 days (mean 12 days)</p>	<p>often vomiting for 2-3 days; then generalized papular or maculopapular rash (more on face and extremities), which becomes vesicular (on day 4 or 5) and then pustular; lesions all in same stage.</p>	<p>fluid in eggs or cell culture, detection by PCR.</p>	<p>persons; infected persons may transmit disease from time rash appears until all lesions have crusted over (about 3 weeks); greatest infectivity during first 10 days of rash.</p>	<p>Airborne Infection Isolation (All)<sup>b</sup> until all scabs have separated (3-4 weeks). Only immune HCWs to care for pts; post-exposure vaccine within 4 days. <b>Vaccinia:</b> HCWs cover vaccination site with gauze and semi-permeable dressing until scab separates (<math>\geq 21</math> days). Observe hand hygiene. <b>Adverse events with virus-containing lesions:<sup>c</sup></b> Standard, Contact Precautions until all lesions crusted; All.</p>
<p><b>Plague</b>  Pneumonic plague most likely to occur if</p>	<p><b>RT:</b> Inhalation of respiratory droplets. <b>Incubation Period:</b> 1 to 6, usually 2 to 3 days.</p>	<p>Pneumonic: fever, chills, headache, cough, dyspnea, hemoptysis, and rapid progression</p>	<p>Presumptive diagnosis from Gram stain or Wayson stain of sputum, CSF, or lymph node aspirate;</p>	<p>Person-to-person transmission occurs via respiratory droplets;</p>	<p>Standard and Droplet precautions until patients have received 72 hours of appropriate therapy.</p>

Agent	Site (Means of Transmission); Incubation Period	Clinical Features	Diagnosis	Infectivity	Recommended Precautions
used as a biological weapon, but some cases of bubonic and 1 <sup>o</sup> septicemia may also occur.	<b>Comment:</b> infective dose 100 to 500 bacteria.	of weakness, circulatory collapse, and bleeding diathesis.	definitive diagnosis from cultures of same material.	respiratory secretions probably remain infectious for 24 to 48 hours after initiation of appropriate therapy.	<b>Chemoprophylaxis:</b> Provide antibiotic prophylaxis for exposed HCWs.
<b>Botulism</b> Toxin ingested or potentially delivered by aerosol in bioterrorist incidents.	<b>GIT:</b> Ingestion of items contaminated with toxin <b>RT:</b> Inhalation of toxin containing aerosol cause disease. <b>Incubation period:</b> 1-5 days. <b>Comment:</b> LD <sub>50</sub> for type A is 0.001 µg/ml/kg.	Ptosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia followed by symmetrical descending paralysis and respiratory failure.	Clinical diagnosis, identification of toxin in stool, serology unless toxin-containing material available for toxin neutralization bioassays.	Not transmitted from person to person. Exposure to toxin necessary for disease.	Standard Precautions.
<b>Tularemia</b> Pneumonic or typhoidal disease likely to occur after bioterrorist event using aerosol delivery.	<b>RT:</b> Inhalation of aerosolized bacteria. <b>GIT:</b> Ingestion of food or drink contaminated with aerosolized bacteria. <b>Incubation period:</b> 2 to 10 days, usually 3 to 5 days. <b>Comment:</b> infective dose 10 to 50	Pneumonia: fever, malaise, cough, sputum production, dyspnea; Typhoidal: fever, prostration, weight loss and frequently an associated pneumonia.	Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be isolated from blood and other body fluids on cysteine-enriched media or mouse inoculation.	Person-to-person spread is rare. Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed.	Standard Precautions. BSL-2 laboratory precautions required.

Agent	Site (Means of Transmission); Incubation Period	Clinical Features	Diagnosis	Infectivity	Recommended Precautions
	bacteria.				
<b>Viral Hemorrhagic Fever (VHF)</b> , e.g., Ebola. Natural disease would probably occur after release of these agents in any form.	As a rule infection develops after exposure of skin, mucous membranes, or RT to viruses (respiratory droplet or aerosol, depending upon the agent, and contact). <b>Incubation period:</b> 2-19 days, usually 5-10 days.	Febrile illnesses with malaise, myalgias, headache, vomiting and diarrhea that are rapidly complicated by hypotension, shock, and hemorrhagic features.	Etiologic diagnosis usually requires viral cultures of blood and other body fluids or serologic studies (role of PCR testing uncertain).	Person-to-person transmission frequent; transmission in healthcare settings common outbreak reports.	<b>Hemorrhagic fever specific barrier precautions:</b> strict hand hygiene plus double-gloves, impermeable gowns, face shields, eye protection, and leg and shoe coverings plus Airborne Infection Isolation <sup>b</sup>

<sup>a</sup> Abbreviations used in this table: RT = respiratory tract; GIT = gastrointestinal tract; CXR = chest x-ray; CT = computerized axial tomography; CSF = cerebrospinal fluid; and LD<sub>50</sub> – lethal dose for 50% of experimental animals; HCWs = healthcare worker; BSL = biosafety level; PAPR = powered air purifying respirator; PCR = polymerase chain reaction

<sup>b</sup> Transmission by the airborne route is a rare event; airborne infection isolation is recommended when possible, but in the event of mass exposures, barrier precautions and containment within a designated area are most important (47, 90).

<sup>c</sup> Vaccinia adverse events with lesions containing infectious virus include inadvertent autoinoculation, ocular lesions (blepharitis, conjunctivitis), generalized vaccinia, progressive vaccinia, eczema vaccinatum; bacterial superinfection also requires addition of contact precautions if exudates cannot be contained (97, 98).

**TABLE 4. RECOMMENDATIONS FOR APPLICATION OF STANDARD PRECAUTIONS FOR THE CARE OF ALL PATIENTS IN ALL HEALTHCARE SETTINGS**

COMPONENT	RECOMMENDATIONS
Hand hygiene	After touching blood, body fluids, secretions, excretions, contaminated items; immediately after removing gloves; between patient contacts
Personal protective equipment (PPE)	
Gloves	For touching blood, body fluids, secretions, excretions, contaminated items; for touching mucous membranes and nonintact skin
Mask, eye protection, face shield	During procedures and patient-care activities likely to generate splashes or sprays of blood, body fluids, secretions
Gown	During procedures and patient-care activities when contact of clothing/exposed skin with blood/body fluids, secretions, and excretions is anticipated.
Soiled patient-care equipment	Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; perform hand hygiene.
Environmental control	Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient-care areas.
Textiles and laundry	Handle in a manner that prevents transfer of microorganisms to others and to the environment
Needles and other sharps	Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; place used sharps in puncture-resistant container
Patient resuscitation	Use mouthpiece, resuscitation bag, other ventilation devices to prevent contact with mouth and oral secretions
Patient placement	Prioritize for single-patient room if patient is at increased risk of transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk of acquiring infection or developing adverse outcome following infection.
Respiratory hygiene/cough etiquette (source containment of infectious respiratory secretions in symptomatic patients, beginning at initial point of encounter e.g., triage and reception areas in emergency departments and physician offices)	Instruct symptomatic persons to cover mouth/nose when sneezing/coughing; use tissues and dispose in no-touch receptacle; observe hand hygiene after soiling of hands with respiratory secretions; wear surgical mask if tolerated or maintain spatial separation, >3 feet if possible.

## **TABLE 5. COMPONENTS OF A PROTECTIVE ENVIRONMENT (PE)**

(Adapted from (4))

### **I. Patients: allogeneic hematopoietic stem cell transplant (HSCT) only**

- Maintain in PE room except for required diagnostic or therapeutic procedures that cannot be performed in the room, e.g. radiology, operating room
- Respiratory protection e.g., N95 respirator, for the patient when leaving PE during periods of construction

### **II. Standard and Expanded Precautions**

- Hand hygiene observed before and after patient contact
- Gown, gloves, mask NOT required for HCWs or visitors for routine entry into the room
- Use of gown, gloves, mask by HCWs and visitors according to Standard Precautions and as indicated for suspected or proven infections for which Expanded Precautions are recommended

### **III. Engineering**

- Central or point-of-use HEPA (99.97% efficiency) filters capable of removing particles 0.3  $\mu\text{m}$  in diameter for supply (incoming) air
- Well-sealed rooms
  - Proper construction of windows, doors, and intake and exhaust ports
  - Ceilings: smooth, free of fissures, open joints, crevices
  - Walls sealed above and below the ceiling
  - If leakage detected, locate source and make necessary repairs
- Ventilation to maintain  $\geq 12$  ACH
- Directed air flow: air supply and exhaust grills located so that clean, filtered air enters from one side of the room, flows across the patient's bed, exits on opposite side of the room
- Positive room air pressure in relation to the corridor
  - Pressure differential of  $>2.5$  Pa [0.01" water gauge]
- Monitor and document results of air flow patterns daily using visual methods (e.g., flutter strips, smoke tubes)
- Self-closing door on all room exits
- Maintain back-up ventilation equipment (e.g., portable units for fans or filters) for emergency provision of ventilation requirements for PE areas and take immediate steps to restore the fixed ventilation system
- For patients who require both a PE and Airborne Infection Isolation, use an anteroom to ensure proper air balance relationships and provide independent exhaust of contaminated air to the outside or place a HEPA filter in the exhaust duct. If an anteroom is not available, place patient in an AII room and use portable ventilation units, industrial-grade HEPA filters to enhance filtration of spores.

### **IV. Surfaces**

- Daily wet-dusting of horizontal surfaces using cloths moistened with EPA-registered hospital disinfectant/detergent
- Avoid dusting methods that disperse dust
- No carpeting in patient rooms or hallways
- No upholstered furniture and furnishings

### **V. Other**

- No flowers (fresh or dried) or potted plants in PE rooms or areas
- Use vacuum cleaner equipped with HEPA filters when vacuum cleaning is necessary

**TABLE 6. CLINICAL SYNDROMES OR CONDITIONS WARRANTING ADDITIONAL EMPIRIC PRECAUTIONS TO PREVENT TRANSMISSION OF EPIDEMIOLOGICALLY IMPORTANT PATHOGENS PENDING CONFIRMATION OF DIAGNOSIS\***

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions
<b>Diarrhea</b>		
Acute diarrhea with a likely infectious cause in an incontinent or diapered patient	Enteric pathogens§	Standard plus Contact (pediatrics and adult)
<b>Meningitis</b>	<i>Neisseria meningitidis</i>	Droplet for first 24 hrs of antimicrobial therapy; mask and face protection for intubation
	Enteroviruses	Contact for infants and children
<b>Rash or exanthems, generalized, etiology unknown</b>		
Petechial/ecchymotic with fever	<i>Neisseria meningitidis</i>	Droplet for first 24 hrs of antimicrobial therapy
Vesicular	Varicella, smallpox, or vaccinia virus	Airborne Infection Isolation plus Contact; Contact if vaccinia
Maculopapular with cough, coryza and fever	Rubeola (measles) virus	Airborne Infection Isolation
<b>Respiratory infections</b>		
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for human immunodeficiency virus (HIV) infection	<i>M. tuberculosis</i> ; severe acute respiratory syndrome virus (SARS-CoV)	Airborne Infection Isolation; add Contact plus eye protection if history of SARS exposure, travel
Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection	<i>M. tuberculosis</i>	Airborne Infection Isolation

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions
Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children	Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus	Contact plus Droplet; Droplet may be discontinued when adenovirus and influenza have been ruled out
<b>Skin or Wound Infection</b>		
Abscess or draining wound that cannot be covered	<i>Staphylococcus aureus</i> , group A streptococcus	Contact
<p>* Infection control professionals should modify or adapt this table according to local conditions. To ensure that appropriate empiric precautions are implemented always, hospitals must have systems in place to evaluate patients routinely according to these criteria as part of their preadmission and admission care.</p> <p>† Patients with the syndromes or conditions listed below may present with atypical signs or symptoms (e.g. neonates and adults with pertussis may not have paroxysmal or severe cough). The clinician's index of suspicion should be guided by the prevalence of specific conditions in the community, as well as clinical judgment.</p> <p>‡ The organisms listed under the column "Potential Pathogens" are not intended to represent the complete, or even most likely, diagnoses, but rather possible etiologic agents that require additional precautions beyond Standard Precautions until they can be ruled out.</p> <p>§ These pathogens include enterohemorrhagic <i>Escherichia coli</i> O157:H7, <i>Shigella spp</i>, hepatitis A virus, and rotavirus.</p>		

# Figure. Donning and Removing Personal Protective Equipment (PPE)

## DONNING PPE

Type of PPE used will vary based on the level of precautions required, e.g., Standard and Contact, Droplet or Airborne Isolation Precautions

### GOWN

- Fully cover torso from neck to knees, arms to end of wrist, and wrap around the back
- Fasten in back at neck and waist



### MASK OR RESPIRATOR

- Secure ties or elastic band at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator



### GOGGLES/FACE SHIELD

- Put over face and eyes and adjust to fit



### GLOVES

- Extend to cover wrist of isolation gown



## SAFE WORK PRACTICES

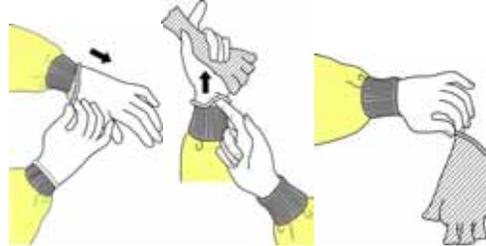
- Keep hands away from face
- Limit surfaces touched
- Change when torn or heavily contaminated
- Perform hand hygiene

## REMOVING PPE

Remove PPE at doorway before leaving patient room or in anteroom; remove respirator outside of room

### **GLOVES**

- Outside of gloves are contaminated!
- Grasp outside of glove with opposite gloved hand; peel off
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist



### **GOGGLES/FACE SHIELD**

- Outside of goggles or face shield are contaminated!
- To remove, handle by “clean” head band or ear pieces
- Place in designated receptacle for reprocessing or in waste container



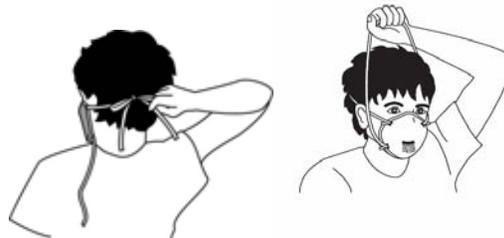
### **GOWN**

- Gown front and sleeves are contaminated!
- Unfasten neck, the waist ties
- Remove gown using a peeling motion; pull gown from each shoulder toward the same hand
- Gown will turn inside out
- Hold removed gown away from body, roll into a bundle and discard into waste or linen receptacle



### **MASK OR RESPIRATOR**

- Front of mask/respirator is contaminated – DO NOT TOUCH!
- Grasp bottom then top ties/elastics and remove
- Discard in waste container



## HAND HYGIENE

Perform immediately after removing all PPE!

## APPENDIX A

### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Abscess			
Draining, major	C	DI	No dressing or containment of drainage; until drainage stops or can be contained by dressing
Draining, minor or limited	S		Dressing covers and contains drainage
Acquired human immunodeficiency syndrome (HIV)	S		
Actinomycosis	S		
Adenovirus infection, in infants and young children (also, see gastroenteritis, adenovirus)	D, C	DI	
Amebiasis	S		
Anthrax			Postexposure chemoprophylaxis; consider post-exposure vaccine(407, 644, 645)
Cutaneous	S		Contact Precautions if large amount of drainage that cannot be contained
Pulmonary	S		
Aerosolizable spore-containing powder	All,C	DE	Until decontamination of environment complete (644)
Antibiotic-associated colitis (see <i>Clostridium difficile</i> )			
Arthropod-borne viral encephalitides (eastern, western, Venezuelan equine encephalomyelitis; St Louis, California encephalitis; West Nile Virus)	S		Not transmitted from person to person except rarely by transfusion, and for West Nile virus by organ transplant, by breastmilk or transplacentally (646);Install screens in windows and doors in endemic areas Use DEET-containing mosquito repellants and clothing to cover extremities
Arthropod-borne viral fevers (dengue, yellow fever, Colorado tick fever)	S		Not transmitted from person to person except by transfusion, rarely Install screens in windows and doors in endemic areas Use DEET-containing mosquito repellants and clothing to cover extremities
Ascariasis	S		Not transmitted from person to person
Aspergillosis	S		Contact Precautions and All if massive soft tissue infection with copious drainage and repeated irrigations required (51)
Avian influenza	All, D, C	14 days after onset of	All preferred (D if All rooms unavailable); N95 respiratory protection (surgical mask if N95 unavailable); eye protection (goggles, face shield)

## APPENDIX A

### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
		symptoms	within 3 feet of patient); 14 days after onset of symptoms or until an alternative diagnosis is established or until diagnostic test results indicate that the patient is not infected with influenza A H5N1 virus. Human-to-human transmission inefficient and rare, but risk of reassortment with human influenza strains and emergence of pandemic strain serious concern.
Babesiosis	S		Not transmitted from person to person except by transfusion, rarely.
Blastomycosis, North American, cutaneous or pulmonary	S		Not transmitted from person to person
Botulism	S		Not transmitted from person to person
Bronchiolitis (see respiratory infections in infants and young children)	C	DI	Use mask according to Standard Precautions and until influenza and adenovirus have been ruled out as etiologic agents
Brucellosis (undulant, Malta, Mediterranean fever)	S		Not transmitted from person to person
<i>Campylobacter</i> gastroenteritis (see gastroenteritis)			
Candidiasis, all forms including mucocutaneous	S		
Cat-scratch fever (benign inoculation lymphoreticulosis)	S		Not transmitted from person to person
Cellulitis	S		
Chancroid (soft chancre)	S		
Chickenpox (see varicella)			
<i>Chlamydia trachomatis</i>			
Conjunctivitis	S		
Genital	S		
Respiratory	S		
Cholera (see gastroenteritis)			
Closed-cavity infection			
Open drain in place; limited or minor drainage	S		Contact Precautions if there is copious uncontained drainage
No drain or closed drainage system in place	S		
<i>Clostridium</i>			
<i>C. botulinum</i>	S		Not transmitted from person to person
<i>C. difficile</i> (also see gastroenteritis, <i>C. difficile</i> )	C	DI	Assess need to discontinue antibiotics Avoid the use of shared electronic thermometers (519, 647).

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			Ensure consistent environmental cleaning and disinfection.
<i>C. perfringens</i>			
Food poisoning	S		Not transmitted from person to person
Gas gangrene	S		Not transmitted from person to person
Coccidioidomycosis (valley fever)			
Draining lesions	S		Not transmitted from person to person
Pneumonia	S		Not transmitted from person to person
Colorado tick fever	S		Not transmitted from person to person
Congenital rubella	C	Until 1 yr. of age	Standard Precautions if nasopharyngeal and urine cultures neg. after 3 mos. of age
Conjunctivitis			
Acute bacterial	S		
<i>Chlamydia</i>	S		
Gonococcal	S		
Acute viral (acute hemorrhagic)	C	DI	
Corona virus associated with SARS (SARS-CoV) (see severe acute respiratory syndrome)			
Coxsackie virus disease (see enteroviral infection)			
Creutzfeldt-Jakob disease CJD, vCJD	S		Use disposable instruments or special sterilization/disinfection for surfaces, objects contaminated with neural tissue if CJD or vCJD suspected and has not been R/O; No special burial procedures(4, 7, 103)
Croup (see respiratory infections in infants and young children)			
Cryptococcosis	S		Not transmitted from person to person
Cryptosporidiosis (see gastroenteritis)			
Cysticercosis	S		Not transmitted from person to person
Cytomegalovirus infection, neonatal or immunosuppressed	S		No additional precautions for pregnant HCWs
Decubitus ulcer (pressure sore) infected			
Major	C	DI	If no dressing or containment of drainage; until drainage stops or can be contained by dressing
Minor or limited	S		If dressing covers and contains drainage

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Dengue fever	S		Not transmitted from person to person
Diarrhea, acute-infective etiology suspected (see gastroenteritis)			
Diphtheria			
Cutaneous	C	CN	Until 2 cultures taken 24 hrs. apart neg.
Pharyngeal	D	CN	Until 2 cultures taken 24 hrs. apart neg.
Ebola viral hemorrhagic fever (see viral hemorrhagic fevers)			
Echinococcosis (hydatidosis)	S		Not transmitted from person to person
Echovirus (see enteroviral infection)			
Encephalitis or encephalomyelitis (see specific etiologic agents)			
Endometritis	S		
Enterobiasis (pinworm disease, oxyuriasis)	S		
<i>Enterococcus</i> species (see multidrug-resistant organisms if epidemiologically significant or vancomycin resistant)			
Enterocolitis, <i>C. difficile</i> (see <i>C. difficile</i> , gastroenteritis)			
Enteroviral infections	S		Use Contact Precautions for diapered or incontinent children for duration of illness and to control institutional outbreaks
Epi­glottitis, due to <i>Haemophilus influenzae</i> type b	D	U 24 hrs	
Epstein-Barr virus infection, including infectious mononucleosis	S		
Erythema infectiosum (also see Parvovirus B19)	S		
<i>Escherichia coli</i> gastroenteritis (see gastroenteritis)			
Food poisoning			
Botulism	S		Not transmitted from person to person
<i>C. perfringens</i> or <i>welchii</i>	S		Not transmitted from person to person
Staphylococcal	S		Not transmitted from person to person
Furunculosis, staphylococcal	S		
Infants and young children	C	DI	
Gangrene (gas gangrene)	S		Not transmitted from person to person
Gastroenteritis	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks for gastroenteritis caused by all of the agents below

## APPENDIX A

### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Adenovirus	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>Campylobacter</i> species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Cholera	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>C. difficile</i>	C	DI	Assess need to discontinue antibiotics Avoid the use of shared electronic thermometers (519, 647); ensure consistent environmental cleaning and disinfection.
<i>Cryptosporidium</i> species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>E. coli</i>			
Enteropathogenic O157:H7 and other shiga toxin-producing strains	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Other species	S <sup>j</sup>		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>Giardia lamblia</i>	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Noroviruses	S		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 vomit should wear masks; ensure consistent environmental cleaning and disinfection. (648)
Rotavirus	C	DI	Ensure consistent environmental cleaning and disinfection; prolonged shedding may occur in the immunocompromised
<i>Salmonella</i> species (including <i>S. typhi</i> )	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>Shigella</i> species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>Vibrio parahaemolyticus</i>	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Viral (if not covered elsewhere)	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
<i>Yersinia enterocolitica</i>	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
German measles (see rubella; see congenital rubella)			
Giardiasis (see gastroenteritis)			
Gonococcal ophthalmia neonatorum (gonorrheal ophthalmia, acute conjunctivitis of newborn)	S		
Gonorrhea	S		
Granuloma inguinale (Donovanosis, granuloma venereum)	S		
Guillain-Barré' syndrome	S		Not an infectious condition
Hand, foot, and mouth disease (see enteroviral infection)			
Hantavirus pulmonary syndrome	S		Not transmitted from person to person
<i>Helicobacter pylori</i>	S		
Hepatitis, viral			
Type A	S		Provide hepatitis A vaccine postexposure as recommended(649)
Diapered or incontinent patients	C		Maintain Contact Precautions in infants and children <3 years of age for duration of hospitalization; for children 3-14 yrs. of age for 2 weeks after onset of symptoms; >14 yrs. of age for 1 week after onset of symptoms
Type B-HbsAg positive; acute or chronic	S		See specific recommendations for care of patients in hemodialysis centers (10)
Type C and other unspecified non-A, non-B	S		See specific recommendations for care of patients in hemodialysis centers (10)
Type D (seen only with hepatitis B)	S		
Type E	S		Use Contact Precautions for diapered or incontinent individuals for the duration of illness
Type G	S		
Herpangina (see enteroviral infection)			
Herpes simplex ( <i>Herpesvirus hominis</i> )			
Encephalitis	S		

## APPENDIX A

### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Mucocutaneous, disseminated or primary, severe	C	Until lesions dry and crusted	
Mucocutaneous, recurrent (skin, oral, genital)	S		
Neonatal	C	Until lesions dry and crusted	Also, for asymptomatic,exposed infants delivered vaginally or by C-section and if mother has active infection and membranes have been ruptured for more than 4 to 6 hrss until infant surface cultures obtained at 24-36 hrs. of age neg after 48 hrs incubation (650, 651)
Herpes zoster (varicella-zoster)			
Disseminated disease in any patient Localized disease in immunocompromised patient	All,C	DI	Susceptible HCWs should not enter room if immune caregivers are available; if entry is required, susceptibles must wear nose/mouth protection; once disseminated disease has been ruled out discontinue All,C. Provide exposed susceptibles post exposure vaccine within 5 days or place unvaccinated exposed susceptibles on administrative leave for 10-21days
Localized in patient with intact immune system with lesions that can be contained/covered	S	DI	Susceptible HCWs should not provide direct patient care when other immune caregivers are available.
Histoplasmosis	S		Not transmitted from person to person
Human immunodeficiency virus (HIV)	S		Post-exposure chemoprophylaxis for high risk blood exposures(353)
Impetigo	C	U 24 hrs	
Infectious mononucleosis	S		
Influenza	D	5 days except DI in immuno compromised persons	Private room when available or cohort; avoid placement with high-risk patients; keep doors closed; mask patient when transported out of room; chemoprophylaxis/vaccine to control/prevent outbreaks (408)
Avian influenza (see Avian influenza)			
Kawasaki syndrome	S		Not an infectious condition
Lassa fever (see viral hemorrhagic fevers)			
Legionnaires' disease	S		
Leprosy	S		
Leptospirosis	S		
Lice (head [pediculosis], body, pubic)	C	U 24 hrs	

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Listeriosis	S		Person-to-person transmission rare (652)
Lyme disease	S		Not transmitted from person to person
Lymphocytic choriomeningitis	S		Not transmitted from person to person
Lymphogranuloma venereum	S		
Malaria	S		Not transmitted from person to person except through transfusion, rarely; install screens in windows and doors in endemic areas; use DEET-containing mosquito repellants and clothing to cover extremities
Marburg virus disease (see hemorrhagic fevers)			
Measles (rubeola)	All	DI	Susceptible HCWs should not enter room if immune care providers are available; wear nose/mouth protection regardless of immune status; no recommendation for type of protection, i.e. surgical mask or respirator; post-exposure vaccine within 72 hrs. or immune globulin within 6 days
Melioidosis, all forms	S		Not transmitted from person to person
Meningitis			
Aseptic (nonbacterial or viral; also see enteroviral infections)	S		Contact for infants and young children
Bacterial, gram-negative enteric, in neonates	S		
Fungal	S		
<i>Haemophilus influenzae</i> , type b known or suspected	D	U 24 hrs	
<i>Listeria monocytogenes</i>	S		Not transmitted from person to person
<i>Neisseria meningitidis</i> (meningococcal) known or suspected	D	U 24 hrs	
<i>Streptococcus pneumoniae</i>	S		
Tuberculosis	S		Concurrent, active pulmonary disease or draining cutaneous lesions necessitate addition of airborne precautions
Other diagnosed bacterial	S		
Meningococcal disease: sepsis, pneumonia, meningitis	D	U 24 hrs	Postexposure chemoprophylaxis for household contacts, HCWs exposed to respiratory secretions; postexposure vaccine only if outbreak.
<i>Molluscum contagiosum</i>	S		
Monkeypox	All,C	Until lesions crusted	See <a href="http://www.cdc.gov/ncidod/monkeypox">www.cdc.gov/ncidod/monkeypox</a> for most current recommendations.

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			Pre- and post-exposure smallpox vaccine recommended for exposed HCWs
Mucormycosis	S		
Multidrug-resistant organisms (MDROs), infection or colonization (e.g., MRSA, VRE, VISA, ESBLs)	S/C		MDROs judged by the infection control program, based on local, state, regional, or national recommendations, to be of clinical and epidemiologic significance. Contact Precautions required in settings with evidence of ongoing transmission, acute care settings with increased risk for transmission or wounds that cannot be contained by dressings; see Recommendations and Appendix B, recommendations for management options; criteria for discontinuing precautions not established. Contact state health department for guidance regarding new or emerging MDRO
Mumps (infectious parotitis)	D	U 9 days	After onset of swelling; susceptible HCWs should not provide care if immune caregivers are available.
Mycobacteria, nontuberculosis (atypical)			
Pulmonary	S		
Wound	S		
<i>Mycoplasma pneumonia</i>	D	DI	
Necrotizing enterocolitis	S		Contact Precautions when cases temporally clustered (653-655)
Nocardiosis, draining lesions, or other presentations	S		
Norovirus (see gastroenteritis)			
Norwalk agent gastroenteritis (see gastroenteritis)			
Orf	S		
Parainfluenza virus infection, respiratory in infants and young children	C	DI	
Parvovirus B19	D		Maintain precautions for duration of hospitalization when chronic disease occurs in an immunodeficient 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 (656)
Pediculosis (lice)	C	U 24 hrs after treatment	
Pertussis (whooping cough)	D	U 5 days	Private room preferred. Cohorting an option. Post-exposure chemoprophylaxis for household contacts and HCWs

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			with prolonged exposure to respiratory secretions.
Pinworm infection	S		
Plague ( <i>Yersinia pestis</i> )			
Bubonic	S		
Pneumonic	D	U 72 hrs	Antimicrobial prophylaxis for exposed HCW.
Pneumonia			
Adenovirus	D, C	DI	
Bacterial not listed elsewhere (including gram-negative bacterial)	S		
<i>B. cepacia</i> in patients with CF, including respiratory tract colonization	C	Unknown	Avoid exposure to other persons with CF; private room preferred. Criteria for D/C precautions not established. See CF foundation guideline (221)
<i>B. cepacia</i> in patients without CF (see Multidrug-resistant organisms)			
<i>Chlamydia</i>	S		
Fungal	S		
<i>Haemophilus influenzae</i> , type b			
Adults	S		
Infants and children	D	U 24 hrs	
<i>Legionella spp.</i>	S		
Meningococcal	D	U 24 hrs	
Multidrug-resistant bacterial (see multidrug-resistant organisms)			
<i>Mycoplasma</i> (primary atypical pneumonia)	D	DI	
Pneumococcal	S		
<i>Pneumocystis carinii</i>	S		Avoid placement in the same room with an immunocompromised patient.
<i>Staphylococcus aureus</i>	S		
<i>Streptococcus</i> , group A			
Adults	S		
Infants and young children	D	U 24 hrs	
Varicella-zoster	All	DI	Contact Precautions if skin lesions present
Viral			

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type <sup>*</sup>	Duration <sup>†</sup>	Comments
Adults	S		
Infants and young children (see respiratory infectious disease, acute)			
Poliomyelitis	C		
Prion disease (See Creutzfeld-Jacob Disease)			
Psittacosis (ornithosis)	S		Not transmitted from person to person
Q fever	S		
Rabies	S	DI	If patient has bitten another individual or saliva has contaminated an open wound or mucous membrane, wash exposed area thoroughly and administer postexposure prophylaxis
Rat-bite fever ( <i>Streptobacillus moniliformis</i> disease, <i>Spirillum minus</i> disease)	S		
Relapsing fever	S		
Resistant bacterial infection or colonization (see multidrug-resistant organisms)			
Respiratory infectious disease, acute (if not covered elsewhere)			
Adults	S		
Infants and young children	C	DI	Also see syndromes or conditions listed in Table 6
Respiratory syncytial virus infection, in infants, young children and immunocompromised adults	C	DI	
Reye's syndrome	S		Not an infectious condition
Rheumatic fever	S		Not an infectious condition
Rickettsial fevers, tickborne (Rocky Mountain spotted fever, tickborne typhus fever)	S		Not transmitted from person to person except through transfusion, rarely
Rickettsialpox (vesicular rickettsiosis)	S		
Ringworm (dermatophytosis, dermatomycosis, tinea)	S		
Ritter's disease (staphylococcal scalded skin syndrome)	S		
Rocky Mountain spotted fever	S		Not transmitted from person to person except through transfusion, rarely
Roseola infantum (exanthem subitum; caused by HHV-6)	S		
Rotavirus infection (see gastroenteritis)			

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Rubella (German measles) ( also see congenital rubella)	D	U 7 days after onset of rash	Susceptible HCWs should not enter room if immune caregivers are available. Wear nose/mouth protection e.g., surgical mask, regardless of immune status.
Rubeola (see measles)			
Severe acute respiratory syndrome (SARS)	All, D,C	DI plus 10 days after resolution of fever, provided respiratory symptoms are absent or improving	All preferred; D if All rooms unavailable. N95 or higher respiratory protection; surgical mask if N95 unavailable; eye protection (goggles, face shield); aerosol-producing procedures and “supershedders” highest risk for transmission; vigilant environmental disinfection ( see <a href="http://www.cdc.gov/ncidoc/sars">www.cdc.gov/ncidoc/sars</a> )
Salmonellosis (see gastroenteritis)			
Scabies	C	U 24	
Scalded skin syndrome, staphylococcal (Ritter's disease)	S		Contact Precautions for 24 hours after initiation of effective therapy if outbreak within a unit
Schistosomiasis (bilharziasis)	S		
Shigellosis (see gastroenteritis)			
Smallpox (variola; see vaccinia for management of vaccinated persons)	All,C	DI	Until all scabs have crusted and separated (3-4 weeks). Non-vaccinated HCWs should not provide care when immune HCWs are available; N95 or higher respiratory protection required for susceptible and successfully vaccinated individuals; postexposure vaccine within 4 days of exposure protective.
Sporotrichosis	S		
<i>Spirillum minus</i> disease (rat-bite fever)	S		
Staphylococcal disease ( <i>S aureus</i> )			
Skin, wound, or burn			
Major <sup>a</sup>	C	DI	No dressing or dressing does not contain drainage adequately
Minor or limited <sup>b</sup>	S		Dressing covers and contains drainage adequately
Enterocolitis	S		Use Contact Precautions for diapered or incontinent children for duration of illness
Multidrug-resistant (see multidrug-resistant organisms)			

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Pneumonia	S		
Scalded skin syndrome	S		
Toxic shock syndrome	S		
<i>Streptobacillus moniliformis</i> disease (rat-bite fever)	S		Not transmitted from person to person
Streptococcal disease (group A streptococcus)			
Skin, wound, or burn			
Major	C	U 24 hrs	No dressing or dressing does not contain drainage adequately
Minor or limited	S		Dressing covers and contains drainage adequately
Endometritis (puerperal sepsis)	S		
Pharyngitis in infants and young children	D	U 24 hrs	
Pneumonia in infants and young children	D	U 24 hrs	
Scarlet fever in infants and young children	D	U 24 hrs	
Serious invasive disease, e.g. necrotizing fasciitis, toxic shock syndrome	D	U24 hrs	Contact Precautions for draining wound as above; follow rec. for antimicrobial prophylaxis in selected conditions (409)
Streptococcal disease (group B streptococcus), neonatal	S		
Streptococcal disease (not group A or B) unless covered elsewhere	S		
Multidrug-resistant (see multidrug-resistant organisms)			
Strongyloidiasis	S		
Syphilis			
Latent (tertiary) and seropositivity without lesions	S		
Skin and mucous membrane, including congenital, primary, secondary	S		
Tapeworm disease			
<i>Hymenolepis nana</i>	S		Not transmitted from person to person
<i>Taenia solium</i> (pork)	S		
Other	S		
Tetanus	S		Not transmitted from person to person
Tinea (e.g., fungus infection, dermatophytosis, dermatomycosis, ringworm)	S		
Toxoplasmosis	S		

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Toxic shock syndrome (staphylococcal disease, streptococcal disease)	S		
Trachoma, acute	S		
Trench mouth (Vincent's angina)	S		
Trichinosis	S		
Trichomoniasis	S		
Trichuriasis (whipworm disease)	S		
Tuberculosis ( <i>M. tuberculosis</i> )			
Extrapulmonary, draining lesion including scrofula)	All,C		Discontinue precautions only when patient is improving clinically, and drainage has ceased or there are three consecutive negative cultures of continued drainage (495, 496). Examine for evidence of active pulmonary tuberculosis.
Extrapulmonary, no draining lesion, meningitis	S		Examine for evidence of pulmonary tuberculosis.
Pulmonary or laryngeal disease, confirmed	All		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.
Pulmonary or laryngeal disease, suspected	All		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
Skin-test positive with no evidence of current active disease	S		
Tularemia			BSL 2 laboratory only for processing cultures
Draining lesion	S		Not transmitted from person to person
Pulmonary	S		Not transmitted from person to person
Typhoid ( <i>Salmonella typhi</i> ) fever (see gastroenteritis)			
Typhus, endemic and epidemic	S		Not transmitted from person to person
Urinary tract infection (including pyelonephritis), with or without urinary catheter	S		
Vaccinia (vaccination site, adverse events following vaccination) *			Only vaccinated HCWs have contact with active vaccination sites and

## APPENDIX A

### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type <sup>*</sup>	Duration <sup>†</sup>	Comments
			care for persons with adverse vaccinia events; if unvaccinated, only HCWs without contraindications to vaccine may provide care.
Vaccination site care (including autoinoculated areas)	S		Vaccination recommended for vaccinators; for newly vaccinated HCWs: semi-permeable dressing over gauze until scab separates, with dressing change as fluid accumulates, ~3-5 days; gloves, hand hygiene for dressing change; vaccinated HCW or HCW without contraindication to vaccine for dressing changes.
Eczema vaccinatum	C	Until lesions dry and crusted, scabs separated	For contact with virus-containing lesions and exudative material
Fetal vaccinia	C		
Generalized vaccinia	C		
Progressive vaccinia			
Postvaccinia encephalitis	S		
Blepharitis or conjunctivitis	S/C		Use Contact Precautions if there is copious drainage
Iritis or keratitis	S		
Vaccinia-associated erythema multiforme (Stevens Johnson Syndrome)	S		Not an infectious condition
Secondary bacterial infection (e.g., <i>S. aureus</i> , group A beta hemolytic streptococcus)	S/C		Follow organism-specific (strep, staph most frequent) recommendations and consider magnitude of drainage
Varicella	All,C	Until lesions dry and crusted	Susceptible HCWs should not enter room if immune caregivers are available; wear nose/mouth protection regardless of immune status; no recommendation for type of protection, i.e. surgical mask or respirator; in immunocompromised host with varicella pneumonia, prolong duration of precautions after lesions crusted; post-exposure vaccine within 120 hours; VZIG within 96 hours for post-exposure prophylaxis for susceptible exposed persons for whom vaccine is contraindicated, including immunocompromised persons, pregnant women, newborns whose mother's varicella onset is ≤5days before delivery or within 48 hrs after delivery
Variola (see smallpox)			
<i>Vibrio parahaemolyticus</i> (see gastroenteritis)			
Vincent's angina (trench mouth)	S		

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### TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Viral hemorrhagic fevers due to Lassa, Ebola, Marburg, Crimean-Congo fever viruses	All, C	DI	Add eye protection, double gloves, leg and shoe coverings, and impermeable gowns, according to hemorrhagic fever specific barrier precautions. See Table 4. Notify public health officials immediately if Ebola is suspected (47, 657) ( <a href="http://www.bt.cdc.gov">www.bt.cdc.gov</a> )
Viral respiratory diseases (not covered elsewhere)			
Adults	S		
Infants and young children (see respiratory infectious disease, acute)			
Whooping cough (see pertussis)			
Wound infections			
Major	C	DI	No dressing or dressing does not contain drainage adequately
Minor or limited	S		Dressing covers and contains drainage adequately
<i>Yersinia enterocolitica</i> gastroenteritis (see gastroenteritis)			
Zoster (varicella-zoster) (see herpes zoster)			
Zygomycosis (phycomycosis, mucormycosis)	S		

Type of Precautions: All, Airborne Infection Isolation; C, Contact; D, Droplet; S, Standard; when A, C, and D are specified, also use S.

† Duration of precautions: CN, until off antimicrobial treatment and culture-negative; DI, duration of illness (with wound lesions, DI means until wounds stop draining); DE, until environment completely decontaminated; U, until time specified in hours (hrs) after initiation of effective therapy;

Unknown: criteria for establishing eradication of pathogen has not been determined.

## Appendix B. Management of MDROs in Healthcare Settings

**I. Epidemiology.** Multidrug-resistant organisms (MDROs) targeted currently for control in healthcare facilities include methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant enterococci (VRE), and certain gram-negative bacilli (GNB), including those producing extended spectrum beta lactamases (ESBLs) and others that are resistant to all but one class of antimicrobial agents (e.g., strains of *Acinetobacter baumannii* resistant to all antimicrobial agents except imipenem) (75, 76, 78-80) or that are intrinsically resistant to the broadest spectrum agents (e.g., *Stenotrophomonas maltophilia* (81-84) or *Burkholderia cepacia* (221, 222, 658). The clinical, logistical, and financial impacts of the emergence and prevalence of a specific MDRO are important factors that determine healthcare facility prioritization of MDRO control programs.

**Variation in MDRO prevalence.** Prevalence of MDROs varies temporally, geographically, and by healthcare setting. For example, VRE emerged in the eastern United States in the early 1990s but did not appear in the western United States until several years later. Recent surveys have indicated that nonsusceptible *Streptococcus pneumoniae* (NSSP) are more prevalent in the eastern United States (659). In general, urban areas report higher frequencies of resistant microbes than do rural areas, presumably reflecting the influence of tertiary care centers and frequent admissions of colonized or infected patients to multiple facilities in a city. The type and level of care also influence the prevalence of MDROs. Intensive care units (ICU), especially those in urban areas and tertiary care facilities, have a higher prevalence of MDRO infections than do small community hospitals or long-term care facilities (LTCFs) (129, 130). High rates of MRSA, VRE, and ESBL-producing *Klebsiella pneumoniae* and *Eschericia coli* colonization prevail in some, but not all, LTCFs; however, the frequency of clinical infection with these pathogens is lower in LTCFs than in acute care hospitals (160, 164, 165, 168, 605, 660).

During the last several decades, the prevalence of MDROs in U.S. hospitals and medical centers has increased steadily. MRSA was first isolated in the United States in 1968. In the early 1990s, MRSA accounted for 20%-25% of *Staphylococcus aureus* isolates from hospitalized patients (575). By 1999, MRSA accounted for >50% of *S. aureus* isolates from patients in ICUs in the National Nosocomial Infection Surveillance (NNIS) system (128)

and in 2002, 57.1% of *S. aureus* isolates in NNIS ICUs were MRSA (144). A similar rise in prevalence has occurred with VRE. From 1990 to 1997, the prevalence of VRE in isolates of enterococci from hospitalized patients increased from <1% to approximately 15% (62). By 1999, almost 25% of enterococcal isolates obtained from patients in NNIS ICUs were VRE (128) and in 2002, 28% of enterococcal isolates in NNIS ICUs were VRE (144).

GNB resistant to ESBLs, fluoroquinolones, carbapenems, and aminoglycosides also have increased in frequency. For example, in 1997, 6.6% of *Klebsiella pneumoniae* isolates from U.S. bloodstream infections were resistant to ceftazidime and other third-generation cephalosporin antibiotics (62). Similarly, in 1999, 23% of *Pseudomonas aeruginosa* isolates in ICUs were resistant to fluoroquinolone antibiotics (130). A 3-month survey of 15 Brooklyn hospitals in 1999 found that 53% of *A. baumannii* strains exhibited resistance to carbapenem and 24% of *P. aeruginosa* strains were resistant to imipenem (77). Finally, in a national review of 35,790 non-duplicate gram-negative aerobic isolates from ICU patients in 43 states during 1994-2000, the activity of most antimicrobial agents showed a decrease in susceptibility of 6% or less over the study period. The overall susceptibility to ciprofloxacin decreased from 86% to 76% and was associated significantly with an increased use of fluoroquinolones in the United States (68).

An analysis of temporal trends in antimicrobial resistance in 23 U.S. hospitals during 1996-1997 and 1998-1999 (549) found significant increases in the prevalence of resistant isolates in non-ICU patients but only for MRSA, ciprofloxacin-resistant *P. aeruginosa* and ciprofloxacin- or ofloxacin-resistant *E. coli*. These increases may be a result of selective pressure exerted by exposure to antimicrobial agents outside of the ICU and/or in the community, poor adherence to infection control practices, or both.

**MDRO-associated morbidity and mortality.** In most instances, MDRO infections have similar clinical manifestations of disease and virulence comparable to infections caused by susceptible pathogens. Although ensuring adequate matching in comparisons of patients infected with MDROs and control patients is problematic, several studies have reported an association between MDRO infections and increased morbidity and mortality, length of stay, and healthcare costs. This is particularly true of MRSA. Some hospitals have observed an increase in the overall occurrence of staphylococcal infections following the introduction of MRSA (248, 546, 661). In addition, when compared with methicillin-

susceptible *S. aureus* (MSSA), higher case fatality rates have been observed for MRSA bacteremias (662-666), poststernotomy mediastinitis (667), and surgical site infections (668). Mortality may be further increased by *S. aureus* with reduced vancomycin susceptibility (VISA) (MIC  $\geq 4$   $\mu\text{g/ml}$ ) (67). MRSA infections also result in increased costs and lengths of stay (669-673). Therefore, strategies to reduce MRSA transmission may yield cost savings for individual facilities (508, 546, 600, 673, 674).

Increased lengths of stay also have been associated with other MDROs (551). Two published studies documented increased mortality, hospital stays, and hospital charges associated with MDR-GNBs: a neonatal intensive care unit (NICU) outbreak of ESBL-producing *K. pneumoniae* (675) and emergence of third-generation cephalosporin resistance in *Enterobacter* spp. in hospitalized adults (676). Vancomycin resistance has been reported to be an independent predictor of death from enterococcal bacteremia (677-680). Furthermore, VRE was associated with increased mortality, length of hospital stay, admission to the ICU, surgical procedures, and costs when VRE patients were compared with a matched hospital population (396). Data are conflicting concerning the potential association of specific virulence factors (e.g., enterococcal surface protein [esp], gelatinase, and hemolysin) with mortality due to enterococcal bacteremia in humans (681-683). However, a strong association has been demonstrated between the presence of the variant *esp*-gene and strains from hospital outbreaks and clinical infections among patients with both vancomycin-resistant *Enterococcus faecium* and vancomycin-susceptible *E. faecium* has been demonstrated (684). The association between the presence of the variant *esp*-gene and enhanced adherence capacities to uroepithelial cells and biofilm formation may explain its role as a virulence factor.

**Reservoirs for MDRO transmission.** MDROs are introduced most often into healthcare settings in two ways: 1) via colonized or infected patients and 2) as a result of antibiotic selective pressure that confers advantages to organisms possessing resistance mechanisms gained through either mutation or gene transfer (53, 170, 685, 686). The rapid increase in prevalence of MRSA and VRE is primarily the result of transmission from colonized or infected patients to other patients who, in some cases, were rendered susceptible by the suppressive effects of antimicrobial therapy on their normal flora (87). The emergence of multidrug-resistant gram-negative bacilli (MDR-GNB) is more likely due

to the emergence of resistance via genetic changes induced by antimicrobial selective pressure, but patient-to-patient transmission for these pathogens also is well documented (382, 384, 687-690).

Once MDROs enter a healthcare setting, the availability of vulnerable patients, selective pressure exerted by antimicrobial use, “colonization pressure” (i.e., increased transmission resulting from the presence of larger numbers of colonized or infected patients (440, 691), and the implementation and success of prevention efforts determine the likelihood of transmission and persistence of MDROs. Patients vulnerable to colonization and infection include those with severe disease, especially those with compromised host defenses from underlying medical conditions; recent surgery; or indwelling medical devices, e.g., urinary catheters or endotracheal tubes (689). As a rule, risk factors are more numerous in hospitalized than nonhospitalized patients, especially those in ICUs, where infection rates tend to be highest. For VRE, the risk of acquisition in an ICU increases significantly once colonization rates or numbers of VRE-patient days of exposure in an ICU exceed a defined threshold (e.g., 50% (440) or 15 patient days (621). A similar effect of colonization pressure has also been demonstrated for MRSA in a medical ICU (691).

Most MDROs are carried from one person to another via the hands of healthcare workers (HCWs) (6, 86-88, 687, 692) which can be easily contaminated during the process of care-giving or having contact with environmental surfaces in close proximity to the patient (338). The latter is especially important when patients have diarrhea and the reservoir of the MDRO is the gastrointestinal tract (335, 337). Without appropriate hand hygiene and glove use, contact with colonized or infected patients or the environment of care may result in transmission of MDROs to other vulnerable patients. Since MDRO transmission occurs by the same routes as antimicrobial susceptible pathogens, **MDRO transmission becomes a sentinel event for identifying breaches in infection control practice.** Occasionally, HCWs become persistently colonized with MDROs, but such workers have a minimal role in transmission unless factors that facilitate transmission are present (e.g., chronic sinusitis (693), upper respiratory infection (623), presence of artificial nails (320-322)).

***Implications of community-onset MRSA.*** The complex relationship between community-onset and healthcare-associated MRSA further complicates the design of effective control strategies. Genetic analyses of MRSA strains from hospitals worldwide

revealed that a relatively small number of MRSA clones have unique qualities that facilitate their transmission from patient to patient within healthcare facilities over wide geographic areas (694). These clones contain the staphylococcal chromosomal cassette (SCC) *mec* types I, II, and III, which encode for resistance to all beta-lactam agents and other classes of antibiotics. A very different mechanism of MRSA resistance occurs in the community. As the prevalence of community-onset MRSA (CO-MRSA) infections increased within certain populations (e.g., children (174-178, 695), prisoners (198, 696, 697), and Alaskan natives (698), the following distinct characteristics challenged the concept that these community-onset strains were merely hospital-acquired strains that had drifted into the community: 1) lack of traditional risk factors associated with healthcare; 2) lack of multi-drug resistance; and 3) proclivity for skin infections. Additionally, a unique cytotoxin, Panton-Valentine leukocidin (PVL), that causes tissue necrosis was more frequently associated with CO-MRSA strains than with healthcare-associated strains (699). Identification in CO-MRSA strains from different geographic locations of a unique SCC *mec* type IV that was small and highly mobile and did not carry any of the multiple antibiotic resistance genes associated with types II and III suggests that CO-MRSA infections are emerging *de novo* outside of healthcare facilities, possibly in response to antibiotic exposure (696, 700, 701). Thus, control of MRSA transmission within healthcare facilities may have a limited effect on the prevalence of CO-MRSA. The extent of transmission of CO-MRSA within healthcare settings (477) and of healthcare strains within the community remains to be determined.

**II. MDRO Prevention and Control.** The medical literature provides many examples of successful MDRO control from countries outside the United States as well as from healthcare coalitions and individual facilities within the United States. Representative studies include:

- Reduced rates of MRSA transmissions in The Netherlands, Belgium, Denmark, and other Scandinavian countries after implementation of aggressive and sustained infection control measures (i.e., active surveillance cultures and placement on Contact Precautions at the time of admission until proven culture negative and, in some instances, closing units to new admissions) to combat MRSA in many of their healthcare facilities (616, 702-705).

- Reduced rates of VRE transmission in healthcare facilities in the three-state Siouxland region (Iowa, Nebraska, South Dakota) following formation of a coalition and development of an effective community-wide infection control plan (459).
- Eradication of endemic MRSA infections over a 65 month period from two NICUs: in the first, with implementation of a combination of strategies, including active surveillance cultures, Contact Precautions, use of triple dye applied to the umbilical cord, and systems changes to improve surveillance and adherence to recommended practices and to reduce over-crowding (248); and in the second, with the use of active surveillance cultures, and Contact plus Droplet Precautions (539).
- Eradication of VRE from a burn unit with implementation of multiple control measures over a 13-month period (518).
- Eradication of MDR-strains of *A. baumannii* from a burn unit with implementation of multiple control measures over a 16-month period (78).

In addition, more than 100 reports published during 1982-2003 support the efficacy of various control measures and strategies to reduce the burden of MRSA, VRE, and MDR-GNBs (Tables B-1, B-2). Reduced case rates or eradication of the pathogen was reported in a majority of studies for VRE (79%), MRSA (100%), and MDR-GNB (93%). VRE was eradicated in seven specialized units (391, 404, 518, 522, 544, 589, 613), one hospital (525), and one LTCF (555); MRSA, in nine special care units (248, 315, 316, 397, 539, 560, 598, 612, 706), one hospital (562), and one LTCF (560), and a MDR-GNB in 12 special units (75, 76, 78, 389, 394, 524, 538, 540, 543, 564, 626, 627) and two hospitals (79, 561).

Four MRSA reports describe continuing success in sustaining low endemic MDRO rates in excess of 5 years (397, 546, 577, 586). In each of these reports, strategies for managing MRSA evolved and changed over time as new challenges to control emerged. Another report describes ongoing success in maintaining low rates of VRE colonization and infection over a 5 year period, but the graphic representation of the data in that report does not support this conclusion (583).

**III. Overview of Control Measures.** The various types of practices that have been used to control or eradicate MDROs may be grouped into the following seven categories and are

the basis of the recommendations for control of MDROs in healthcare settings (Tables B3-6).

**Administrative support and intervention measures.** Several investigators have indicated that administrative support was an important factor in the success of their MDRO control programs (240, 248, 299, 518, 520, 574, 588), and authorities in infection control strongly recommend such support (6, 53, 87, 196, 297, 300). Use of active surveillance cultures as an intervention is a strategy requires administrative commitment of fiscal and human resources (75, 78, 87, 248, 336, 358, 371, 387, 395, 486, 510, 513, 518, 520, 537, 539, 546, 560, 568, 574, 598-601, 707). Other system issues that require administrative support include 1) prompt and effective communications (e.g., computer alerts to identify patients previously known to be colonized/infected with MDROs) (358, 510, 511, 574); 2) provision of appropriate numbers and placement of handwashing sinks and alcohol-containing handrub dispensers (6); 3) maintenance of staffing levels appropriate to the intensity of care required (241, 246, 248, 249, 252-255, 257, 584, 585); and 4) enforcement of adherence to recommended infection control precautions for MDRO control. Direct observation with feedback to HCWs on adherence to recommended precautions and feedback on changes in transmission rates have been associated with a positive impact on prevention efforts (240, 248, 299, 312, 393, 508, 511, 512, 548).

**Education.** Facility-wide or unit-targeted educational campaigns were included in several successful intervention studies (240, 248, 358, 382, 395, 510, 513, 520, 588). Campaigns to enhance adherence to hand hygiene practices have been associated temporally with sustained decreases in MDRO transmission, in both high- and low-risk healthcare settings (6, 163, 555, 559).

**Judicious use of antimicrobial agents.** A temporal association between formulary changes and decreased occurrence of a target MDRO was found in several studies, especially in those that focused on MDR-GNBs (128, 380, 382, 384-386, 393, 395, 402, 403, 533). Although some MRSA and VRE control efforts have attempted to limit antimicrobial use, the relative importance of this measure for controlling these MDROs remains unclear (358, 395, 399, 520). Failure to control resistance through antimicrobial restrictions may be the result of a combination of factors, including 1) the role of antimicrobials in inducing selective pressure initially, rather than perpetuating resistance

once it has emerged; 2) inadequate extent of restrictions; or 3) insufficient time to observe the impact of this intervention.

The CDC Campaign to Prevent Antimicrobial Resistance that was launched in 2002 provides evidence-based principles for judicious use of antimicrobials ([www.cdc.gov/drugresistance/healthcare](http://www.cdc.gov/drugresistance/healthcare)). Programs have been developed for hospitalized adults, surgical patients, dialysis patients, hospitalized pediatric patients and for residents in long term care facilities. This promotional effort targets all healthcare settings and focuses on effective antimicrobial treatment of infections, use of narrow spectrum agents, treatment of infections and not contaminants, limiting duration of therapy whenever possible, and restricting use of broad-spectrum or new, more potent antimicrobials to treatment of serious infections when no other active agents are available. Achievement of these objectives would likely diminish the selective pressure that favors proliferation of MDROs. Strategies for influencing antimicrobial prescribing patterns within the hospital include education; formulary restriction; prior-approval programs, including pre-approved indications; stop orders; academic detailing; antimicrobial cycling (595, 708, 709); computer-assisted management programs (590, 591, 594), and active efforts to reduce use of redundant antimicrobial combinations (593).

**Surveillance.** Many MDRO control reports include initiation of active surveillance cultures when new pathogens emerge in order to define the epidemiology of the particular agent (63, 64, 87, 557, 710) and when continued transmission of a target MDRO is apparent, despite implementation of basic infection control measures. This is especially important for MRSA and VRE because clinical cultures detect only a small proportion of patients who could potentially transmit these MDROs to other patients (75, 78, 87, 248, 336, 358, 371, 387, 395, 459, 486, 510, 518, 520, 537, 539, 546, 560, 568, 574, 598-601). Surveillance cultures to detect colonization or transmission were implemented in 67% to 97% of the studies reviewed (Table B-2). This approach requires several types of support and represents a series of interventions: 1) personnel to obtain the proper culture; 2) microbiology laboratory personnel to process the culture; 3) communication of results to caregivers; and 4) concurrent decisions about continuing or implementing additional isolation measures. The continuous use of active surveillance cultures has been described

only in acute care hospitals and only in the context of attempting to control an outbreak or reduce endemic levels.

Protocols for specimen collection vary. Some hospital programs have obtained cultures from patients upon admission to the hospital or at the time of transfer to or from designated units (e.g., ICU) (75), in other studies, cultures were obtained from patients on a periodic basis (e.g., weekly (589) or at varying intervals (546)) to detect silent transmission. The authors of several studies concluded that active surveillance, in combination with Contact Precautions and increased attention to infection control practices contributed directly to the decline or eradication of the target MDRO (78, 87, 395, 441, 539, 546, 574). The specific aspects of this series of interventions that were responsible for these outcomes, e.g., presence of personnel obtaining surveillance cultures, reporting of results to clinical staff, use of Contact Precautions, reduced number of personnel entering the rooms, increased number of staff, has not been studied. In contrast, one report did not find surveillance cultures for MDR-GNBs to be an effective infection control strategy in the absence of an outbreak (606).

Sites selected for surveillance cultures in various studies reflect the epidemiology of the specific MDRO, e.g., skin wounds and nares for MRSA (248, 546) and stool or perirectal swabs for VRE and MDR-GNBs (395, 518, 606). Some MDRO reports describe surveillance cultures of healthcare workers during outbreaks, but colonized or infected healthcare workers are rarely the source of ongoing transmission (78, 248, 371, 486, 518, 539, 573). Finally, some control efforts have found ongoing population-based calculation and analysis of incidence and prevalence rates and molecular typing of selected isolates to confirm clonal transmission useful for monitoring changes in MDRO transmission (78, 248, 320, 358, 371, 477, 537, 546, 547, 687, 690, 706).

**Standard and Contact Precautions.** No studies have directly compared Standard Precautions alone and Standard Precautions plus Contact Precautions combined with active surveillance cultures for control of MDROs. Some reports mention the use of one or both sets of precautions as part of successful MDRO control efforts; however, the precautions were not the primary focus of the intervention (169, 315, 382, 385, 537, 548, 578, 579). Standard Precautions has an essential role in preventing MDRO transmission, even in facilities that use Contact Precautions for patients with an identified MDRO.

Colonization with MDROs is frequently undetected, and even surveillance cultures may fail to identify colonized persons due to lack of sensitivity, laboratory deficiencies, or intermittent colonization due to antimicrobial therapy (441). Therefore, Standard Precautions must be relied on to prevent transmission in these patients. Hand hygiene is an important component of Standard Precautions. In the *Guideline for Hand Hygiene in Healthcare Settings* (6), the authors cite nine studies that demonstrated a temporal relationship between improved adherence to recommended hand hygiene practices and control of MDROs at the same time that other control measures remained in place.

MDRO control efforts frequently involve changes in isolation practices, especially in outbreaks. In 66% to 87% of reports reviewed, healthcare facilities adopted Contact Precautions for MDRO control (see Table B-2). In general, Contact Precautions was implemented for all patients colonized or infected with the target MDRO. However, some facilities used Contact Precautions for new admissions until their screening cultures returned and were negative for the target MDRO (620) or for all patients admitted to a specific unit (341). The barriers used in Contact Precautions may prevent transmission, but their use may also draw attention to the need for hand hygiene, a good effect, or reduce staff contact with patients a poor effect. The frequency of hand hygiene was not improved with the use of Contact Precautions but was improved when only gloves were worn for routine contact with MDRO patients (711),

Three studies evaluated the use of gloves with or without gowns for all patient contacts to prevent VRE acquisition in ICU settings. However, they yielded disparate results and their differing methodologies made comparisons difficult (341, 620, 621). Specifically, healthcare worker adherence to the recommended regimen, influence of added precautions on the number of HCW-patient interactions, and colonization pressure were not assessed consistently in all studies.

Approaches to control MDRO transmission during outbreaks reflect a hierarchy of measures that have been implemented stepwise, based on the outcome of initial efforts. In several reports, cohorting of patients (75, 78, 248, 335, 385, 387, 395, 574) and in some instances staff (361, 387, 395, 574), use of designated beds or units (520, 574), and even unit closure (78, 525, 587, 589, 615, 616) as the extreme were necessary to control transmission. Some studies have presented the latter two strategies as the turning points in

their control efforts; however, the measures usually followed in the wake of many other actions to prevent dissemination, making it difficult to assess their utility.

**Environmental measures.** Some studies have focused on potential reservoirs for transmission of VRE and other MDROs in the inanimate environment. In several studies, environmental cultures were used to document contamination and led to interventions that included use of dedicated noncritical medical equipment (78, 395), assignment of dedicated cleaning personnel to the affected patient care unit (75, 358, 395, 401, 518, 588, 589), and special attention to cleaning and disinfection of high-touch surfaces e.g., bedrails, charts, bedside commodes, doorknobs) with monitoring of adherence to recommended practices (2, 4, 479, 480, 628). Rarely, control of the target MDRO was not achieved until patient care units were vacated for complete environmental cleaning and assessment (394, 512, 615). The more frequent explanation for environmental contamination and transmission of an MDRO was a failure to follow routine cleaning and disinfection practices rather than the failure of the recommended practices. Thus, in settings where the prevalence of MDROs is stable and low, an increased focus on environmental cultures and cleaning to control MDROs is not warranted. Adherence to routine cleaning, sterilization, and disinfection practices, as recommended in the Guideline for Environmental Infection Control in Healthcare Facilities (4) and the Guideline for Disinfection and Sterilization in Healthcare Facilities (in preparation) (7), should suffice under such conditions. Monitoring for adherence is likely to be an important determinant for success in controlling transmission of MDROs and other pathogens in the environment.

**Decolonization.** Decolonization entails treatment of colonized persons to eradicate carriage of MDROs. Although some investigators have attempted to decolonize patients harboring VRE (399) and MDR-GNB, few have achieved success. However, decolonization of persons carrying MRSA in their nares has proved possible with several regimens, including topical mupirocin alone or in combination with orally administered antibiotics (e.g., rifampin in combination with trimethoprim- sulfamethoxazole or ciprofloxacin) plus the use of an antimicrobial soap for bathing (630). In one report daily baths accompanied nasal therapy with mupirocin for 3 days with povidone-iodine for 3 days (487).

Most healthcare facilities coping with MDROs have limited the use of decolonization to MRSA outbreaks or other high prevalence situations, especially those affecting special

care units. Identification of candidates for decolonization requires surveillance cultures. Those considering this approach must also choose carefully the recipients and decolonization regimen(s) and perform follow-up cultures to document eradication. Recolonization with the same strain, initial colonization with a mupiricin-resistant strain, and emergence of resistance to mupiricin during treatment limit the utility of this control measure on a widespread basis (444, 630, 633, 637, 712). HCWs implicated in transmission of MRSA are prime candidates for decolonization and should be culture negative before returning to work. This use of mupiricin prophylaxis must be distinguished from the use of mupiricin prophylaxis in selected groups of patients at high risk for *S. aureus* infections in whom clinical and cost effectiveness have been demonstrated (e.g., dialysis patients (632), but in whom emergence of resistance remains a consideration.

**IV. Perspectives on the MDRO control literature.** More than 100 reports published during 1982-2003 testify to the importance of dedicated and knowledgeable teams of healthcare professionals who are willing to persist for years if necessary, to control MDROs. Eradication and control of MDROs often required periodic reassessment of control measures and the addition of new and more stringent measures when previous measures were failing. For example, interventions were added to control measures in a stepwise fashion during a 3-year effort that eventually eradicated MRSA from a NICU in Dallas (248). A series of interventions were adopted throughout the course of a year to eradicate VRE from a burn unit (518). Similarly, eradication of carbapenem-resistant strains of *A. baumannii* from a New York City hospital required multiple and progressively more intense interventions over several years (79). However, it has not been possible to determine the effectiveness of individual interventions or a specific combination of interventions that would be appropriate for all healthcare facilities due to the following considerations:

**Methods.** Despite the volume of published studies on the control of MDROs, an appropriate set of evidence-based control measures has not been established with certainty due to methodological variations and limitations. For example, there is an absence of randomized, controlled trials comparing one MDRO control measure or strategy with another and a paucity of comparative studies i.e., studies using similar methodologies to evaluate competing control measures or strategies. The data are largely descriptive, experiential, and uncontrolled. Factors that challenge the interpretation of results include

differences in definitions, study design, endpoints and variables measured, and period of follow-up. Two-thirds of the reports involved perceived outbreaks, and one-third described efforts to reduce endemic transmission (Table B-1). None described preemptive efforts or prospective studies to control MDROs before they had become problematic in a facility.

Nearly all studies reporting successful MDRO control employed a median of 7 to 8 different measures concurrently or sequentially (Table B-1). These figures may underestimate the actual number of control measures used because authors of these reports may have considered their earliest efforts routine, e.g., added emphasis on handwashing, and not included them as interventions and some “single measures” are, in fact, a complex of several interventions, as noted above. The use of multiple concurrent control measures in these reports underscores the need for a comprehensive approach for controlling MDROs, but also makes it difficult to assess the value of any single component of these control programs. The shortcomings of published studies of MRSA control and their inadequacy to support national recommendations have been reviewed (722, 723).

**Accuracy of detection of patients colonized with target MDROs.** Rectal swabs identify only 60% of individuals harboring VRE (441). Cultures of the nares identify most patients with MRSA and perirectal and wound cultures can identify additional carriers (603, 604). However, there is a delay of 2-3 days before most MDRO surveillance culture results are available. Thus, the specific methods used for detection of individuals colonized with a target MDRO may account for variation in success of control programs.

**Impact of interventions on other MDROs.** Few studies report on the effect of colonization or infection with more than a single species of MDRO. Only one of the reports described control efforts directed at more than one MDRO, i.e., MDR-GNB and MRSA (512). However, two reports (525, 713) of VRE control efforts demonstrated a rise in MRSA following the prioritization of VRE patients to private rooms and cohort beds as part of a VRE control intervention. An outbreak of susceptible *Serratia marcescens* that was temporally associated with efforts to control an MRSA outbreak demonstrates the importance of monitoring for the impact on other pathogens when implementing a program that targets a single pathogen (158, 714) found that nearly 50% of residents in a skilled care unit were colonized with a target MDRO and that 26% were co-colonized with >1 MDRO; a detailed analysis showed that risk factors for colonization varied by pathogen in this study.

From a more overarching perspective, Safdar's review of the literature (715) reported that the same patient risk factors were associated with colonization with MRSA, VRE, MDR-GNB, *C. difficile* and *Candida* sp. This review of 74 published studies concluded that control programs that focus on only one organism or one antimicrobial drug are unlikely to succeed.

***Impact of MDRO control interventions on patient care and well-being.*** Another concern is the limited data regarding the impact of Contact Precautions on patients. Although additional work is needed, several studies have demonstrated adverse effects of Contact Precautions. One study (434) found that HCWs were two times less likely to enter the rooms of patients on Contact Precautions than those not on Contact Precautions. Similarly, Saint and colleagues found that attending physicians on a medical unit were approximately half as likely to examine patients on Contact Precautions compared with those not on Contact Precautions (35% vs. 73%,  $p < 0.001$ ); there was no difference for senior medical residents (84% versus 87%) (435). Two studies reported that use of private rooms and barrier precautions for MDRO patients increased their scores for anxiety and depression (436, 437). Another matched study found that patients with MRSA who were on Contact Precautions had significantly more preventable adverse events, expressed greater dissatisfaction with their treatment, and had less documented care than control patients who were not in isolation (233).

***Costs.*** Although several authors have argued for the cost-effectiveness of approaches that use active surveillance cultures (539, 599, 600, 607, 668, 673, 716), these arguments invariably rely on assumptions, projections, and estimated attributable costs of MDRO infections. To date, no studies have directly compared the benefits and costs associated with different MDRO control strategies.

***Feasibility.*** Smaller hospitals, LTCFs and ambulatory-care facilities may lack the on-site laboratory services needed to obtain active surveillance cultures in a timely manner. This factor and the need to provide appropriate psychosocial conditions for long-term residents could limit the applicability of an aggressive program based on obtaining active surveillance cultures and placing patients on Contact Precautions.

***Lack of national and local consensus on the optimal strategy to control MDROs.*** There are several controversies and lack of consensus concerning specific MDRO control strategies. These include the optimal use of active surveillance cultures in

management efforts (87, 717, 718) and indications for routine use of both gowns and gloves for the care of all ICU patients. The latter is largely due to conflicting results from observations of HCW adherence to recommended practices (341, 620, 621).

This lack of consensus is reflected in differences in recommendations among the various guidelines currently available that exhibit a spectrum of approaches, which their authors deem to be evidence-based. The guideline for control of MRSA and VRE approved by the Board of the Society for Healthcare Epidemiology of America (SHEA) in 2003 (87) occupies one end of this spectrum. It advocates an aggressive approach, especially in acute care facilities, with an emphasis on routine use of active surveillance cultures and Contact Precautions. However, this position paper does not address control of MDR-GNBs. In contrast, the guideline for LTCFs approved by the SHEA Board in 1996 exemplifies the other end of the spectrum (160). This guideline emphasizes Standard Precautions, relies on results of cultures obtained for clinical indications to monitor the problem, and provides for additional measures when the problem exceeds defined thresholds. Other guidelines for VRE and MRSA, e.g., those proffered by the Michigan Society for Infection Control ([www.msic-online.org/resource\\_sections/aro\\_guidelines](http://www.msic-online.org/resource_sections/aro_guidelines)), occupy a more intermediate position on the guideline spectrum, emphasizing consistent practice of Standard Precautions and tailoring the use of active surveillance cultures and Contact Precautions to local conditions and the presence of risk factors for transmission.

The magnitude of the MDRO problem, especially the emergence of vancomycin-resistant *S. aureus* (VRSA) that resulted from the transfer of the van A resistance gene from a VRE strain to an MRSA strain (66), understandably motivates those advocating the most aggressive approach (87), and in many situations this approach is needed and appropriate. Notwithstanding, the many factors that influence strategies to control MDROs, discussed below, argue against adoption of the most comprehensive methods as the sole approach to this problem. In addition, data are lacking to validate the necessity for an aggressive approach in LTCFs and outpatient healthcare settings. Therefore, individualized decisions to implement control programs that rely heavily on active surveillance cultures to define the MDRO reservoir must be made based on validated principles of MDRO epidemiology and control.

**V. Factors that influence selection of MDRO control measures.** Although some common management principles apply, the preceding evaluation of the literature indicates that no single approach to the control of MDROs is appropriate for all healthcare facilities. Many factors influence the choice of interventions to be applied within an institution, including:

**Differences in the specific MDRO prevalent within the institution.** Some facilities have an MRSA problem while others have ESBL-producing *Klebsiella pneumoniae*. Some facilities have no VRE colonization or disease; others have high rates of VRE colonization without disease; and still others have ongoing VRE outbreaks.

**Variability in colonization and infection rates.** The experiences of healthcare facilities with any given MDRO ranges from no prior identification of MDROs to prolonged, extensive outbreaks. Between these extremes, facilities may have low or high levels of endemic colonization and variable levels of infection.

**Differences in risk factors based on type of facility and/or the patient population served.** Larger, tertiary care hospitals have more patients at high risk for VRE and/or MRSA infection and the associated complications than do smaller, rural hospitals. Similarly, nursing home residents appear less likely to develop MDRO infections, despite high colonization rates, than do patients in acute care facilities (160, 164, 605, 660). Among the few studies performed in ambulatory healthcare settings, one study of adult outpatients in a primary care clinic (720) and one study of children attending a pediatric clinic (721) reported low prevalences of MRSA colonization, 0.2% and 3%, respectively, and it appears that MDRO transmission seldom occurs in those settings. However, patient-to-patient transmission of both *B. cepacia* and *P. aeruginosa* in cystic fibrosis clinics for both children and adults has been documented (221). Emergence of VRSA within the ambulatory setting demonstrates an important role for this setting in detection and prevention of transmission (63, 64, 66, 69)

**Levels of available infection control personnel (e.g., full-time or part-time) and microbiology laboratory resources (e.g., on- or off-site) and competing priorities for those resources** (243). An administrative decision to allocate necessary resources for control often requires demonstration of the potential or actual negative impact of MDROs within the institution.

**VI. Tiered Approach for Control of MDROs.** Details of several categories of interventions to control MDROs (Table B-3) have been discussed. These reports indicate that facilities confronting an MDRO problem selected a combination of control measures, implemented them, and reassessed their impact. In some cases new measures were added serially, to further enhance control efforts. This evidence indicates that the control of MDROs is a dynamic process that requires a systematic approach tailored to the problem and healthcare setting. Furthermore, the absence of evidence-based data and consensus suggests that flexibility is needed to prevent and control of MDRO transmission.

Detailed recommendations for MDRO control in all healthcare settings are delineated in **Part II. Recommendations (section V)** in the body of this guideline and are summarized in Tables B 3-6 in **Appendix B**. A multi-intervention, two-tiered approach is detailed in the table and permits each facility to maximize or minimize the various components of its MDRO control systems as changes in circumstance may dictate. Table B-3, which applies to all settings where healthcare is provided recommends a baseline level of MDRO control activity for all facilities to ensure recognition of MDRO problems, definition of institutional goals, involvement of healthcare administrators and provision of safeguards for managing unidentified carriers of MDROs. Tables B-4, B-5, and B-6 elaborate on modifications of the baseline level of control activities that may be necessary for LCTFs, ambulatory settings, and home care settings.

Once an MDRO problem emerges in any type of healthcare setting, facilities need to select additional control measures from the seven major categories of interventions presented in Table B-3. Decisions to intensify MDRO control activity arise from surveillance observations and assessments of the risk to patients in various settings. Accordingly, a number of problematic circumstances may trigger these decisions:

- Isolation of an MDRO from even one patient in a facility or special unit with a highly vulnerable patient population (e.g., an ICU, NICU, burn unit) that had previously not encountered that MDRO.
- Increased isolations of MDROs in a unit or facility, especially when associated with infectious morbidity.

In general, the combination of new or frequent MDRO isolation and patients at risk necessitates escalation of efforts to achieve or re-establish control, i.e., to reduce rates of

transmission to the lowest possible level. Ongoing surveillance determines whether selected control measures are efficacious or not.

**VII. Conclusions.** Decreasing the prevalence of MDROs and the impact of infection caused by these pathogens on patient outcomes requires that all healthcare facilities and agencies assume responsibility for the problem (52, 53); ([www.cdc.gov/drugresistance/healthcare/overview.htm](http://www.cdc.gov/drugresistance/healthcare/overview.htm)). Only by prioritizing the MDRO problem and allotting sufficient resources will healthcare facilities eradicate these pathogens or reduce their transmission to a minimum level. Commitment and support from organizational leadership are essential for successful control efforts (240, 296, 299, 300). Leadership must provide authority for targeting specific MDROs and adopting stricter control measures when needed. In addition, institutional administrators can authorize supplemental resources for infection control, including expert consultations, laboratory support, specialized products, adherence monitoring, and data analysis. Further, when organizational leaders participate in efforts to reduce MDRO transmission, infection control professionals find healthcare personnel more receptive and adherent to the recommended control measures (240).

**Table 1. Categorization of Reports about Control of MDROs in Healthcare Settings, 1982-2003**

<b>MDRO</b>	<b>MDR-GNB</b>	<b>MRSA</b>	<b>VRE</b>
No. of Studies Reviewed/category	29	33	38
<b>Types of Healthcare Facilities from which Study or Report Arose</b>			
No. (%) from academic facilities <sup>α</sup>	29 (100)	28 (85)	32 (84)
No. (%) from other hospitals	0	3 (10)	3 (8)
No. (%) from LTCFs	0	1 (3)	2 (5)
No. (%) from multiple facilities in a region	0	1 (3)	1 (3)
<b>Unit of Study for MDRO Control Efforts</b>			
Special unit <sup>β</sup>	19	13	19
Hospital	10	18	16
LTCF	0	1	2
Region	0	1	1
<b>Nature of Study or Report on MDRO Control<sup>χ</sup></b>			
Outbreak	21	18	27
Non-outbreak	8	15	11
<b>Total Period of Observation after Interventions Introduced</b>			
Less than 1 year	16	13	24
1-2 years	6	6	6
2-5 years	5	10	8
Greater than 5 years	2	4	
<b>Numbers of Control Measures Employed in Outbreaks/Studies</b>			
Range	2-12	0-11	1-12
Median	7	7	8
Mode	8	7	9

<sup>α</sup> Variably described as university hospitals, medical school affiliated hospitals, VA teaching hospitals, and, to a much lesser extent, community teaching hospitals

<sup>β</sup> Includes intensive care units, burn units, dialysis units, hematology/oncology units, neonatal units, neonatal intensive care units, and, in a few instances, individual wards of a hospital

<sup>χ</sup> Based on authors' description – if they called their experience an outbreak or not; authors vary in use of term so there is probable overlap between two categories

**Table 2. Control Measures for MDROs Employed in Studies Performed in Healthcare Settings, 1982-2003**

Focus of MDRO (No. of Studies)	MDR-GNB (n=29)	MRSA (n=33)	VRE (n=38)
No. (%) of Studies Using Control Measure			
Education of staff, patients or visitors	18 (62)	9 (27)	20 (53)
Emphasis on handwashing	15 (52)	20 (61)	8 (21)
Use of antiseptics for handwashing	8 (30)	12 (36)	15 (39)
Contact Precautions or glove use <sup>α</sup>	19 (66)	25 (76)	33 (87)
Private Rooms	4 (15)	9 (27)	10 (27)
Segregation of cases	4 (15)	3 (9)	5 (14)
Cohorting of Patients	10 (34)	11 (33)	13 (35)
Cohorting of Staff	2 (7)	5 (15)	8 (22)
Change in Antimicrobial Use	12 (41)	1 (3)	16 (42)
Surveillance cultures of patients	18 (67)	32 (97)	35 (92)
Surveillance cultures of staff	9 (31)	7 (21)	7 (19)
Environmental cultures	14 (48)	14 (42)	14 (37)
Extra cleaning & disinfection	10 (34)	7 (21)	19 (50)
Dedicated Equipment	5 (17)	0	12 (32)
Decolonization	3 (10)	23 (70)	4 (11)
Ward closure to new admission or to all patients	6 (21)	4 (12)	5 (14)
Other miscellaneous measures	6 (22) <sup>β</sup>	9 (27) <sup>χ</sup>	16 (42) <sup>δ</sup>

<sup>α</sup> Contact Precautions mentioned specifically, use of gloves with gowns or aprons mentioned, barrier precautions, strict isolation, all included under this heading

<sup>β</sup> includes signage, record flagging, unannounced inspections, selective decontamination in a small number of studies (1 to 4 studies employing any of these measures)

<sup>χ</sup> includes requirements for masks, signage, record tracking, alerts, early discharge, and preventive isolation of new admissions pending results of screening cultures (1 to 3 studies employing any of these measures)

<sup>δ</sup> includes computer flags, signage, requirement for mask, one-to-one nursing, changing type of thermometer used, and change in rounding sequence (1 to 6 studies employing any of these measures)

**References for Tables B-1 and B-2:**

**MDR-GNBs** (75, 76, 78, 79, 380, 382, 384, 385, 389, 392-394, 400, 510, 512, 524, 531, 537, 538, 540, 543, 561, 564, 606, 608, 614, 626, 627, 658)

**MRSA** (248, 315, 316, 397, 444, 486, 487, 508, 511, 512, 520, 539, 546-548, 560, 562, 573, 577, 579, 586-588, 598, 609, 610, 612, 615, 625, 706, 724-726)

**VRE** (240, 317, 335, 336, 341, 358, 381, 383, 386, 387, 391, 395, 398, 401, 404, 459, 518, 519, 522, 523, 525, 533, 544, 545, 555, 559, 574, 583, 589, 601, 613, 617, 620, 621, 727-730)

**Table B-3. Summary of Recommended Measures for the Prevention and Control of MDROs**

Administrative Measures/Adherence Monitoring	MDRO Education	Judicious Antimicrobial Use	Surveillance	Infection Control Precautions to Prevent Transmission	Environmental Measures	Decolonization
<p>Designate MDRO prevention/control an organizational priority with administrative support and resource allocation (IB)</p> <p>Implement/maintain systems to communicate information about reportable MDROs to administrative personnel and state/local health departments (IC/II)</p> <p>Implement/maintain a multi-disciplinary program to improve adherence to recommended practices for hand hygiene, Standard/ Expanded Precautions, including feedback (IB)</p> <p>Implement/maintain communication systems to notify receiving HCWs when known patients with MDROs are transferred (IB)</p>	<p>Include MDRO education in the required curriculum of all healthcare worker professional training programs (II)</p> <p>Provide education and training on transmission risks and prevention of MDRO transmission to patient care personnel during orientation and periodic educational updates, including information on organizational experience, goals (IB)</p>	<p>Implement a system to <u>prompt</u> prescribers to verify that prescribed antibiotics are active against the patient's clinical isolates (IB)</p> <p>Avoid treating colonization (II)</p> <p>In hospitals and LTCFs, ensure that a multi-disciplinary committee reviews antimicrobial utilization patterns and compares them with resistance patterns for purposes of minimizing selective pressure and providing appropriate antimicrobial coverage (IB/IC)</p>	<p>Establish laboratory-based systems to detect and communicate evidence of MDROs in clinical isolates (IB)</p> <p>Prepare and monitor facility-specific and high-risk unit-specific antimicrobial susceptibility reports. Provide physicians with summary reports. If microbiology services are outsourced, request local or regional aggregate susceptibility trends (IB)</p> <p>Notify infection control of novel resistance patterns, e.g., VISA, VRSA (IB/IC)</p> <p>Develop local, regional coalitions to share resistance data via health depts (II)</p> <p>Identify specific MDROs (e.g., MRSA, VRE, MDR-GNBs) for systematic monitoring through review of susceptibility trends (IB)</p> <p>Determine prevalence and define frequency of MDROs that would trigger intensification of MDRO control (IB)</p>	<p>Observe Standard Precautions during all patient encounters on assumption any patient could be colonized with an MDRO (IB/IC)</p> <p>Prioritize known MDRO patients for single patient rooms or placement with like MDRO, or low-risk patient (IB)</p> <p>For patients known to be colonized/infected with MDROs</p> <p>--- In <i>acute care settings</i>: Implement Contact Precautions upon room entry (IB)</p> <p>--- In <i>LTCFs, ambulatory, home care</i>: Use hand hygiene, gloves. Implement Contact Precautions on a case-by-case basis determined by risks for transmission (IB)</p> <p>---In <i>hemodialysis units</i>: Follow dialysis specific guidelines (IA)</p> <p>No recommendation for routine gloving or gowning in ambulatory or home care settings</p>	<p>Use routine cleaning, sterilization, and disinfection procedures for maintaining patient care areas, critical and noncritical devices, and medical equipment</p>	<p>Not recommended routinely</p>
<p><b>Measures above this line should be implemented by all healthcare settings. Measures below this line should be implemented if 1) transmission of MDROs is continuing, despite use of routine control measures, 2) if prevalence of MDROs is above institutional thresholds, or 3) if a novel MDRO is emerging within the facility</b></p>						
<p>Intensify MDRO control when ongoing transmission, prevalence exceeds institutional goals, or new MDRO (IB)</p> <p>In the absence of dedicated infection control staff, consult with experienced infection control professionals and healthcare epidemiologists for assessment, design, implementation, evaluation of MDRO control measures (IB)</p> <p>Evaluate system factors, including staffing levels and adherence, for role in MDRO transmission (IB)</p> <p>Provide feedback to clinicians and administrators on facility trends in resistance, adherence monitoring, and system failures (IB)</p> <p>When increased incidence of a targeted MDRO is observed, implement intensive monitoring of selected indicators (IB)</p>	<p>Implement educational programs facility-wide and/or in high-risk units targeted for intensified MDRO control interventions. Include relevant information on MDRO trends, system failures, action plans and their outcomes (IB)</p>	<p>Impose limitations on the use of antimicrobial agents associated with increased prevalence of target MDRO e.g., vancomycin, third-generation cephalosporins, anti-aerobic agents for VRE; third generation cephalosporins for ESBLs; carbapenems, quinolones (IB)</p>	<p>Calculate and analyze prevalence and incidence rates of target MDROs (single isolates/patient; location-, service-specific) (IB)</p> <p>Increase frequency of compiling, monitoring antimicrobial susceptibility summary reports (II)</p> <p>Implement laboratory protocols for storing isolates of selected MDROs for molecular typing; perform typing if needed (IB)</p> <p>Develop and implement protocols to obtain active surveillance cultures in at-risk populations as defined locally (IB)</p> <p>---Obtain culture at time of admission</p> <p>---Conduct unit point prevalence studies</p> <p>---Repeat cultures at defined intervals and at discharge until transmission has ceased</p> <p>---Obtain surveillance cultures from roommates and other patients with significant exposure to known MDRO-pos. patients</p> <p>Obtain cultures from HCWs for target MDROs only if HCWs epidemiologically implicated as a source of transmission (IB)</p>	<p>Implement interim policies for patient placement and staffing as needed to prevent transmission (e.g., cohorting patients/staff; unit or facility closure) (IB)</p> <p>Implement Contact Precautions for all patients colonized/infected with target MDRO (IA)</p> <p>When active surveillance cultures are done, routinely use Contact Precautions (e.g. gloves, gowns) for room entry and contact with patients and their environment pending negative surveillance culture results (IB)</p> <p>No recommendation for criteria to discontinue Contact Precautions; consult experts</p> <p>No recommendation for universal use of gloves and/or gowns</p> <p>Masks are not recommended for routine use to prevent MDRO transmission. Use mask to prevent transmission of MRSA/VISA/VRSA during patient interactions that may result in droplet aerosols (IB)</p>	<p>Implement patient.-dedicated use of noncritical equipment (IB)</p> <p>Assign dedicated cleaning personnel who have been trained in MDRO transmission to targeted patient care areas to enhance consistency of cleaning and disinfection (II)</p> <p>Implement procedures that ensure consistent attention is given to "high touch" surfaces in patient care areas (IB).</p> <p>Obtain cultures from environmental sources (e.g., surfaces, shared equipment) only when epidemiologically implicated in transmission (IB)</p> <p>Vacate units for environmental assessment and intensive cleaning when previous efforts to control environmental transmission have failed (II)</p>	<p>Obtain expert consultation to determine if persons would benefit from MRSA decolonization when ongoing transmission is not prevented by other measures (II)</p> <p>Do not use topical mupirocin routinely for MRSA decolonization as a component of MRSA control programs (IB)</p> <p>No recommendations for decolonization for VRE, MDR-GNB</p> <p>Decolonize HCW s found to be infected or colonized with MRSA only when implicated epidemiologically in ongoing transmission (IA)</p>

**Table B-4. Summary of Recommendations for Management of MDROs in Long-Term Care Facilities (LTCFs)**

Administrative Measures	Education of Staff	Judicious Antibiotic Use	Surveillance	Infection Control Precautions	Environmental Measures	Decolonization
<p>Designate MDRO prevention/control an organizational priority in objectives for patient safety <i>(I)</i></p> <p>Implement systems for MDRO reporting as required by local/state health departments <i>(IC/II)</i></p> <p>Implement programs to improve adherence to recommended practices for hand hygiene, Standard/ Expanded Precautions; provide feedback on performance measures to HCWs and administrators <i>(IB)</i> (Appropriate responsibility for Safety or Quality Committees in the absence of an infection control committee)</p> <p>Implement systems to communicate presence of MDRO's to HCW's <i>(IB)</i></p> <ul style="list-style-type: none"> <li>➤ Implement systems to identify patients with MDROs upon admission/re-admission to the facility and during the course of stay in the facility. (Identification may rely on patient information supplied by other providers)</li> <li>➤ Incorporate information on MDRO into written patient care plans</li> </ul>	<p>Provide education and training on preventing transmission of MDROs during HCW orientation and periodic infection control updates. Include information on organizational experience with MDROs <i>(II)</i></p> <p>Focus education and training on the following:</p> <ul style="list-style-type: none"> <li>➤ risks of MDROs to patients</li> <li>➤ how MDROs are transmitted</li> <li>➤ importance of adhering to Standard Precautions</li> <li>➤ procedures for communicating information about patients with MDROs</li> <li>➤ policies regarding patient movement within the facility</li> </ul>	<p>Implement a system to <u>prompt</u> prescribers to verify that prescribed antibiotics are active against the patient's clinical isolates when such information is available <i>(IB)</i></p> <p>Avoid treating colonization in the absence of clinical disease <i>(II)</i></p> <p>Establish a multi-disciplinary process to ensure adequate antibiotic coverage and minimize selective pressure <i>(IB/IC)</i></p> <ul style="list-style-type: none"> <li>➤ include the Medical Director, Director of Nursing, pharmacist and infection control coordinator</li> <li>➤ review information at least annually, but more frequently in the presence of persistent or emerging resistance</li> <li>➤ assure appropriate use of culture and susceptibility data for adjustment of treatment regimens</li> <li>➤ compare the compatibility of antibiotic utilization patterns with antimicrobial susceptibility data</li> </ul>	<p>Identify specific MDROs (e.g., MRSA, VRE, MDR-GNB) for systematic monitoring of susceptibility trends <i>(IB)</i></p> <ul style="list-style-type: none"> <li>➤ Assess whether a newly identified MDRO is due to transmission within the facility</li> <li>➤ Obtain expert consultation when there is evidence of MDRO transmission within the facility to determine appropriate intensified MDRO measures</li> </ul> <p>Define when the frequency of MDROs would trigger intensification of MDRO control <i>(IB)</i></p> <p>Establish systems to detect and communicate evidence of MDROs in clinical isolates. Require by contract that laboratories notify an institutional infection control designate when a target or novel MDRO is identified <i>(IB)</i></p> <p>Require by contract that the primary reference laboratory provide an annual summary antimicrobial susceptibility report (facility-specific, local or regional as available). Provide clinicians with copy of report <i>(IB)</i></p> <p>In facilities with special care units (e.g., ventilator-dependent), request unit-specific reports. <i>(IB)</i></p> <p>Review local trends in resistance in referring facilities at least annually, but more frequently if new patterns are emerging <i>(II)</i></p>	<p>Observe Standard Precautions during all patient encounters on the assumption that any patient could be colonized with an MDRO <i>(IB/IC)</i></p> <p>Observe hand hygiene before and after all contacts with patients and their surrounding environmental surfaces</p> <ul style="list-style-type: none"> <li>--- If hands are visibly soiled</li> <li>--- Before and after contact with the patient</li> <li>--- Before performance of an aseptic procedure</li> <li>--- After removal of gloves <i>(IB)</i></li> </ul> <p>Prioritize known MDRO patients for single patient rooms or placement with like MDRO, or low risk patient <i>(IB)</i></p> <ul style="list-style-type: none"> <li>➤ Determine the degree of socialization and use of common areas for patients with MDROs</li> <li>➤ Base decisions on the ability to contain infected/colonized body fluids or body sites, patient hygiene (e.g., handwashing, keeping hands away from infected/colonized areas) and risk to other patients.</li> <li>➤ Implement Contact Precautions on a case-by-case basis as determined by risks for transmission including uncontrolled secretions, stool incontinence, draining wounds, diarrhea, total dependence for activities of daily living <i>(IB)</i></li> </ul> <p>Discontinue Contact Precautions on a case-by-case basis after considering the following:</p> <ul style="list-style-type: none"> <li>➤ Repeatedly negative cultures when available or</li> <li>➤ No active infection or draining wounds</li> <li>➤ Patient not implicated in transmission</li> <li>➤ Patient remains colonized but risk factors for transmission are no longer present <i>(IB)</i></li> </ul>	<p>Use routine cleaning, sterilization, and disinfection procedures for maintaining patient care areas and medical equipment <i>(IB)</i></p>	<p>Not recommended routinely <i>(IB)</i></p>

Recommendations in this table apply to all long-term care facilities. When a facility determines that a more intensified MDRO control program is indicated, refer to Table B-3 and to the recommendations section for guidance in developing the program. In the absence of dedicated infection control staff, consult with experienced infection control professionals and healthcare epidemiologists for assessment, design, implementation, evaluation of MDRO control measures

Table B-5. Summary of Recommendations for Management of MDROs in Ambulatory Care Settings

Administrative Measures	Education of Staff	Judicious Antibiotic Use	Surveillance	Infection Control Precautions	Environmental Measures	Decolonization
<p>Designate MDRO prevention/control an organizational priority. <i>Incorporate into administrative planning/minutes* (II)</i></p> <p>Implement systems for MDRO reporting as required by local/state health departments. <i>Incorporate into existing communicable disease reporting procedures* (IC/II)</i></p> <p>Implement programs to improve adherence to recommended practices for hand hygiene, Standard/ Expanded Precautions and provide feedback on performance measures to HCWs and administrators <i>(IB)</i> <i>Incorporate into existing quality improvement and safety processes. If such a process does not exist, assign responsibility to nurse managers to ensure that appropriate infection control policies and procedures are developed, maintained and monitored for adherence* (II)</i></p> <p>Implement systems to identify patients with MDRO's upon initial and subsequent encounters. <i>Utilize patient information or information supplied by other organizations or the patient's physician* (IB)</i></p> <p>Implement systems to communicate presence of MDRO's to HCW's; <i>incorporate into patient care records* (IB)</i></p>	<p>Provide education and training on preventing transmission of MDROs during HCW orientation and periodic infection control updates. Include information on organizational experience with MDROs <i>(II)</i></p> <p>Focus education and training on the following:</p> <ul style="list-style-type: none"> <li>➤ risks of MDROs to patients</li> <li>➤ how MDROs are transmitted</li> <li>➤ importance of adhering to Standard Precautions</li> <li>➤ procedures for communicating information about patients with MDROs</li> <li>➤ policies regarding patient movement within the ambulatory care setting</li> </ul>	<p>Incorporate the following into existing quality improvement activities:</p> <p>Implement a system to prompt prescribers (e.g., physicians, P.A., N.P.) to verify that prescribed antibiotics are active against the patient's clinical isolates when such information is available <i>(IB)</i></p> <p>Avoid treating colonization in the absence of clinical disease <i>(II)</i></p>	<p>The following are applicable to ambulatory care sites that evaluate and treat patient infections:</p> <p>Review information on local or regional trends in resistance patterns and predominant MDROs in referring healthcare facilities within the community at least annually, but more frequently if new patterns are emerging <i>(II)</i></p> <p>Identify specific MDROs (e.g., MRSA, VRE, MDR-GNB) for systematic monitoring of susceptibility trends <i>(IB)</i></p> <p>Establish systems to detect and communicate evidence of MDROs in clinical isolates. Require by contract that laboratories notify an institutional infection control designate when a target or novel MDRO is identified <i>(IB)</i></p>	<p>Observe Standard Precautions during all patient encounters on the assumption that any patient could be colonized with an MDRO <i>(IB/IC)</i></p> <p>Observe hand hygiene before and after all contacts with patients and their surrounding environmental surfaces</p> <ul style="list-style-type: none"> <li>--- If hands are visibly soiled</li> <li>--- Before and after contact with the patient</li> <li>--- Before performance of an aseptic procedure</li> <li>--- After removal of gloves <i>(IB)</i></li> </ul> <p>Implement Contact Precautions for a patient with a known MDRO on a case-by-case basis when the nature of the patient interaction and/or the risk of acquisition and associated adverse outcomes to other patients in the area indicate a need to intensify barriers used to prevent transmission, (e.g. MDRO patient has uncontrolled secretions, stool incontinence, ostomy tubes/bags or immunocompromised patients are seen in the same clinic area <i>(IB)</i></p> <p>Place patients who require Contact Precautions in an examination room or cubicle as soon as possible.</p> <p>Develop procedures for management of a patient with an MDRO of particular epidemiologic importance (e.g., VRSA), throughout the time spent in the ambulatory care setting <i>(II)</i></p>	<p>Use routine cleaning, sterilization, and disinfection procedures for maintaining patient care areas and patient care equipment <i>(IB)</i></p> <p>In hemodialysis centers, follow recommendations in dialysis-specific guidelines <i>(IA)</i></p>	<p>Not recommended routinely <i>(IB)</i></p>

Recommendations in this table apply to ambulatory settings that provide medical care, except hemodialysis centers and ambulatory settings where cystic fibrosis patients are cared for since specific guidelines have been developed for these two populations (10, 215). This table does not apply to settings where medical treatment is not provided (e.g., dental, podiatric, chiropractic offices). When a facility determines that a more intensified MDRO control program is indicated, refer to Table B.3 and to the recommendations section for guidance in developing the program. In the absence of dedicated infection control staff, consult with experienced infection control professionals and healthcare epidemiologists for assessment, design, implementation, and evaluation of MDRO control measures.

\* *Italicized statements indicate suggestions for implementing the recommendation*

**Table B-6. Summary of Recommendations for Management of MDRO's in Home Care Settings**

Administrative Measures	Education of Staff	Judicious Antibiotic Use	Surveillance	Infection Control Precautions	Environmental Measures	Decolonization
<p>Designate MDRO prevention/control an organizational priority. <i>Incorporate into administrative planning/minutes * (II)</i></p> <p>Implement systems for MDRO reporting as required by local/state health departments. <i>Incorporate into existing communicable disease reporting procedures * (IC/II)</i></p> <p>Implement systems to identify patients with MDRO's who are receiving home care. <i>Review for MDROs at time of admission, re-admission during the course of ongoing home care services. This may rely upon patient information supplied by other organizations or the patient's physician * (IB)</i></p> <p>Implement systems to communicate presence of MDRO's to HCW's. <i>Incorporate into patient care records *(IB)</i></p> <p>Implement programs to improve adherence to recommended practices for hand hygiene, Standard/ Expanded Precautions and provide feedback to HCWs and administrators <i>Incorporate into existing home care quality improvement and safety processes * (IB)</i></p>	<p>Provide education and training on preventing transmission of MDROs during HCW orientation and periodic infection control updates. Include information on organizational experience with MDROs (II)</p> <p>Focus education and training on the following:</p> <ul style="list-style-type: none"> <li>➤ risks of MDROs to patients</li> <li>➤ how MDROs are transmitted</li> <li>➤ importance of adhering to Standard Precautions</li> <li>➤ procedures for communicating information about patients with MDROs</li> <li>➤ policies regarding care of MDRO patients in the home</li> </ul>	<p>Incorporate the following into existing quality improvement activities:</p> <p>Implement a system to prompt prescribers (e.g., physicians, P.A., N.P.) to verify that prescribed antibiotics are active against the patient's clinical isolates when such information is available (IB)</p> <p>Avoid treating colonization in the absence of clinical disease (II)</p>	<p>Identify specific MDROs (e.g., MRSA, VRE, MDR-GNB) for systematic monitoring of susceptibility trends (IB)</p> <p>Review information on local or regional trends in resistance patterns and predominant MDROs in referring healthcare facilities within the community at least annually, but more frequently if new patterns are emerging (II)</p> <p>Establish systems to detect and communicate evidence of MDROs in clinical isolates. Require by contract that laboratories notify an institutional infection control designate when a target or novel MDRO is identified (IB)</p>	<p>Observe Standard Precautions and hand hygiene during all patient encounters on the assumption that any patient could be colonized with an MDRO (IB/IC)</p> <p>Dedicate reusable patient care items to patients known to be colonized or infected with MDRO's (e.g., BP cuff, stethoscope, thermometer) (II)</p> <p>Observe hand hygiene before and after all contacts with patients and their surrounding environmental surfaces</p> <ul style="list-style-type: none"> <li>--- If hands are visibly soiled</li> <li>--- Before and after contact with the patient</li> <li>--- Before performance of an aseptic procedure</li> <li>--- After removal of gloves (IB)</li> </ul> <p>Implement Contact Precautions for a home care patient with a known MDRO on a case-by-case basis when the nature of the patient interaction indicate a need to intensify barriers used to prevent transmission (e.g., MDRO patients has uncontrolled secretions, stool incontinence, ostomy tubes/bags) (IB).</p> <p>Develop procedures for management of a patient with an MDRO e.g., VRSA, throughout the course of home care (II)</p>	<p>Use routine cleaning, sterilization and disinfection procedures for maintaining patient care areas and patient care equipment (IB)</p> <p>Limit the amount of patient care equipment brought into the home of patients who require Contact Precautions(II)</p> <p>Perform surface disinfection (i.e., clean outside surfaces with a detergent/disinfectant before transporting used equipment (II)</p>	<p>Not recommended routinely (IB)</p>

**Recommendations in this table apply to all home care patients except hemodialysis and cystic fibrosis patients since specific guidelines have been developed for these two populations (10, 215). When a home care organization detects an MDRO problem, consult with experienced infection control professionals and healthcare epidemiologists for assessment, design, implementation, evaluation of MDRO control measures.**

*\* Italicized statements indicate suggestions for implementing the recommendation*

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