American Journal of Infection Control

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2007 guideline for isolation precautions: Preventing transmission of infectious agents in health care settings
JD Siegel, E Rhinehart, M Jackson, L Chiarello, for the Health Care Infection Control Practices Advisory Committee

Management of multidrug-resistant organisms in health care settings, 2006
JD Siegel, E Rhinehart, M Jackson, L Chiarello, and the Healthcare Infection Control Practices Advisory Committee

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2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings

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(Am J Infect Control 2007;35:S65-164.)
0196-6553/$32.00
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doi:10.1016/j.ajic.2007.10.007
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EXECUTIVE SUMMARY

The Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings 2007 updates and expands the 1996 Guideline for Isolation Precautions in Hospitals. The following developments led to these revisions of the 1996 guideline:

1. The transition of health care delivery from primarily acute care hospitals to other health care settings (eg, home care, ambulatory care, freestanding specialty care sites, long-term care) created a need for recommendations that can be applied in all health care settings using common principles of infection control practice, yet can be modified to reflect setting-specific needs.
Accordingly, the revised guideline addresses the spectrum of health care delivery settings. Furthermore, the term “nosocomial infections” is replaced by “health care–associated infections” (HAIs), to reflect the changing patterns in health care delivery and difficulty in determining the geographic site of exposure to an infectious agent and/or acquisition of infection.

2. The emergence of new pathogens (eg, severe acute respiratory syndrome coronavirus [SARS-CoV] associated with SARS avian influenza in humans), renewed concern for evolving known pathogens (eg, Clostridium difficile, noroviruses, community-associated methicillin-resistant Staphylococcus aureus [CA-MRSA]), development of new therapies (eg, gene therapy), and increasing concern for the threat of bioweapons attacks, necessitates addressing a broader scope of issues than in previous isolation guidelines.

3. The successful experience with Standard Precautions, first recommended in the 1996 guideline, has led to a reaffirmation of this approach as the foundation for preventing transmission of infectious agents in all health care settings. New additions to the recommendations for Standard Precautions are respiratory hygiene/cough etiquette and safe injection practices, including the use of a mask when performing certain high-risk, prolonged procedures involving spinal canal punctures (eg, myelography, epidural anesthesia). The need for a recommendation for respiratory hygiene/cough etiquette grew out of observations during the SARS outbreaks, when failure to implement simple source control measures with patients, visitors, and health care workers (HCWs) with respiratory symptoms may have contributed to SARS-CoV transmission. The recommended practices have a strong evidence base. The continued occurrence of outbreaks of hepatitis B and hepatitis C viruses in ambulatory settings indicated a need to reiterate safe injection practice recommendations as part of Standard Precautions. The addition of a mask for certain spinal injections grew from recent evidence of an associated risk for developing meningitis caused by respiratory flora.

4. The accumulated evidence that environmental controls decrease the risk of life-threatening fungal infections in the most severely immunocompromised patients (ie, those undergoing allogeneic hematopoietic stem cell transplantation [HSCT]) led to the update on the components of the protective environment (PE).

5. Evidence that organizational characteristics (eg, nurse staffing levels and composition, establishment of a safety culture) influence HCWs’ adherence to recommended infection control practices, and thus are important factors in preventing transmission of infectious agents, led to a new emphasis and recommendations for administrative involvement in the development and support of infection control programs.

6. Continued increase in the incidence of HAIs caused by multidrug-resistant organisms (MDROs) in all health care 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 health care settings.

This document is intended for use by infection control staff, health care epidemiologists, health care administrators, nurses, other health care providers, and persons responsible for developing, implementing, and evaluating infection control programs for health care 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.

PARTS I, II, AND III: REVIEW OF THE SCIENTIFIC DATA REGARDING TRANSMISSION OF INFECTIOUS AGENTS IN HEALTH CARE SETTINGS

Part I reviews the relevant scientific literature that supports the recommended prevention and control practices. As in the 1996 guideline, the modes and factors that influence transmission risks are described in detail. New to the section on transmission are discussions of bioaerosols and of how droplet and airborne transmission may contribute to infection transmission. This became a concern during the SARS outbreaks of 2003, when transmission associated with aerosol-generating procedures was observed. Also new is a definition of “epidemiologically important organisms” that was developed to assist in the identification of clusters of infections that require investigation (ie multidrug-resistant organisms, C difficile). Several other pathogens of special infection control interest (ie, norovirus, SARS, Centers for Disease Control and Prevention [CDC] category A bioterrorist agents, prions, monkeypox, and the hemorrhagic fever viruses) are also discussed, to present new information and infection control lessons learned from experience with these agents. This section of the guideline
also presents information on infection risks associated with specific health care settings and patient populations.

Part II updates information on the basic principles of hand hygiene, barrier precautions, safe work practices, and isolation practices that were included in previous guidelines. However, new to this guideline is important information on health care system components that influence transmission risks, including those components under the influence of health care administrators.

An important administrative priority that is described is the need for appropriate infection control staffing to meet the ever-expanding role of infection control professionals in the complex modern health care system. Evidence presented also demonstrates another administrative concern: the importance of nurse staffing levels, including ensuring numbers of appropriately trained nurses in intensive care units (ICUs) for preventing HAI.

The role of the clinical microbiology laboratory in supporting infection control is described, to emphasize the need for this service in health care facilities.

Other factors that influence transmission risks are discussed, including the adherence of HCWs to recommended infection control practices, organizational safety culture or climate, and education and training.

Discussed for the first time in an isolation guideline is surveillance of health care–associated infections. The information presented will be useful to new infection control professionals as well as persons involved in designing or responding to state programs for public reporting of HAI rates.

Part III describes each of the categories of precautions developed by the Health Care Infection Control Practices Advisory Committee (HICPAC) and the CDC and provides guidance for their application in various health care settings. The categories of Transmission-Based Precautions are unchanged from those in the 1996 guideline: Contact, Droplet, and Airborne. One important change is the recommendation to don the indicated personal protective equipment (PPE—gowns, gloves, mask) on entry into the patient’s room for patients who are on Contact and/or Droplet Precautions, because the nature of the interaction with the patient cannot be predicted with certainty, and contaminated environmental surfaces are important sources for transmission of pathogens. In addition, the PE for patients undergoing allogeneic HSCT, described in previous guidelines, has been updated.

TABLES, APPENDICES, AND OTHER INFORMATION

Five tables summarize important information. Table 1 provides a summary of the evolution of this document. Table 2 gives guidance on using empiric isolation precautions according to a clinical syndrome. Table 3 summarizes infection control recommendations for CDC category A agents of bioterrorism. Table 4 lists the components of Standard Precautions and recommendations for their application, and Table 5 lists components of the PE.

A glossary of definitions used in this guideline also is provided. New to this edition of the guideline is a figure showing the recommended sequence for donning and removing PPE used for isolation precautions to optimize safety and prevent self-contamination during removal.

APPENDIX A: TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Appendix A provides an updated alphabetical list of most infectious agents and clinical conditions for which isolation precautions are recommended. A preamble to the appendix provides a rationale for recommending the use of 1 or more Transmission-Based Precautions in addition to Standard Precautions, based on a review of the literature and evidence demonstrating a real or potential risk for person-to-person transmission in health care settings. 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. Relevant citations are included.

PREPUBLICATION OF THE GUIDELINE ON PREVENTING TRANSMISSION OF MDROS

New to this guideline is a comprehensive review and detailed recommendations for prevention of transmission of MDROs. This portion of the guideline was published electronically in October 2006 and updated in November 2006 (Siegel JD, Rhinehart E, Jackson M, Chiarello L and HICPAC. Management of multidrug-resistant organisms in health care settings, 2006; available from http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf), and is considered a part of the Guideline for Isolation Precautions. This section provides a detailed review of the complex topic of MDRO control in health care settings and is intended to provide a context for evaluation of MDRO at individual health care settings. 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 health care settings, information concerning the judicious use of antimicrobial agents also is presented, because such practices are intricately related to the size of the reservoir of MDROs, which in turn influences transmission (eg, colonization pressure). Two tables summarize recommended prevention and control practices using 7 categories of interventions to control MDROs: administrative measures, education of HCWs, judicious antimicrobial use, surveillance, infection control precautions, environmental measures, and decolonization. Recommendations for each category apply to and are adapted for the various health care settings.
<table>
<thead>
<tr>
<th>Clinical syndrome or condition</th>
<th>Potential pathogens</th>
<th>Empiric precautions (always includes Standard Precautions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>Enteric pathogens(^\text{(z)})</td>
<td>Contact Precautions (pediatrics and adult)</td>
</tr>
<tr>
<td>Acute diarrhea with a likely infectious cause in an incontinent or diapered patient</td>
<td><em>Neisseria meningitidis</em></td>
<td>Droplet Precautions for first 24 hours of antimicrobial therapy; mask and face protection for intubation</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Enteroviruses</td>
<td>Contact Precautions for infants and children</td>
</tr>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td></td>
<td>Airborne Precautions if pulmonary infiltrate present</td>
</tr>
<tr>
<td>Rash or exanthems, generalized, etiology unknown</td>
<td><em>Neisseria meningitidis</em></td>
<td>Airborne Precautions plus Contact Precautions if potentially infectious draining body fluid present</td>
</tr>
<tr>
<td>Petechial/ecchymotic with fever (general)</td>
<td><em>Ebola, Lassa, Marburg viruses</em></td>
<td>Droplet Precautions for the first 24 hours of antimicrobial therapy</td>
</tr>
<tr>
<td>Positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever</td>
<td><em>Ebolavirus, Lassa, Marburg viruses</em></td>
<td>Droplet Precautions plus Contact Precautions, with face/eye protection, emphasizing safety sharps and Barrier Precautions when blood exposure likely. N95 or higher-level respiratory protection when aerosol-generating procedure performed</td>
</tr>
<tr>
<td>Vesicular</td>
<td>Varicella-zoster, herpes simplex, variola (smallpox), vaccinia viruses</td>
<td>Airborne Precautions plus Contact Precautions</td>
</tr>
<tr>
<td></td>
<td><em>Vaccinia virus</em></td>
<td>Contact Precautions only if herpes simplex, localized zoster in an immunocompetent host, or vaccinia virus likely</td>
</tr>
<tr>
<td>Maculopapular with cough, coryza, and fever</td>
<td><em>Rubeola (measles) virus</em></td>
<td>Airborne Precautions</td>
</tr>
<tr>
<td>Respiratory infections</td>
<td><em>M. tuberculosis, respiratory viruses, Streptococcus pneumoniae, Staphylococcus aureus</em> (MSSA or MRSA)</td>
<td>Airborne Precautions plus Contact Precautions</td>
</tr>
<tr>
<td>Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for HIV infection</td>
<td><em>M. tuberculosis, respiratory viruses, S pneumoniae, S aureus</em> (MSSA or MRSA)</td>
<td>Airborne Precautions plus Contact Precautions; eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated; Droplet Precautions instead of Airborne Precautions if tuberculosis unlikely and airborne infection isolation room and/or respirator unavailable (tuberculosis more likely in HIV-infected than in HIV-negative individuals)</td>
</tr>
<tr>
<td>Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection</td>
<td><em>M tuberculosis, respiratory viruses</em></td>
<td>Airborne Precautions plus Contact Precautions plus eye protection; Droplet Precautions instead of Airborne Precautions if SARS and tuberculosis unlikely</td>
</tr>
<tr>
<td>Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10 to 21 days) to countries with active outbreaks of SARS, avian influenza</td>
<td><em>M tuberculosis, severe acute respiratory syndrome virus</em> (SARS-CoV), avian influenza</td>
<td>Contact plus Droplet Precautions; discontinue Droplet Precautions if adenovirus and influenza ruled out</td>
</tr>
<tr>
<td>Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children</td>
<td><em>Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, human metapneumovirus</em></td>
<td>Airborne Precautions plus Contact Precautions plus eye protection; Droplet Precautions instead of Airborne Precautions if SARS and tuberculosis unlikely</td>
</tr>
<tr>
<td>Skin or wound infection</td>
<td><em>S aureus</em> (MSSA or MRSA), group A streptococcus</td>
<td>Contact Precautions, plus Droplet Precautions for the first 24 hours of appropriate antimicrobial therapy if invasive group A streptococcal disease suspected</td>
</tr>
</tbody>
</table>

\(^{\text{a}}\)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.

\(^{\text{b}}\)Patients with the syndromes or conditions listed below may present with atypical signs or symptoms (eg, 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.

\(^{\text{c}}\)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.

\(^{\text{d}}\)These pathogens include enterohemorrhagic *Escherichia coli* O157:H7, *Shigella* spp, hepatitis A virus, noroviruses, rotavirus, and *Clostridium difficile*. 

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Table 2. Clinical syndromes or conditions warranting empiric transmission-based precautions in addition to Standard Precautions pending confirmation of diagnosis\(^{\text{a}}\)
Table 3. Infection control considerations for high-priority (CDC category A) diseases that may result from bioterrorist attacks or are considered bioterrorist threats (see http://www.bt.cdc.gov)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Anthrax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site(s) of infection; transmission mode</td>
<td>Cutaneous: (contact with spores); RT: (inhalation of spores); GIT: (ingestion of spores [rare])</td>
</tr>
<tr>
<td>Cutaneous and inhalation disease</td>
<td>Comment: Spores can be inhaled into the lower respiratory tract. The infectious dose of Bacillus anthracis in humans by any route is not precisely known. In primates, the LD50 for an aerosol challenge with B anthracis is estimated to be 8,000 to 50,000 spores; the infectious dose may be as low as 1 to 3 spores.</td>
</tr>
<tr>
<td>Incubation period</td>
<td>Cutaneous: 1 to 12 days; RT: Usually 1 to 7 days, but up to 43 days reported; GIT: 15 to 72 hours</td>
</tr>
<tr>
<td>Clinical features</td>
<td>Cutaneous: Painful, reddish papule that develops a central vesicle or bulla in 1 to 2 days; over the next 3 to 7 days, the lesion becomes pustular and then necrotic, with black eschar and extensive surrounding edema</td>
</tr>
<tr>
<td>RT: Initial flu-like illness for 1 to 3 days with headache, fever, malaise, cough; by day 4, severe dyspnea and shock. Usually fatal (85% to 90%) if untreated; meningitis develops in 50% of RT cases.</td>
<td></td>
</tr>
<tr>
<td>GIT:</td>
<td>In intestinal form, necrotic, ulcerated, edematous lesions develop in intestines with fever, nausea, and vomiting and progression to hematemesis and bloody diarrhea; 25% to 60% mortality</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Cutaneous: Swabs of lesion (under eschar) for IHC, PCR, and culture; punch biopsy for IHC, PCR, and culture: vesicular fluid aspirate for Gram's stain and culture; blood culture if systemic symptoms present; acute and convalescent sera for ELISA serology</td>
</tr>
<tr>
<td>RT:</td>
<td>CXR or CT demonstrating wide mediastinal widening and/or pleural effusion and hilar abnormalities; blood for culture and PCR; pleural effusion for culture, PCR, and IHC; CSF (if meningeval signs present) for IHC, PCR, and culture; and acute and convalescent sera for ELISA serology; pleural and/or bronchial biopsy specimens for IHC</td>
</tr>
<tr>
<td>Infectivity</td>
<td>Cutaneous: Person-to-person transmission from contact with lesion of untreated patient is possible but rare</td>
</tr>
<tr>
<td>RT and GIT:</td>
<td>Person-to-person transmission does not occur</td>
</tr>
<tr>
<td>Recommended precautions</td>
<td>Aerosolized powder, environmental exposures: Highly infectious if aerosolized</td>
</tr>
<tr>
<td>Cutaneous:</td>
<td>Standard Precautions; Contact Precautions if uncontained copious drainage present</td>
</tr>
<tr>
<td>RT and GIT:</td>
<td>Standard Precautions.</td>
</tr>
<tr>
<td>Aerosolized powder, environmental exposures: Respirator (N95 mask or powered air-purifying respirator), protective clothing; decontamination of persons with powder on them (see <a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5133a3.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5133a3.htm</a>)</td>
<td></td>
</tr>
<tr>
<td>Hand hygiene:</td>
<td>Handwashing for 30 to 60 seconds with soap and water or 2% chlorhexidine gluconate after spore contact; alcohol hand rubs are inactive against spores.</td>
</tr>
<tr>
<td>Aerosolized powder, environmental exposures:</td>
<td>Postexposure prophylaxis after environmental exposure: A 60-day course of antimicrobials (doxycycline, ciprofloxacin, or levofloxacin) and postexposure vaccine under IND.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disease</th>
<th>Botulism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site(s) of infection; transmission mode</td>
<td>GIT: Ingestion of toxin-containing food; RT: Inhalation of toxin containing aerosol. Comment: Toxin ingested or potentially delivered by aerosol in bioterrorist incidents. LD50 for type A is 0.001 μg/mL/kg.</td>
</tr>
<tr>
<td>Incubation period</td>
<td>1 to 5 days</td>
</tr>
<tr>
<td>Clinical features</td>
<td>Pniosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia, followed by symmetrical descending paralysis and respiratory failure.</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Clinical diagnosis: identification of toxin in stool, serology, unless toxin-containing material available for toxin neutralization bioassays.</td>
</tr>
<tr>
<td>Infectivity</td>
<td>Not transmitted from person to person; exposure to toxin necessary for disease.</td>
</tr>
<tr>
<td>Recommended precautions</td>
<td>Standard Precautions.</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Disease</th>
<th>Smallpox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site(s) of infection; transmission mode</td>
<td>RT: Inhalation of droplets or, rarely, aerosols; and skin lesions (contact with virus). Comment: If used as a biological weapon, natural disease (which has not occurred since 1977) likely will result.</td>
</tr>
<tr>
<td>Incubation period</td>
<td>7 to 19 days (mean, 12 days).</td>
</tr>
<tr>
<td>Clinical features</td>
<td>Fever, malaise, backache, headache, and often vomiting for 2 to 3 days, followed by generalized papular or maculopapular rash (more on face and extremities), which becomes vesicular (on day 4 or 5) and then pustular; lesions all in same stage.</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Electron microscopy of vesicular fluid or culture of vesicular fluid by a World Health Organization–approved laboratory (CDC); detection by PCR available only at select LRN laboratories, the CDC, and US Army Medical Research Institute of Infectious Diseases.</td>
</tr>
<tr>
<td>Infectivity</td>
<td>Secondary attack rates up to 50% in unvaccinated persons. Infected persons may transmit disease from the time that rash appears until all lesions have crusted over (about 3 weeks). Infectivity is greatest during the first 10 days of rash.</td>
</tr>
<tr>
<td>Recommended precautions</td>
<td>Combined use of Standard, Contact, and Airborne Precautions should be maintained until all scabs have separated (3 to 4 weeks). Only immune HCWs should care for patients. Postexposure vaccine should be provided within 4 days.</td>
</tr>
<tr>
<td>Vaccinia</td>
<td>1. HCWs to cover vaccination site with gauze and semipermeable dressing until scab separates (⇌ 21 days). Hand hygiene should be observed.</td>
</tr>
<tr>
<td>Adverse events with virus-containing lesions</td>
<td>Standard Precautions plus Contact Precautions until all lesions are crusted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disease</th>
<th>Tularemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site(s) of infection; transmission mode</td>
<td>RT: Inhalation of aerosolized bacteria; GIT: Ingestion of food or drink contaminated with aerosolized bacteria. Comment: Pneumonic or typhoidal disease likely to occur after bioterrorist event using aerosol delivery. Infective dose, 10 to 50 bacteria.</td>
</tr>
<tr>
<td>Incubation period</td>
<td>2 to 10 days; usually 3 to 5 days.</td>
</tr>
<tr>
<td>Clinical features</td>
<td>Pneumonic: malaise, cough, sputum production, dyspnea. Typhoidal: fever, prostration, weight loss and frequently an associated pneumonia.</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by PCR (LRN) or isolated from blood and other body fluids on cytostatic-enriched media or mouse inoculation.</td>
</tr>
<tr>
<td>Infectivity</td>
<td>Person-to-person spread is rare. Laboratory workers who encounter/hold cultures of this organism are at high risk for disease if exposed.</td>
</tr>
<tr>
<td>Recommended precautions</td>
<td>Standard Precautions</td>
</tr>
</tbody>
</table>

AIR, airborne infection isolation room; BSL, biosafety level; CSF, cerebrospinal fluid; CT, computed tomography; CXR, chest x-ray; ELISA, enzyme-linked immunosorbent assay; GIT, gastrointestinal tract; HCW, health care worker; IHC, immunohistochemistry; LD50, lethal dose for 50% of experimental animals; LRN, Laboratory Response Network; PAPR, powered air-purifying respirator; PCR, polymerase chain reaction; RT, respiratory tract; VHF, viral hemorrhagic fever.

Pneumonic plague is not as contagious as is often thought. Historical accounts and contemporary evidence indicate that persons with plague usually transmit the infection only when the disease is in the end stage. These persons cough copious amounts of bloody sputum that contains many plague bacteria. Patients in the early stage of primary pneumonic plague (approximately the first 20 to 24 hours) apparently pose little risk (Wu L-T. A treatise on pneumonic plague. Geneva, Switzerland: League of Nations; 1926; Kool JL. Risk of person-to-person transmission of pneumonic plague. Clin Infect Dis 2005;40:1166-72). Antibiotic medication rapidly clears the sputum of plague bacilli, so that a patient generally is not infectious within hours after initiation of effective antibiotic treatment (Butler TC. Plague and other Yersinia infections. In: Greenough WB, editor. Current topics in infectious disease. New York: Plenum; 1983). This means that in modern times, many patients will never reach a stage where they pose a significant risk to others. Even in the end stage of disease, transmission occurs only after close contact. Simple protective measures, such as wearing masks, maintaining good hygiene, and avoiding close contact, have been effective in interrupting transmission during many pneumonic plague outbreaks; in the United States, the last known case of person-to-person transmission of pneumonic plague occurred in 1925 (Kool JL. Risk of person-to-person transmission of pneumonic plague. Clin Infect Dis 2005;40:1166-72). Transmission by the airborne route is a rare event. Airborne Precautions are recommended when possible, but in the event of mass exposures, Barrier Precautions and containment within a designated area are most important.104,212

Vaccinia adverse events with lesions containing infectious virus include inadvertent autoinoculation, ocular lesions (blepharitis, conjunctivitis), generalized vaccinia, progressive vaccinia, and eczema vaccinatum. Bacterial superinfection also requires addition of Contact Precautions if exudates cannot be contained.116, 217
With the increasing incidence and prevalence of MDROs, all health care facilities must prioritize effective control of MDRO transmission. Facilities should identify prevalent MDROs at the facility, implement control measures, assess the effectiveness of control programs, and demonstrate decreasing MDRO rates. A set of intensified MDRO prevention interventions is to be added if the incidence of transmission of a target MDRO is not decreasing despite implementation of basic MDRO infection control measures, and when the first case of an epidemiologically important MDRO is identified within a health care facility.

**SUMMARY**

This updated guideline responds to changes in health care delivery and addresses new concerns about transmission of infectious agents to patients and HCWs in the United States and infection control. The primary objective of the guideline is to improve the safety of the nation's health care delivery system by reducing the rates of HAIs.
### Table 5. Components of a protective environment

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
</table>
| I. Patients: allogeneic hematopoietic stem cell transplantation only | - Maintain in protective environment (PE) room except for required diagnostic or therapeutic procedures that cannot be performed in the room (eg, radiology, surgery)  
- Respiratory protection (eg, 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 health care workers (HCWs) or visitors for routine entry into the room  
- Use of gown, gloves, and mask by HCWs and visitors according to Standard Precautions and as indicated for suspected or proven infections for which transmission-based precautions are recommended |
| III. Engineering | - Central or point-of-use high-efficiency particulate air (HEPA) filters (99.97% efficiency) filters capable of removing particles 0.3 μm in diameter in 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 ≥12 air changes/hour  
- 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, and exits on opposite side of the room  
- Positive room air pressure in relation to the corridor; pressure differential of ≥2.5 Pa (0.01-inch water gauge)  
- Air flow patterns monitored and recorded daily using visual methods (eg, flutter strips, smoke tubes) or a hand-held pressure gauge  
- Self-closing door on all room exits  
- Back-up ventilation equipment (eg, portable units for fans or filters) maintained for emergency provision of ventilation requirements for PE areas, with immediate steps taken to restore the fixed ventilation system  
- For patients who require both a PE and an airborne infection isolation room (AIIR), 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 AIIR 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  
- Vacuum cleaner equipped with HEPA filters when vacuum cleaning is necessary |

Adapted from Centers for Disease Control and Prevention.¹¹

### Abbreviations Used in the Guideline

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIA</td>
<td>American Institute of Architects</td>
</tr>
<tr>
<td>AIIR</td>
<td>Airborne infection isolation room</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CF</td>
<td>Cystic fibrosis</td>
</tr>
<tr>
<td>CJD</td>
<td>Creutzfeld-Jakob Disease</td>
</tr>
<tr>
<td>ESBL</td>
<td>Extended-spectrum beta-lactamase</td>
</tr>
<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
</tr>
<tr>
<td>HAI</td>
<td>Health care–associated infection</td>
</tr>
<tr>
<td>HBV</td>
<td>Hepatitis B virus</td>
</tr>
<tr>
<td>HCV</td>
<td>Hepatitis C virus</td>
</tr>
<tr>
<td>HEPA</td>
<td>High-efficiency particulate air</td>
</tr>
<tr>
<td>HICPAC</td>
<td>Health Care Infection Control Practices Advisory Committee</td>
</tr>
<tr>
<td>HIV</td>
<td>Human immunodeficiency virus</td>
</tr>
<tr>
<td>HCW</td>
<td>Health care worker</td>
</tr>
<tr>
<td>HFV</td>
<td>Hemorrhagic fever virus</td>
</tr>
<tr>
<td>HSCT</td>
<td>Hematopoietic stem cell transplantation</td>
</tr>
<tr>
<td>ICP</td>
<td>Infection prevention and control professional</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive care unit</td>
</tr>
<tr>
<td>LTCF</td>
<td>Long-term care facility</td>
</tr>
<tr>
<td>MDR-GNB</td>
<td>Multidrug-resistant gram-negative bacilli</td>
</tr>
<tr>
<td>MDRO</td>
<td>Multidrug-resistant organism</td>
</tr>
<tr>
<td>MRSA</td>
<td>Methicillin-resistant <em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>MSSA</td>
<td>Methicillin-susceptible <em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>NICU</td>
<td>Neonatal intensive care unit</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
</tr>
<tr>
<td>NNIS</td>
<td>National Nosocomial Infection Surveillance</td>
</tr>
<tr>
<td>NSSP</td>
<td>Nonsusceptible <em>Streptococcus pneumoniae</em></td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PCR</td>
<td>Polymerase chain reaction</td>
</tr>
<tr>
<td>PE</td>
<td>Protective environment</td>
</tr>
<tr>
<td>PFGE</td>
<td>Pulsed-field gel electrophoresis</td>
</tr>
<tr>
<td>PICU</td>
<td>Pediatric intensive care unit</td>
</tr>
</tbody>
</table>
The Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings 2007 builds on 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

I.A.1. Objectives and Methods. The objectives of this guideline are to (1) provide infection control recommendations for all components of the health care delivery system, including hospitals, long-term care facilities, ambulatory care, home care, and hospice; (2) reaffirm Standard Precautions as the foundation for preventing transmission during patient care in all health care settings; (3) reaffirm the importance of implementing Transmission-Based Precautions based on the clinical presentation or syndrome and likely pathogens until the infectious etiology has been determined (Table 2); and (4) provide epidemiologically sound and, whenever possible, evidence-based recommendations.

This guideline is designed for use by individuals who are charged with administering infection control programs in hospitals and other health care settings. The information also will be useful for other HCWs, health care administrators, and anyone needing information about infection control measures to prevent transmission of infectious agents. Commonly used abbreviations are provided, and terms used in the guideline are defined in the Glossary.

Medline and PubMed were used to search for relevant studies published in English, focusing on those published since 1996. Much of the evidence cited for preventing transmission of infectious agents in health care settings is derived from studies that used “quasi-experimental designs,” also referred to as nonrandomized preintervention and postintervention study designs.2 Although these types of studies can provide valuable information regarding the effectiveness of various interventions, several factors decrease the certainty of attributing improved outcome to a specific intervention. These include: difficulties in controlling for important confounding variables, the use of multiple interventions during an outbreak, and results that are explained by the statistical principle of regression to the mean (eg, improvement over time without any intervention).3 Observational studies remain relevant and have been used to evaluate infection control interventions.4,5 The quality of studies, consistency of results, and correlation with results from randomized controlled trials, when available, were considered during the literature review and assignment of evidence-based categories (see Part IV: Recommendations) to the recommendations in this guideline. Several authors have summarized properties to consider when evaluating studies for the purpose of determining whether the results should change practice or in designing new studies.2,6,7

I.A.2. Changes or Clarifications in Terminology. This guideline contains 4 changes in terminology from the 1996 guideline:

1. The term “nosocomial infection” is retained to refer mainly to infections acquired in hospitals. The term “health care–associated infection” (HAI) is used to refer to infections associated with health care delivery in any setting (eg, hospitals, long-term care facilities, ambulatory settings, home care). This term reflects the inability to determine with certainty where the pathogen was acquired, because patients may be colonized with or exposed to potential pathogens outside of the health care setting before receiving health care, or may develop infections caused by those pathogens when exposed to the conditions associated with delivery of health care. In addition, patients frequently move among the various settings within the health care system.8

2. A new addition to the practice recommendations for Standard Precautions is respiratory hygiene/cough etiquette. Whereas Standard Precautions generally apply to the recommended practices of HCWs during patient care, respiratory hygiene/cough etiquette applies broadly to all persons who enter a health care setting, including HCWs, patients, and visitors. These recommendations evolved from observations during the SARS epidemic that failure to implement basic source control measures with patients, visitors, and HCWs with signs and symptoms of respiratory tract infection may have contributed to SARS-CoV transmission. This concept has been incorporated into CDC planning documents for SARS and pandemic influenza.9,10

3. The term “Airborne Precautions” has been supplemented by the term “Airborne Infection Isolation Room” (AIIR), to achieve consistency with the Guidelines for Environmental Infection Control in Health Care Facilities.11
Health Care Facilities,\textsuperscript{11} the Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Settings 2005,\textsuperscript{12} and the American Institute of Architects (AIA) 2006 guidelines for design and construction of hospitals.\textsuperscript{13}

4. A set of prevention measures known as the protective environment (PE) has been added to the precautions for preventing HAIs. These measures, which have been defined in previous guidelines, consist of engineering and design interventions aimed at decreasing the risk of exposure to environmental fungi for severely immunocompromised patients undergoing allogeneic HSCT during the times of highest risk, usually the first 100 days posttransplantation or longer in the presence of graft-versus-host disease.\textsuperscript{11,13-15} Recommendations for a PE apply only to acute care hospitals that provide care to patients undergoing HSCT.

I.A.3. Scope. This guideline, like its predecessors, focuses primarily on interactions between patients and health care providers. The Guidelines for the Prevention of MDRO Infection were published separately in November 2006 and are available online at http://www.cdc.gov/ncidod/dhqp/index.html. Several other HICPAC guidelines to prevent transmission of infectious agents associated with health care delivery are cited, including Guideline for Hand Hygiene, Guideline for Environmental Infection Control, Guideline for Prevention of Health Care–Associated Pneumonia, and Guideline for Infection Control in Health Care Personnel.\textsuperscript{11,14,16,17} In combination, these provide comprehensive guidance on the primary infection control measures for ensuring a safe environment for patients and HCWs.

This guideline does not discuss in detail specialized infection control issues in defined populations that are addressed elsewhere (eg, Recommendations for Preventing Transmission of Infections Among Chronic Hemodialysis Patients, Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Facilities 2005, Guidelines for Infection Control in Dental Health Care Settings, and Infection Control Recommendations for Patients With Cystic Fibrosis).\textsuperscript{12,18-20} An exception has been made by including abbreviated guidance for a PE used for allogeneic HSCT recipients, because components of the PE have been defined more completely since publication of the Guidelines for Preventing Opportunistic Infections Among HSCT Recipients in 2000 and the Guideline for Environmental Infection Control in Health Care Facilities.\textsuperscript{11,15}

I.B. Rationale for Standard and Transmission-Based Precautions in Health Care Settings

Transmission of infectious agents within a health care setting requires 3 elements: a source (or reservoir) of infectious agents, a susceptible host with a portal of entry receptive to the agent, and a mode of transmission for the agent. This section describes the interrelationship of these elements in the epidemiology of HAIs.

I.B.1. Sources of Infectious Agents. Infectious agents transmitted during health care derive primarily from human sources but inanimate environmental sources also are implicated in transmission. Human reservoirs include patients,\textsuperscript{20-28} HCWs,\textsuperscript{17,29-39} and household members and other visitors.\textsuperscript{40-45} Such source individuals may have active infections, may be in the asymptomatic and/or incubation period of an infectious disease, or may be transiently or chronically colonized with pathogenic microorganisms, particularly in the respiratory and gastrointestinal tracts. Other sources of HAIs are the endogenous flora of patients (eg, bacteria residing in the respiratory or gastrointestinal tract).\textsuperscript{46-54}

I.B.2. Susceptible Hosts. Infection is the result of a complex interrelationship between a potential host and an infectious agent. Most of the factors that influence infection and the occurrence and severity of disease are related to the host. However, characteristics of the host–agent interaction as it relates to pathogenicity, virulence, and antigenicity also are important, as are the infectious dose, mechanisms of disease production, and route of exposure.\textsuperscript{55} There is a spectrum of possible outcomes after exposure to an infectious agent. Some persons exposed to pathogenic microorganisms never develop symptomatic disease, whereas others become severely ill and even die. Some individuals are prone to becoming transiently or permanently colonized but remain asymptomatic. Still others progress from colonization to symptomatic disease either immediately after exposure or after a period of asymptomatic colonization. The immune state at the time of exposure to an infectious agent, interaction between pathogens, and virulence factors intrinsic to the agent are important predictors of an individual’s outcome. Host factors such as extremes of age and underlying disease (eg, diabetes\textsuperscript{56,57}, human immunodeficiency virus/acquired immune deficiency syndrome [HIV/AIDS],\textsuperscript{58,59} malignancy, and transplantation\textsuperscript{18,60,61}) can increase susceptibility to infection, as can various medications that alter the normal flora (eg, antimicrobial agents, gastric acid suppressors, corticosteroids, antirejection drugs, antineoplastic agents, immunosuppressive drugs). Surgical procedures and radiation therapy impair defenses of the skin and other involved organ systems. Indwelling devices, such as urinary catheters, endotracheal tubes, central venous and arterial catheters,\textsuperscript{62-64} and synthetic implants, facilitate development of HAIs by allowing potential pathogens to bypass local defenses that ordinarily would impede their invasion and by providing surfaces for development of biofilms that may facilitate adherence of
microorganisms and protect from antimicrobial activity. Some infections associated with invasive procedures result from transmission within the health care facility; others arise from the patient’s endogenous flora. High-risk patient populations with noteworthy risk factors for infection are discussed further in Sections I.D, I.E, and I.F.

1.B.3. Modes of Transmission. Several classes of pathogens can cause infection, including bacteria, viruses, fungi, parasites, and prions. The modes of transmission vary by type of organism, and some infectious agents may be transmitted by more than one route. Some are transmitted primarily by direct or indirect contact, (e.g., herpes simplex virus [HSV], respiratory syncytial virus, S aureus), others by the droplet, (e.g., influenza virus, Bordetella pertussis) or airborne routes (e.g. Mycobacterium tuberculosis). Other infectious agents, such as bloodborne viruses (e.g. hepatitis B virus [HBV], hepatitis C virus [HCV], HIV), are rarely transmitted in health care settings through percutaneous or mucous membrane exposure. Importantly, not all infectious agents are transmitted from person to person; these are listed in Appendix A. The 3 principal routes of transmission—contact, droplet, and airborne—are summarized below.

1.B.3.a. Contact Transmission. The most common mode of transmission, contact transmission is divided into 2 subgroups: direct contact and indirect contact.

1.B.3.a.i. Direct Contact Transmission. Direct transmission occurs when microorganisms are transferred from an infected person to another person without a contaminated intermediate object or person. Opportunities for direct contact transmission between patients and HCWs have been summarized in HICPAC’s *Guideline for Infection Control in Health Care Personnel, 1998* and include the following:

- Blood or other blood-containing body fluids from a patient directly enters a HCW’s body through contact with a mucous membrane or breaks (ie, cuts, abrasions) in the skin.
- Mites from a scabies-infested patient are transferred to a HCW’s skin while he or she is in direct un gloved contact with the patient’s skin.
- A HCW develops herpetic whitlow on a finger after contact with HSV when providing oral care to a patient without using gloves, or HSV is transmitted to a patient from a herpetic whitlow on an un gloved hand of a HCW.

1.B.3.a.ii. Indirect Contact Transmission. Indirect transmission involves the transfer of an infectious agent through a contaminated intermediate object or person. In the absence of a point-source outbreak, it is difficult to determine how indirect transmission occurs. However, extensive evidence cited in the *Guideline for Hand Hygiene in Health Care Settings* suggests that the contaminated hands of HCWs are important contributors to indirect contact transmission. Examples of opportunities for indirect contact transmission include the following:

- A HCWs’ hands may transmit pathogens after touching an infected or colonized body site on 1 patient or a contaminated inanimate object, if hand hygiene is not performed before touching another patient.
- Patient-care devices (e.g., electronic thermometers, glucose monitoring devices) may transmit pathogens if devices contaminated with blood or body fluids are shared between patients without cleaning and disinfecting between patients.
- Shared toys may become a vehicle for transmitting respiratory viruses (eg, respiratory syncytial virus [RSV]) or pathogenic bacteria (eg, *Pseudomonas aeruginosa*) among pediatric patients.
- Instruments that are inadequately cleaned between patients before disinfection or sterilization (e.g., endoscopes or surgical instruments) or that have manufacturing defects that interfere with the effectiveness of reprocessing may transmit bacterial and viral pathogens.

Clothing, uniforms, laboratory coats, or isolation gowns used as PPE may become contaminated with potential pathogens after care of a patient colonized or infected with an infectious agent, (eg, MRSA, vancomycin-resistant enterococci [VRE], and *C difficile*). Although contaminated clothing has not been implicated directly in transmission, the potential exists for soiled garments to transfer infectious agents to successive patients.

1.B.3.b. Droplet Transmission. Droplet transmission is technically a form of contact transmission; some infectious agents transmitted by the droplet route also may be transmitted by direct and indirect contact routes. However, in contrast to contact transmission, respiratory droplets carrying infectious pathogens transmit infection when they travel directly from the respiratory tract of the infectious individual to susceptible mucosal surfaces of the recipient, generally over short distances, necessitating facial protection. Respiratory droplets are generated when an infected person coughs, sneezes, or talks or during such procedures as suctioning, endotracheal intubation, cough induction by chest physiotherapy, and cardio pulmonary resuscitation. Evidence for droplet transmission comes from epidemiologic studies of disease outbreaks from experimental studies, and from information on aerosol dynamics. Studies have shown that the nasal mucosa, conjunctivae, and, less frequently, the mouth are susceptible portals of entry for respiratory viruses. The maximum
distance for droplet transmission is currently unresolved; pathogens transmitted by the droplet route have not been transmitted through the air over long distances, in contrast to the airborne pathogens discussed below. Historically, the area of defined risk has been a distance of < 3 feet around the patient, based on epidemiologic and simulated studies of selected infections.\textsuperscript{103,104} Using this distance for donning masks has been effective in preventing transmission of infectious agents through the droplet route. However, experimental studies with smallpox\textsuperscript{107,108} and investigations during the global SARS outbreaks of 2003\textsuperscript{101} suggest that droplets from patients with these 2 infections could reach persons located 6 feet or more from their source. It is likely that the distance that droplets travel depends on the velocity and mechanism by which respiratory droplets are propelled from the source, the density of respiratory secretions, environmental factors (eg, temperature, humidity), and the pathogen’s ability to maintain infectivity over that distance.\textsuperscript{105} Thus, a distance of < 3 feet around the patient is best considered an example of what is meant by “a short distance from a patient” and should not be used as the sole criterion for determining when a mask should be donned to protect from droplet exposure. Based on these considerations, it may be prudent to don a mask when within 6 to 10 feet of the patient or on entry into the patient’s room, especially when exposure to emerging or highly virulent pathogens is likely. More studies are needed to gain more insight into droplet transmission under various circumstances.

Droplet size is another variable under investigation. Droplets traditionally have been defined as being > 5 \( \mu \text{m} \) in size. Droplet nuclei (ie, particles arising from desiccation of suspended droplets) have been associated with airborne transmission and defined as < 5 \( \mu \text{m} \) in size,\textsuperscript{105} a reflection of the pathogenesis of pulmonary tuberculosis that is not generalizable to other organisms. Observations of particle dynamics have demonstrated that a range of droplet sizes, including those of diameter \( \geq 30 \mu \text{m} \), can remain suspended in the air.\textsuperscript{109} The behavior of droplets and droplet nuclei affect recommendations for preventing transmission. Whereas fine airborne particles containing pathogens that are able to remain infective may transmit infections over long distances, requiring AIIR to prevent its dissemination within a facility; organisms transmitted by the droplet route do not remain infective over long distances and thus do not require special air handling and ventilation. Examples of infectious agents transmitted through the droplet route include \( B \) pertussis,\textsuperscript{110} influenza virus,\textsuperscript{23} adenovirus,\textsuperscript{111} rhinovirus,\textsuperscript{104} \textit{Mycoplasma pneumoniae},\textsuperscript{112} SARS-CoV,\textsuperscript{21,96,113} group A streptococcus,\textsuperscript{114} and \textit{Neisseria meningitides}.\textsuperscript{95,103,115} Although RSV may be transmitted by the droplet route, direct contact with infected respiratory secretions is the most important determinant of transmission and consistent adherence to Standard Precautions plus Contact Precautions prevents transmission in health care settings.\textsuperscript{24,116,117}

Rarely, pathogens that are not transmitted routinely by the droplet route are dispersed into the air over short distances. For example, although \textit{S aureus} is transmitted most frequently by the contact route, viral upper respiratory tract infection has been associated with increased dispersal of \textit{S aureus} from the nose into the air for a distance of 4 feet under both outbreak and experimental conditions; this is known as the “cloud baby” and “cloud adult” phenomenon.\textsuperscript{118-120}

\textbf{I.B.3.c. Airborne Transmission.} Airborne transmission occurs by dissemination of either airborne droplet nuclei or small particles in the respirable size range containing infectious agents that remain infective over time and distance (eg, spores of \textit{Aspergillus} spp and \textit{M tuberculosis}). Microorganisms carried in this manner may be dispersed over long distances by air currents and may be inhaled by susceptible individuals who have not had face-to-face contact with (or even been in the same room with) the infectious individual.\textsuperscript{121-124} Preventing the spread of pathogens that are transmitted by the airborne route requires the use of special air handling and ventilation systems (eg, AIIRs) to contain and then safely remove the infectious agent.\textsuperscript{11} Infectious agents to which this applies include \textit{M tuberculosis},\textsuperscript{124-127} rubeola virus (measles),\textsuperscript{122} and varicella-zoster virus (chickenpox).\textsuperscript{123} In addition, published data suggest the possibility that variola virus (smallpox) may be transmitted over long distances through the air under unusual circumstances, and AIIRs are recommended for this agent as well; however, droplet and contact routes are the more frequent routes of transmission for smallpox.\textsuperscript{108,128,129} In addition to AIIRs, respiratory protection with a National Institute for Occupational Safety and Health (NIOSH)-certified N95 or higher-level respirator is recommended for HCWs entering the AIIR, to prevent acquisition of airborne infectious agents such as \textit{M tuberculosis}.\textsuperscript{12}

For certain other respiratory infectious agents, such as influenza\textsuperscript{130,131} and rhinovirus,\textsuperscript{104} and even some gastrointestinal viruses (eg, norovirus\textsuperscript{132} and rotavirus\textsuperscript{135} ), there is some evidence that the pathogen may be transmitted through small-particle aerosols under natural and experimental conditions. Such transmission has occurred over distances > 3 feet but within a defined air space (eg, patient room), suggesting that it is unlikely that these agents remain viable on air currents that travel long distances. AIIRs are not routinely required to prevent transmission of these agents. Additional issues concerning small-particle aerosol transmission of agents that are most frequently transmitted by the droplet route are discussed below.

I.B.3.d.i. Transmission From Patients. The emergence of SARS in 2002, the importation of monkeypox into the United States in 2003, and the emergence of avian influenza present challenges to the assignment of isolation categories due to conflicting information and uncertainty about possible routes of transmission. Although SARS-CoV is transmitted primarily by contact and/or droplet routes, airborne transmission over a limited distance (eg, within a room) has been suggested, although not proven.\(^{134-141}\) This is true of other infectious agents as well, such as influenza virus\(^{130}\) and noroviruses.\(^{132,142,143}\) Influenza viruses are transmitted primarily by close contact with respiratory droplets, and acquisition by HCWs has been prevented by Droplet Precautions, even when positive-pressure rooms were used in one center.\(^{144}\) However, inhalational transmission could not be excluded in an outbreak of influenza in the passengers and crew of an aircraft.\(^{130}\)

Observations of a protective effect of ultraviolet light in preventing influenza among patients with tuberculosis during the influenza pandemic of 1957–1958 have been used to suggest airborne transmission.\(^{149}\) However, transmission could not be excluded in an outbreak of influenza in the passengers and crew of an aircraft.\(^{130}\)

In contrast to the strict interpretation of an airborne route for transmission (ie, long distances beyond the patient room environment), short-distance transmission by small-particle aerosols generated under specific circumstances (eg, during endotracheal intubation) to persons in the immediate area near the patient also has been demonstrated. Aerosolized particles < 100 μm in diameter can remain suspended in air when room air current velocities exceed the terminal settling velocities of the particles.\(^{109}\) SARS-CoV transmission has been associated with endotracheal intubation, noninvasive positive pressure ventilation, and cardiopulmonary resuscitation.\(^{139,94,96,98,141}\) Although the most frequent routes of transmission of noroviruses are contact and foodborne and waterborne routes, several reports suggest that noroviruses also may be transmitted through aerosolization of infectious particles from vomitus or fecal material.\(^{142,143,147,148}\) It is hypothesized that the aerosolized particles are inhaled and subsequently swallowed.

Roy and Milton have proposed a new classification for aerosol transmission when evaluating routes of SARS transmission:

- Obligate. Under natural conditions, disease occurs after transmission of the agent only through inhalation of small-particle aerosols (eg, tuberculosis).
- Preferential. Natural infection results from transmission through multiple routes, but small-particle aerosols are the predominant route (eg, measles, varicella).
- Opportunistic. Under special circumstances, agents that naturally cause disease through other routes may be transmitted through small-particle aerosols.\(^{149}\)

This conceptual framework can explain rare occurrences of airborne transmission of agents that are transmitted most frequently by other routes (eg, smallpox, SARS, influenza, noroviruses). Concerns about unknown or possible routes of transmission of agents associated with severe disease and no known treatment often result in the adoption of overextreme prevention strategies, and recommended precautions may change as the epidemiology of an emerging infection becomes more well defined and controversial issues are resolved.

I.B.3.d.ii. Transmission From the Environment. Some airborne infectious agents are derived from the environment and do not usually involve person-to-person transmission; for example, anthrax spores present in a finely milled powdered preparation can be aerosolized from contaminated environmental surfaces and inhaled into the respiratory tract.\(^{150,151}\) Spores of environmental fungi (eg, Aspergillus spp) are ubiquitous in the environment and may cause disease in immunocompromised patients who inhale aerosolized spores (through, eg, construction dust).\(^{152,153}\) As a rule, neither of these organisms is subsequently transmitted from infected patients; however, there is 1 well-documented report of person-to-person transmission of Aspergillus sp in the ICU setting that was most likely due to the aerosolization of spores during wound debridement.\(^{154}\) The PE involves isolation practices designed to decrease the risk of exposure to environmental fungal agents in allogeneic HSCT patients.\(^{11,14,15,155-158}\)

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

I.B.3.e. Other Sources of Infection. Sources of infection transmission other than infectious individuals include those associated with common environmental sources or vehicles (eg, contaminated food, water, or medications, such as intravenous fluids). Although Aspergillus spp have been recovered from hospital water systems,\(^{159}\) the role of water as a reservoir for immunosuppressed patients remains unclear. Vectorborne transmission of infectious agents from mosquitoes, flies, rats, and other vermin also can occur in health care settings. Prevention of vectorborne transmission is not addressed in this document.

I.C. Infectious Agents of Special Infection Control Interest for Health Care Settings

This section discusses several infectious agents with important infection control implications that either were not discussed extensively in previous isolation...
guidelines or have emerged only recently. Included are epidemiologically important organisms (eg, *C. difficile*), agents of bioterrorism, prions, SARS-CoV, monkeypox, noroviruses, and the hemorrhagic fever viruses (HFVs). Experience with these agents has broadened the understanding of modes of transmission and effective preventive measures. These agents are included for information purposes and, for some (ie, SARS-CoV, monkeypox), to highlight the lessons that have been learned about preparedness planning and responding effectively to new infectious agents.

**I.C.1. Epidemiologically Important Organisms.** Under defined conditions, any infectious agent transmitted in a health care setting may become targeted for control because it is epidemiologically important. *C. difficile* is specifically discussed below because of its current prevalence and seriousness in US health care facilities. In determining what constitutes an “epidemiologically important organism,” the following criteria apply:

- **A propensity for transmission within health care facilities** based on published reports and the occurrence of temporal or geographic clusters of more than 2 patients, (eg, *C. difficile*, norovirus, RSV, influenza, *Enterobacter* spp, *Serratia* spp, group A streptococcus). A single case of health care–associated invasive disease caused by certain pathogens (eg, group A streptococcus postoperatively,160 in a burn unit,161 or in a LTCF,162 *Legionella* spp,14,163 *Aspergillus* spp164) is generally considered a trigger for investigation and enhanced control measures because of the risk of additional cases and the severity of illness associated with these infections. Antimicrobial resistance can have the following characteristics:

- **Resistance to first-line therapies** (eg, MRSA, vancomycin-resistant/intermediate/resistant *S. aureus* [VISA], vancomycin-resistant *S. aureus* [VRSA], VRE, extended-spectrum beta-lactamase [ESBL]-producing organisms)

- **Common and uncommon microorganisms with unusual patterns of resistance** within a facility (eg, the first isolate of *Burkholderia cepacia* complex or *Ralstonia* spp in non-CF patients or a quinolone-resistant strain of *P. aeruginosa* in a facility)

- **Difficult to treat** because of innate or acquired resistance to multiple classes of antimicrobial agents (eg, *Stenotrophomonas maltophilia*, *Acinetobacter* spp)

- **Association with serious clinical disease** and increased morbidity and mortality (eg, MRSA and methicillin-susceptible *S. aureus* [MSSA], group A streptococcus)

- **A newly discovered or reemerging pathogen.**

**I.C.1.a. Clostridium difficile.** *C. difficile* is a spore-forming gram-positive anaerobic bacillus that was first isolated from stools of neonates in 1935165 and identified as the most frequent causative agent of antibiotic-associated diarrhea and pseudomembranous colitis in 1977.166 This pathogen is a major cause of health care–associated diarrhea and has been responsible for many large outbreaks in health care settings that have proven extremely difficult to control. Important factors contributing to health care–associated outbreaks include environmental contamination, persistence of spores for prolonged periods, resistance of spores to routinely used disinfectants and antiseptics, hand carriage by HCWs to other patients, and exposure of patients to frequent courses of antimicrobial agents.167 Antimicrobials most frequently associated with increased risk of *C. difficile* include third-generation cephalosporins, clindamycin, vancomycin, and fluoroquinolones.

Since 2001, outbreaks and sporadic cases of *C. difficile* with increased morbidity and mortality have occurred in several US states, Canada, England, and the Netherlands.168-172 The same strain of *C. difficile* has been implicated in all of these outbreaks;173 this strain, toxinotype III, North American pulsed-field gel electrophoresis (PFGE) type 1, and polymerase chain reaction (PCR)-ribotype 027 (NAP1/027), has been found to hyperproduce toxin A (a 16-fold increase) and toxin B (a 23-fold increase) compared with isolates from 12 other PFGE types. A recent survey of US infectious disease physicians found that 40% of the respondents perceived recent increases in the incidence and severity of *C. difficile* disease.174 Standardization of testing methodology and surveillance definitions is needed for accurate comparisons of trends in rates among hospitals.175 It is hypothesized that the incidence of disease and apparent heightened transmissibility of this new strain may be due, at least in part, to the greater production of toxins A and B, increasing the severity of diarrhea and producing more environmental contamination. Considering the greater morbidity, mortality, length of stay, and costs associated with *C. difficile* disease in both acute care and long-term care facilities, control of this pathogen is becoming increasingly important.

Prevention of transmission focuses on syndromic application of Contact Precautions for patients with diarrhea, accurate identification of affected patients, environmental measures (eg, rigorous cleaning of patient rooms), and consistent hand hygiene. Using soap and water rather than alcohol-based handrubs for mechanical removal of spores from hands and using a bleach-containing disinfectant (5000 ppm) for environmental disinfection may be valuable in cases of transmission in health care facilities. Appendix A provides for recommendations.
I.C.1.b. Multidrug-Resistant Organisms. In general, MDROs are defined as microorganisms—predominantly bacteria—that are resistant to 1 or more classes of antimicrobial agents. Although the names of certain MDROs suggest resistance to only a single agent (eg, MRSA, VRE), these pathogens are usually resistant to all but a few commercially available antimicrobial agents. This latter feature defines MDROs that are considered to be epidemiologically important and deserve special attention in health care facilities. Other MDROs of current concern include multidrug-resistant Streptococcus pneumoniae, 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 ESBLs; and strains of S. aureus that are intermediate or resistant to vancomycin (ie, VISA and VRSA).

MDROs are transmitted by the same routes as antimicrobial susceptible infectious agents. Patient-to-patient transmission in health care 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.

Preventing the emergence and transmission of these pathogens requires a comprehensive approach that includes administrative involvement and measures (eg, nurse staffing, communication systems, performance improvement processes to ensure adherence to recommended infection control measures), education and training of medical and other HCWs, judicious antibiotic use, comprehensive surveillance for targeted MDROs, application of infection control precautions during patient care, environmental measures (eg, cleaning and disinfection of the patient care environment and equipment, dedicated single-patient use of noncritical equipment), and decolonization therapy when appropriate.

The prevention and control of MDROs is a national priority, one that requires that all health care facilities and agencies assume responsibility and participate in community-wide control programs. A detailed discussion of this topic and recommendations for prevention published in 2006 is available at http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf.

I.C.2. Agents of Bioterrorism. The CDC has designated the agents that cause 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 necessitate special action for public health preparedness. General information relevant to infection control in health care settings for Category A agents of bioterrorism is summarized in Table 3. (See 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.) Category B and C agents are important but are not as readily disseminated and cause less morbidity and mortality than Category A agents.

Health care facilities confront a different set of issues when dealing with a suspected bioterrorism event compared with other communicable diseases. An understanding of the epidemiology, modes of transmission, and clinical course of each disease, as well as carefully drafted plans that specify an approach and relevant websites and other resources for disease-specific guidance to health care, administrative, and support personnel, are essential for responding to and managing a bioterrorism event. Infection control issues to be addressed include (1) identifying persons who may be exposed or infected; (2) preventing transmission among patients, HCWs, and visitors; (3) providing treatment, chemoprophylaxis, or vaccine to potentially large numbers of people; (4) protecting the environment, including the logistical aspects of securing sufficient numbers of AIIRs or designating areas for patient cohorts when an insufficient number of AIIRs is available; (5) providing adequate quantities of appropriate PPE; and (6) identifying appropriate staff to care for potentially infectious patients (eg, vaccinated HCWs for care of patients with smallpox). The response is likely to differ for exposures resulting from an intentional release compared with a naturally occurring disease because of the large number of persons that can be exposed at the same time and possible differences in pathogenicity.

Various sources offer guidance for the management of persons exposed to the most likely agents of bioterrorism. Federal agency websites (eg, http://www.usamriid.army.mil/publications/index.html and http://www.bt.cdc.gov) and state and county health department websites should be consulted for the most up-to-date information. Sources of information on specific agents include anthrax,205 smallpox,204-206 plague,207-208 botulinum toxin,209 tularemia,210 and hemorrhagic fever viruses.211,212

I.C.2.a. Pre-Event Administration of Smallpox (Vaccinia) Vaccine to Health Care Workers. Vaccination of HCWs in preparation for a possible smallpox exposure has important infection control implications. These include the need for meticulous screening for vaccine contraindications in persons at increased risk for adverse vaccinia events; containment and monitoring of the vaccination site to prevent transmission in the health care setting and at home; and management of patients with vaccinia-related
adverse events. The pre-event US smallpox vaccination program of 2003 is an example of the effectiveness of carefully developed recommendations for both screening potential vaccinees for contraindications and vaccination site care and monitoring. Between December 2002 and February 2005, approximately 760,000 individuals were vaccinated in the Department of Defense and 40,000 in the civilian or public health populations, including approximately 70,000 who worked in health care settings. No cases of eczema vaccinatum, progressive vaccinia, fetal vaccinia, or contact transfer of vaccinia were reported in health care settings or in military workplaces.

Outside the health care setting, there were 53 cases of contact transfer from military vaccinees to close personal contacts (eg, bed partners or contacts during participation in sports such as wrestling). All contact transfers were from individuals who were not following recommendations to cover their vaccination sites. Vaccinia virus was confirmed by culture or PCR in 50 cases, 2 of which resulted from tertiary transfer. All recipients, including 1 breast-fed infant, recovered without complications. Subsequent studies using viral culture and PCR techniques have confirmed the effectiveness of semipermeable dressings to contain vaccinia. This experience emphasizes the importance of ensuring that newly vaccinated HCWs adhere to recommended vaccination site care, especially those caring for high-risk patients. Recommendations for pre-event smallpox vaccination of HCWs and vaccinia-related infection control recommendations are published in the Morbidity and Mortality Weekly Report216,225 with updates posted on the CDC’s bioterrorism website.

1.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. CJD is believed to be caused by a transmissible proteinaceous infectious agent known as a prion. Infectious prions are isoforms of a host-encoded glycoprotein known as the prion protein. The incubation period (ie, time between exposure and and onset of symptoms) varies from 2 years to many decades. However, death typically occurs within 1 year of the onset of symptoms. Approximately 85% of CJD cases occur sporadically with no known environmental source of infection, and 10% of cases are familial. Iatrogenic transmission has occurred, with most cases resulting from treatment with human cadaver pituitary-derived growth hormone or gonadotropin from implantation of contaminated human dura mater grafts or from corneal transplants. Transmission has been linked to the use of contaminated neurosurgical instruments or stereotactic electroencephalogram electrodes.

Prion diseases in animals include 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 in 1986, was associated with a major epidemic among cattle that had consumed contaminated meat and bone meal. The possible transmission of BSE to humans causing variant CJD (vCJD) was first described in 1996 and was subsequently found to be associated with consumption of BSE-contaminated cattle products primarily in the United Kingdom. There is strong epidemiologic and laboratory evidence for a causal association between the causative agent of BSE and vCJD. Although most cases of vCJD have been reported from the United Kingdom, a few cases also have been reported from Europe, Japan, Canada, and the United States. Most persons affected with vCJD worldwide lived in or visited the United Kingdom during the years of a large outbreak of BSE (1980–1996) and may have consumed contaminated cattle products during that time (see http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm). Although there has been no indigenously acquired vCJD in the United States, the sporadic occurrence of BSE in cattle in North America has heightened awareness of the possibility that such infections could occur and have led to increased surveillance activities. Updated information may be found at http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm. The public health impact of prion diseases has been reviewed previously.

vCJD in humans has different clinical and pathologic characteristics than sporadic or classic CJD, including (1) younger median age at death (28 [range, 16 to 48] vs 68 years), (2) longer median duration of illness (14 months vs 4 to 6 months), (3) increased frequency of sensory symptoms and early psychiatric symptoms with delayed onset of frank neurologic signs; and (4) detection of prions in tonsillar and other lymphoid tissues, not present in sporadic CJD. Similar to sporadic CJD, there have been no reported cases of direct human-to-human transmission of vCJD by casual or environmental contact, droplet, or airborne routes. Ongoing blood safety surveillance in the United States has not detected sporadic CJD transmission through blood transfusion; however, bloodborne transmission of vCJD is believed to have occurred in 2 patients in the United Kingdom. The following FDA websites provide information on steps currently being taken in the United States to protect the blood supply from CJD and vCJD: http://www.fda.gov/cber/gdlns/cjdvocjd.htm and http://www.fda.gov/cber/gdlns/cjdqcjdq&a.htm.

Standard Precautions are used when caring for patients with suspected or confirmed CJD or vCJD. However, special precautions are recommended for tissue handling in the histology laboratory and for conducting...
an autopsy, embalming, and coming into contact with a body that has undergone autopsy.\textsuperscript{246} Recommendations for reprocessing surgical instruments to prevent transmission of CJD in health care settings have been published by the World Health Organization (WHO) and are currently under review at the CDC.

Questions may arise concerning notification of patients potentially exposed to CJD or vCJD through contaminated instruments and blood products from patients with CJD or vCJD or at risk of having vCJD. The risk of transmission associated with such exposures is believed to be extremely low but may vary based on the specific circumstance. Therefore, consultation on appropriate options is advised. The United Kingdom has developed several documents that clinicians and patients in the United States may find useful (see \url{http://www.hpa.org.uk/infections/topics_az/cjd/information_documents.htm}).

**I.C.4. Severe Acute Respiratory Syndrome.** SARS is a newly discovered respiratory disease that emerged in China late in 2002 and spread to several countries.\textsuperscript{135,146} In particular, mainland China, Hong Kong, Hanoi, Singapore, and Toronto have been significantly affected. SARS is caused by SARS-CoV, a previously unrecognized member of the coronavirus family.\textsuperscript{247,248} The incubation period from exposure to the onset of symptoms is typically 2 to 7 days, but can be as long as 10 days and in rare cases even longer.\textsuperscript{249} The illness is initially difficult to distinguish from other common respiratory infections. Signs and symptoms usually include fever above 38.0°C and chills and rigor, sometimes accompanied by headache, myalgia, and mild to severe respiratory symptoms. A radiographic profile of atypical pneumonia is an important clinical indicator of possible SARS. Compared with adults, children are affected less frequently, have milder disease, and are less likely to transmit SARS-CoV.\textsuperscript{135,249-251} The overall case fatality rate is approximately 6%; underlying disease and advanced age increase the risk of mortality (see \url{http://www.who.int/csr/sarsarchive/2003_05_07a/en/}).

Outbreaks in health care settings, with transmission to large numbers of HCWs and patients, has been a striking feature of SARS; undiagnosed infectious patients and visitors have been important initiators of these outbreaks.\textsuperscript{21,252-254} The relative contribution of potential modes of transmission is not known precisely. There is ample evidence for droplet and contact transmission;\textsuperscript{98,96,101,113} however, opportunistic airborne transmission cannot be excluded.\textsuperscript{109,135-139,149,254} For example, exposure to aerosol-generating procedures (eg, endotracheal intubation, suctioning) has been associated with transmission of infection to large numbers of HCWs outside of the United States.\textsuperscript{93,94,96,98,253} Therefore, aerosolization of small infectious particles generated during these and other similar procedures could be a risk factor for transmission to others within a multibed room or shared airspace. A review of the infection control literature generated from the SARS outbreaks of 2003 concluded that the greatest risk of transmission is to those who have close contact, are not properly trained in use of protective infection control procedures, and do not consistently use PPE, and that N95 or higher-level respirators may offer additional protection to those exposed to aerosol-generating procedures and high-risk activities.\textsuperscript{255,256}

Organizational and individual factors that affect adherence to infection control practices for SARS also were identified.\textsuperscript{256} Control of SARS requires a coordinated, dynamic response by multiple disciplines in a health care setting. Early detection of cases is accomplished by screening persons with symptoms of a respiratory infection for history of travel to areas experiencing community transmission or contact with SARS patients, followed by implementation of respiratory hygiene/cough etiquette (ie, placing a mask over the patient’s nose and mouth) and physical separation from other patients in common waiting areas. The precise combination of precautions to protect HCWs has not yet been determined. At the time of this publication, the CDC recommends Standard Precautions, with emphasis on the use of hand hygiene; Contact Precautions, with emphasis on environmental cleaning due to the detection of SARS-CoV RNA by PCR on surfaces in rooms occupied by SARS patients;\textsuperscript{138,254,257} and Airborne Precautions, including use of fit-tested NIOSH-approved N95 or higher-level respirators and eye protection.\textsuperscript{258} In Hong Kong, the use of Droplet and Contact Precautions, including the use of a mask but not a respirator, was effective in protecting HCWs.\textsuperscript{113} However, in Toronto, consistent use of an N95 respirator was found to be slightly more protective than a mask.\textsuperscript{93} It is noteworthy that no transmission of SARS-CoV to public hospital workers occurred in Vietnam despite inconsistent use of infection control measures, including use of PPE, which suggests other factors (eg, severity of disease, frequency of high-risk procedures or events, environmental features) may influence opportunities for transmission.\textsuperscript{259}

SARS-CoV also has been transmitted in the laboratory setting through breaches in recommended laboratory practices. Research laboratories in which SARS-CoV was under investigation were the source of most cases reported after the first series of outbreaks in the winter and spring of 2003.\textsuperscript{260,261} Studies of the SARS outbreaks of 2003 and transmissions occurring in the laboratory reaffirm the effectiveness of recommended infection control precautions and highlight the importance of consistent adherence to these measures.
Lessons learned from the SARS outbreaks are useful in devising plans to respond to future public health crises, such as pandemic influenza and bioterrorism events. Surveillance for cases among patients and HCWs, ensuring availability of adequate supplies and staffing, and limiting access to health care facilities were important factors in the response to SARS.9 Guidance for infection control precautions in various settings is available at http://www.cdc.gov/ncidod/sars.

1.C.5. Monkeypox. Monkeypox is a rare viral disease found mostly in the rain forest countries of Central and West Africa. The disease is caused by an orthopoxvirus that is similar in appearance to smallpox but causes a milder disease. The only recognized outbreak of human monkeypox in the United States was detected in June 2003, after several people became ill after contact with sick pet prairie dogs. Infection in the prairie dogs was subsequently traced to their contact with a shipment of animals from Africa, including giant Gambian rats.262 This outbreak demonstrates the importance of recognition and prompt reporting of unusual disease presentations by clinicians to enable prompt identification of the etiology, as well as the potential of epizootic diseases to spread from animal reservoirs to humans through personal and occupational exposure.263

Only 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 secretions; airborne transmission from animals to humans is unlikely but cannot be excluded, and may have occurred in veterinary practices (eg, during administration of nebulized medications to ill prairie dogs264). In humans, 4 instances of monkeypox transmission in hospitals have been reported in Africa among children, usually related to sharing the same ward or bed.265,266 Additional recent literature documents transmission of Congo Basin monkeypox in a hospital compound for an extended number of generations.267

There has been no evidence of airborne or any other person-to-person transmission of monkeypox in the United States, and no new cases of monkeypox have been identified since the outbreak in June 2003.268 The outbreak strain is a clade of monkeypox distinct from the Congo Basin clade and may have different epidemiologic properties (including human-to-human transmission potential) from monkeypox strains of the Congo Basin;269 this awaits further study. Smallpox vaccine is 85% protective against Congo Basin monkeypox.270 Because there is an associated case fatality rate of <10%, administration of smallpox vaccine within 4 days to individuals who have had direct exposure to patients or animals with monkeypox is a reasonable policy.271 For the most current information on monkeypox, see http://www.cdc.gov/ncidod/monkeypox/clinicians.htm.

1.C.6. Noroviruses. Noroviruses, formerly referred to as Norwalk-like viruses, are members of the Caliciviridae family. These agents are transmitted via contaminated food or water and from person to person, causing explosive outbreaks of gastrointestinal disease.272 Environmental contamination also has been documented as a contributing factor in ongoing transmission during outbreaks.273,274 Although noroviruses cannot be propagated in cell culture, DNA detection by molecular diagnostic techniques has brought a greater appreciation of their role in outbreaks of gastrointestinal disease.275 Reported outbreaks in hospitals,132,142,276 nursing homes,274,277-282 cruise ships,283,284 hotels,143,147 schools,148 and large crowded shelters established for hurricane evacuees285 has demonstrated their highly contagious nature, their potentially disruptive impact in health care facilities and the community, and the difficulty of controlling outbreaks in settings in which people share common facilities and space. Of note, there is nearly a 5-fold increase in the risk to patients in outbreaks when a patient is the index case compared with exposure of patients during outbreaks when a staff member is the index case.286

The average incubation period for gastroenteritis caused by noroviruses is 12 to 48 hours, and the clinical course lasts 12 to 60 hours.272 Illness is characterized by acute onset of nausea, vomiting, abdominal cramps, and/or diarrhea. The disease is largely self-limited; rarely, death due to severe dehydration can occur, particularly in elderly persons with debilitating health conditions.

The epidemiology of norovirus outbreaks shows that even though primary cases may result from exposure to a fecally contaminated food or water, secondary and tertiary cases often result from person-to-person transmission facilitated by contamination of fomites272,287 and dissemination of infectious particles, especially during the process of vomiting.132,142,143,147,148,272,278 Widespread, persistent, and apparently unrelated contamination of the environment and fomites can make outbreaks extremely difficult to control.147,274,283 These clinical observations and the detection of norovirus DNA on horizontal surfaces 5 feet above the level that might be touched normally suggest that under certain circumstances, aerosolized particles may travel distances beyond 3 feet.147 It is hypothesized that infectious particles may be aerosolized from vomitus, inhaled, and swallowed. In addition, individuals who are responsible for cleaning the environment may be at increased risk of infection. Development of disease and transmission may be facilitated by the low infectious dose (ie, <100 viral particles)288 and the resistance of these viruses to the usual cleaning and disinfection agents.
HFVs in humans has not been documented. A study of airplane passengers exposed to an in-flight index case of Lassa fever found no transmission to any passengers.\textsuperscript{307}

In the laboratory setting, animals have been infected experimentally with Marburg or Ebola virus through direct inoculation of the nose, mouth, and/or conjunctiva\textsuperscript{308,309} and by using mechanically generated virus-containing aerosols\textsuperscript{310,311}. Transmission of Ebola virus among laboratory primates in an animal facility has been described.\textsuperscript{312} The secondarily infected animals were in individual cages separated by approximately 3 meters. Although the possibility of airborne transmission was suggested, the investigators were not able to exclude droplet or indirect contact transmission in this incidental observation.

Guidance on infection control precautions for HFVs transmitted person-to-person have been published by the CDC\textsuperscript{1,211} and by the Johns Hopkins Center for Civilian Biodefense Strategies.\textsuperscript{212} The most recent recommendations at the time of publication of this document were posted on the CDC website on May 19, 2005.\textsuperscript{313} Inconsistencies among the various recommendations have raised questions about the appropriate precautions to use in US hospitals. In less developed countries, outbreaks of HFVs have been controlled with basic hygiene, barrier precautions, safe injection practices, and safe burial practices.\textsuperscript{298,305} The preponderance of evidence on HFV transmission indicates that Standard, Contact, and Droplet Precautions with eye protection are effective in protecting HCWs and visitors coming in contact with an infected patient. Single gloves are adequate for routine patient care; double-gloving is advised during invasive procedures (eg, surgery) that pose an increased risk of blood exposure. Routine eye protection (ie, goggles or face shield) is particularly important. Fluid-resistant gowns should be worn for all patient contact. Airborne Precautions are not required for routine patient care; however, use of AIIRs is prudent when procedures that could generate infectious aerosols are performed (eg, endotracheal intubation, bronchoscopy, suctioning, autopsy procedures involving oscillating saws). N95 or higher-level respirators may provide added protection for individuals in a room during aerosol-generating procedures (Table 3, Appendix A). When a patient with a syndrome consistent with hemorrhagic fever also has a history of travel to an endemic area, precautions are initiated on presentation and then modified as more information is obtained (Table 2). Patients with hemorrhagic fever syndrome in the setting of a suspected bioweapons attack should be managed using Airborne Precautions, including AIIRs, because the epidemiology of a potentially weaponized hemorrhagic fever virus is unpredictable.
I.D. Transmission Risks Associated With Specific Types of Health Care Settings

Numerous factors influence differences in transmission risks among the various health care settings. These factors include the population characteristics (e.g., increased susceptibility to infections, type and prevalence of indwelling devices), intensity of care, exposure to environmental sources, length of stay, and frequency of interaction between patients/residents with each other and with HCWs. These factors, as well as organizational priorities, goals, and resources, influence how different health care settings adapt transmission prevention guidelines to meet their specific needs.314,315 Infection control management decisions are informed by data regarding institutional experience/Epidemiology; trends in community and institutional HAIs; local, regional, and national Epidemiology; and emerging infectious disease threats.

I.D.1. Hospitals. Infection transmission risks are present in all hospital settings. However, certain hospital settings and patient populations have unique conditions that predispose patients to infection and merit special mention. These are often sentinel sites for the emergence of new transmission risks that may be unique to that setting or present opportunities for transmission to other settings in the hospital.

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, overdose, stroke, gastrointestinal bleeding, renal failure, hepatic failure, multiorgan system failure, and extremes of age). Although ICUs account for a relatively small proportion of hospitalized patients, infections acquired in these units account for > 20% of all HAIs.316 In the National Nosocomial Infection Surveillance (NNIS) system, 26.6% of HAIs were reported from ICU and high-risk nursery (neonatal ICU [NICU]) patients in 2002 (NNIS, unpublished data). This patient population has increased susceptibility to colonization and infection, especially with MDROs and *Candida* spp.317,318 because of underlying diseases and conditions, the invasive medical devices and technology used in their care (e.g., central venous catheters and other intravascular devices, mechanical ventilators, extracorporeal membrane oxygenation, hemodialysis filtration, pacemakers, implantable left-ventricular assist devices), the frequency of contact with HCWs, prolonged lengths of stay, and prolonged exposure to antimicrobial agents.319-330 Furthermore, adverse patient outcomes in this setting are more severe and are associated with a higher mortality.351 Outbreaks associated with various bacterial, fungal, and viral pathogens due to common-source and person-to-person transmissions are frequent in adult ICUs and pediatric ICUs.31,332-337

I.D.1.b. Burn Units. Burn wounds can provide optimal conditions for colonization, infection, and transmission of pathogens; infection acquired by burn patients is a frequent cause of morbidity and mortality.319,338,339 The risk of invasive burn wound infection is particularly high in patients with a burn injury involving > 30% of the total body surface area (TBSA).340,341 Infections occurring in patients with burn injuries involving < 30% of the TBSA are usually associated with the use of invasive devices. MSSA, MRSA, enterococci (including VRE), gram-negative bacteria, and *Candida* spp are prevalent pathogens in burn infections.53,339,342-344 and outbreaks of these organisms have been reported.350,353 Shifts over time in the predominance of pathogens causing infections in burn patients often lead to changes in burn care practices.342,354-357 Burn wound infections caused by *Aspergillus* spp or other environmental molds may result from exposure to supplies contaminated during construction358 or to dust generated during construction or other environmental disruption.359

Hydrotherapy equipment is an important environmental reservoir of gram-negative organisms. Its use in burn care is discouraged based on demonstrated associations between the use of contaminated hydrotherapy equipment and infections. Burn wound infections and colonization, as well as bloodstream infections, caused by multidrug-resistant *P aeruginosa*,360 *Actinobacter baumannii*,361 and MRSA351 have been associated with hydrotherapy; thus, excision of burn wounds in operating rooms is the preferred approach.

Advances in burn care (specifically, early excision and grafting of the burn wound, use of topical antimicrobial agents, and institution of early enteral feeding) have led to decreased infectious complications. Other advances have included prophylactic antimicrobial use, selective digestive decontamination, and use of antimicrobial-coated catheters; however, few epidemiologic studies and no efficacy studies have been performed to investigate the relative benefit of these measures.356

There is no consensus on the most effective infection control practices to prevent transmission of infections to and from patients with serious burns (e.g., single-bed rooms,357 laminar flow,362 and high-efficiency particulate air [HEPA] filtration,359 or maintaining burn patients in a separate unit with no exposure to patients or equipment from other units363). There also is controversy regarding the need for and type of barrier precautions in the routine care of burn patients. One retrospective study demonstrated the efficacy and cost-effectiveness of a simplified barrier
isolation protocol for wound colonization, emphasizing handwashing and use of gloves, caps, masks, and impermeable plastic aprons (rather than isolation gowns) for direct patient contact. However, to date no studies have determined 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. Pediatric ICU patients and the lowest birth weight babies in the NICU monitored in the NNIS system have had high rates of central venous catheter–associated bloodstream infections. In addition, 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. This results in more patients and their sibling visitors with transmissible infections in pediatric health care settings, especially during seasonal epidemics (eg, pertussis, respiratory viral infections, including those caused by RSV, influenza viruses, parainfluenza virus, human metapneumovirus, and adenoviruses; rubeola [measles]; varicella [chickenpox]; and rotavirus).

Close physical contact between HCWs and infants and young children (eg, cuddling, feeding, playing, changing soiled diapers, and cleaning copious uncontaminated respiratory secretions) provides abundant opportunities for transmission of infectious material. Such practices and behaviors as congregation of children in play areas where toys and bodily secretions are easily shared and rooming-in of family members with pediatric patients can further increase the risk of transmission. Pathogenic bacteria have been recovered from toys used by hospitalized patients; contaminated bath toys were implicated in an outbreak of multidrug-resistant P. aeruginosa on a pediatric oncology unit. In addition, several patient factors increase the likelihood that infection will result from exposure to pathogens in health care settings (eg, immaturity of the neonatal immune system, lack of previous natural infection and resulting immunity, prevalence of patients with congenital or acquired immune deficiencies, congenital anatomic anomalies, and use of life-saving invasive devices in NICUs and PICUs). There are theoretical concerns that infection risk will increase in association with innovative practices used in the NICU for the purpose of improving developmental outcomes, Such factors include co-bedding and kangaroo care, which may increase opportunity for skin-to-skin exposure of multiple gestation infants to each other and to their mothers, respectively; although the risk of infection actually may be reduced among infants receiving kangaroo care. Children who attend child care centers and pediatric rehabilitation units may increase the overall burden of antimicrobial resistance by contributing to the reservoir of CA-MRSA. Patients in chronic care facilities may have increased rates of colonization with resistant gram-negative bacilli and may be sources of introduction of resistant organisms to acute care settings.

I.D.2. Nonacute Health Care Settings. Health care is provided in various settings outside of hospitals, including long-term care facilities (LTCFs) (eg nursing homes), homes for the developmentally disabled, behavioral health service settings, rehabilitation centers, and hospices. In addition, health care may be provided in non–health care settings, such as workplaces with occupational health clinics, adult day care centers, assisted-living facilities, homeless shelters, jails and prisons, school clinics, and infirmaries. Each of these settings has unique circumstances and population risks that must be considered when designing and implementing an infection control program. Several of the most common settings and their particular challenges are discussed below. Although this guideline does not address each setting, the principles and strategies provided herein may be adapted and applied as appropriate.

I.D.2.a. Long-Term Care. The designation LTCF applies to a diverse group of residential settings, ranging from institutions for the developmentally disabled to nursing homes for the elderly and pediatric chronic care facilities. Nursing homes for the elderly predominate numerically and frequently represent long-term care as a group of facilities. Approximately 1.8 million Americans reside in the nation’s 16,500 nursing homes. Estimates of HAI rates of 1.8 to 15.5 per 1000 resident-care days have been reported, with a range of 3 to 7 per 1000 resident-care days in the more rigorous studies. The infrastructure described in the Department of Veterans Affairs’ nursing home care units is a promising example for the development of a nationwide HAI surveillance system for LTCFs.

LTCFs are different from other health care settings in that elderly patients at increased risk for infection are brought together in one setting and remain in the facility for extended periods; 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. Because able residents interact freely with each other, controlling infection transmission in this setting can be challenging. A residents who is colonized or infected with certain microorganisms are in some cases restricted to his or her room. However,
because of the psychosocial risks associated with such restriction, balancing psychosocial needs with infection control needs is important in the LTCF setting. \(^\text{405-408}\) Documented LTCF outbreaks have been caused by various viruses (eg, influenza virus, \(^\text{35,409-411}\) rhinovirus, \(^\text{412}\) adenovirus [conjunctivitis], \(^\text{413}\) norovirus \(^\text{274,277,278,280}\) and bacteria, including group A streptococcus, \(^\text{162}\) B pertussis, \(^\text{414}\) nonsusceptible \(^\text{S pneumoniæ, 197,198}\) other MDROs, and \(^\text{C difficile}\.\(^\text{415}\) These pathogens can lead to substantial morbidity and mortality, as well as increased medical costs; prompt detection and implementation of effective control measures are needed.

Risk factors for infection are prevalent among LTCF residents. \(^\text{394,416,417}\) Age-related declines in immunity may affect the response to immunizations for influenza and other infectious agents and increase the susceptibility to tuberculosis. Immobility, incontinence, dysphagia, underlying chronic diseases, poor functional status, and age-related skin changes increase susceptibility to urinary, respiratory, and cutaneous and soft tissue infections, whereas malnutrition can impair wound healing. \(^\text{418-422}\) Medications (eg, drugs that affect level of consciousness, immune function, gastric acid secretions, and normal flora, including antimicrobial therapy) and invasive devices (eg, urinary catheters and feeding tubes) heighten the susceptibility to infection and colonization in LTCF residents.\(^\text{425-425}\) Finally, limited functional status and total dependence on HCWs for activities of daily living have been identified as independent risk factors for infection \(^\text{400,416,426}\) and for colonization with MRSA \(^\text{427,428}\) and ESBL-producing \(Klebsiella pneumoniæ.\(^\text{429}\) Several position papers and review articles provide guidance on various aspects of infection control and antimicrobial resistance in LTCFs. \(^\text{405-407,430-435}\) The Centers for Medicare and Medicaid Services has established regulations for the prevention of infection in LTCFs. \(^\text{436}\)

Because residents of LTCFs are hospitalized frequently, they can transfer pathogens between LTCFs and health care facilities in which they receive care. \(^\text{8,437-440}\) This also is true for pediatric long-term care populations. Pediatric chronic care facilities have been associated with the importation of extended-spectrum cephalosporin-resistant, gram-negative bacilli into a PICU. \(^\text{50}\) Children from pediatric rehabilitation units may contribute to the reservoir of community-associated MRSA. \(^\text{384,386-390}\)

**I.D.2.b. Ambulatory Care.** Over the past decade, health care delivery in the United States has shifted from the acute, inpatient hospital to various ambulatory and community-based settings, including the home. Ambulatory care is provided in hospital-based outpatient clinics, nonhospital-based clinics and physicians’ offices, public health clinics, free-standing dialysis centers, ambulatory surgical centers, urgent care centers, and other setting. In 2000, there were 83 million visits to hospital outpatient clinics and more than 823 million visits to physicians’ offices; \(^\text{441}\) ambulatory care now accounts for most patient encounters with the health care system.\(^\text{442}\) Adapting transmission prevention guidelines to these settings is challenging, because patients remain in common areas for prolonged periods waiting to be seen by a health care provider or awaiting admission to the hospital, examination or treatment rooms are turned around quickly with limited cleaning, and infectious patients may not be recognized immediately. Furthermore, immunocompromised patients often receive chemotherapy in infusion rooms, where they stay for extended periods along with other types of patients.

Little data exist on the risk of HAIs in ambulatory care settings, with the exception of hemodialysis centers. \(^\text{8,443,444}\) Transmission of infections in outpatient settings has been reviewed in 3 studies. \(^\text{445-447}\) Goodman and Solomon \(^\text{445}\) summarized 53 clusters of infections associated with the outpatient setting between 1961 and 1990. Overall, 29 clusters were associated with common source transmission from contaminated solutions or equipment, 14 were associated with person-to-person transmission from or involving HCWs, and 10 were associated with airborne or droplet transmission among patients and health care workers. Transmission of bloodborne pathogens (ie, HBV, HCV, and, rarely, HIV) in outbreaks, sometimes involving hundreds of patients, continues to occur in ambulatory settings. These outbreaks often are related to common source exposures, usually a contaminated medical device, multidose vial, or intravenous solution. \(^\text{82,448-452}\) In all cases, transmission has been attributed to failure to adhere to fundamental infection control principles, including safe injection practices and aseptic technique. This subject has been reviewed, and recommended infection control and safe injection practices have been summarized. \(^\text{453}\)

Airborne transmission of \(M tuberculosis\) and measles in ambulatory settings, most often emergency departments, has been reported. \(^\text{34,127,445,447,454-456}\) Measles virus was transmitted in physicians’ offices and other outpatient settings during an era when immunization rates were low and measles outbreaks in the community were occurring regularly. \(^\text{34,122,457}\) Rubella has been transmitted in the outpatient obstetric setting; \(^\text{33}\) there are no published reports of varicella transmission in the outpatient setting. In the ophthalmology setting, adenovirus type 8 epidemic keratoconjunctivitis has been transmitted through incompletely disinfected ophthalmology equipment and/or from HCWs to patients, presumably by contaminated hands. \(^\text{17,445,447,458-461}\)
Preventing transmission in outpatient settings necessitates screening for potentially infectious symptomatic and asymptomatic individuals, especially those at possible risk for transmitting airborne infectious agents (eg, *M tuberculosis*, varicella-zoster virus, rubella [measles]), at the start of the initial patient encounter. On identification of a potentially infectious patient, implementation of prevention measures, including prompt separation of potentially infectious patients and implementation of appropriate control measures (eg, respiratory hygiene/cough etiquette and Transmission-Based Precautions) can decrease transmission risks.\(^9,12\) Transmission of MRSA and VRE in outpatient settings has not been reported, but the association of CA-MRSA in HCWs working in an outpatient HIV clinic with environmental CA-MRSA contamination in that clinic suggests the possibility of transmission in that setting.\(^462\)

\*I.D.2.c. Home Care.\* Home care in the United States is delivered by more than 20,000 provider agencies, including home health agencies, hospices, durable medical equipment providers, home infusion therapy services, and personal care and support services providers. Home care is provided to patients of all ages with both acute and chronic conditions. The scope of services ranges from assistance with activities of daily living and physical and occupational therapy to the care of wounds, infusion therapy, and chronic ambulatory peritoneal dialysis.

The incidence of infection in home care patients, other than that associated with infusion therapy, has not been well studied.\(^465-470\) However, data collection and calculation of infection rates have been done for central venous catheter–associated bloodstream infections in patients receiving home infusion therapy\(^469,473\) and for the risk of blood contact through percutaneous or mucosal exposures, demonstrating that surveillance can be performed in this setting.\(^474\) Draft definitions for home care–associated infections have been developed.\(^475\)

Transmission risks during home care are presumed to be minimal. The main transmission risks to home care patients are from an infectious home care provider or contaminated equipment; a provider also can be exposed to an infectious patient during home visits. Because home care involves patient care by a limited number of personnel in settings without multiple patients or shared equipment, the potential reservoir of pathogens is reduced. Infections of home care providers that could pose a risk to home care patients include infections transmitted by the airborne or droplet routes (eg, chickenpox, tuberculosis, influenza), skin infestations (eg, scabies\(^69\) and lice), and infections transmitted by direct or indirect contact (eg, impetigo). There are no published data on indirect transmission of MDROs from one home care patient to another, although this is theoretically possible if contaminated equipment is transported from an infected or colonized patient and used on another patient. Of note, investigations of the first case of VISA in home care\(^186\) and the first 2 reported cases of VRSA\(^178,180,181,183\) found no evidence of transmission of VISA or VRSA to other home care recipients. Home health care also may contribute to antimicrobial resistance; a review of outpatient vancomycin use found that 39% of recipients did not receive prescribed antibiotics according to recommended guidelines.\(^476\)

Although most home care agencies implement policies and procedures aimed at preventing 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 professional guidance.\(^477,478\) This issue has proven very challenging to 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.\(^479\) Although the home environment may not always appear clean, the use of barriers between 2 noncritical surfaces has been questioned.\(^480,481\) Opportunities exist to conduct research in home care related to infection transmission risks.\(^482\)

\*I.D.2.d. Other Sites of Health Care Delivery.\* Facilities that are not primarily health care settings but in which health care is delivered include clinics in correctional facilities and shelters. Both of these settings can have suboptimal features, such as crowded conditions and poor ventilation. Economically disadvantaged individuals who may have chronic illnesses and health care problems related to alcoholism, injected drug use, poor nutrition, and/or inadequate shelter often receive their primary health care at such sites.\(^483\) Infectious diseases of special concern for transmission include tuberculosis, scabies, respiratory infections (eg, *N meningitides*, *S pneumoniae*), sexually transmitted and bloodborne diseases (eg, HIV, HBV, HCV, syphilis, gonorrhea), hepatitis A virus, diarrheal agents such as norovirus, and foodborne diseases.\(^485,484-487\) A high index of suspicion for tuberculosis and CA-MRSA in these populations is needed; outbreaks in these settings or among the populations they serve have been reported.\(^488-496\)

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

I.E. Transmission Risks Associated With Special Patient Populations

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

1.E.1. Immunocompromised Patients. Patients who have congenital primary immune deficiencies or acquired disease (e.g., treatment-induced immune deficiencies) are at increased risk for numerous types of infections while receiving health care; these patients may be located throughout the health care facility. The specific immune system defects determine the types of infections most likely to be acquired (e.g., viral infections are associated with T cell defects, and fungal and bacterial infections occur in patients who are neutropenic). As a general group, immunocompromised patients can be cared for in the same environment as other patients; however, it is always advisable to minimize exposure to other patients with transmissible infections, such as influenza and other respiratory viruses. The use of more intense chemotherapy regimens for treatment of childhood leukemia may be associated with prolonged periods of neutropenia and suppression of other components of the immune system, extending the period of infection risk and raising the concern that additional precautions may be indicated for select groups. With the application of newer and more intense immunosuppressive therapies for various medical conditions (e.g., rheumatologic disease, inflammatory bowel disease), immunosuppressed patients are likely to be more widely distributed throughout a health care facility rather than localized to single patient units (e.g., hematology-oncology). Guidelines for preventing infections in certain groups of immunocompromised patients have been published previously.

Published data provide evidence to support placing patients undergoing allogeneic HSCT in a PE. In addition, guidelines have been developed that address the special requirements of these 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. As more intense chemotherapy regimens associated with prolonged periods of neutropenia or 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. Compared with other patients, CF patients require additional protection to prevent transmission from contaminated respiratory therapy equipment. Such infectious agents as B cepacia complex and P aeruginosa have unique clinical and prognostic significance. In CF patients, B cepacia infection has been associated with increased morbidity and mortality, whereas delayed acquisition of chronic P aeruginosa infection may be associated with an improved long-term clinical outcome.

Person-to-person transmission of B cepacia complex has been demonstrated among children and adults with CF in health care settings and from various social contacts. Most notably attendance at camps for patients with CF has been associated with increased disease in adults and among siblings. Successful infection control measures used to prevent transmission of respiratory secretions include segregation of CF patients from each other in ambulatory and hospital settings (including use of private rooms with separate showers), environmental decontamination of surfaces and equipment contaminated with respiratory secretions, elimination of group chest physiotherapy sessions, and disbanding of CF camps. The Cystic Fibrosis Foundation has published a consensus document with evidence-based recommendations for infection control practices in CF patients.

I.F. New Therapies Associated With Potentially Transmissible Infectious Agents

I.F.1. Gene Therapy. Gene therapy has been attempted using various viral vectors, including nonreplicating retroviruses, adenoviruses, adeno-associated viruses, and replication-competent strains of poxviruses. Unexpected adverse events have restricted the prevalence of gene therapy protocols.

The infectious hazards of gene therapy are theoretical at this time but require meticulous surveillance due to the possible occurrence of in vivo recombination and the subsequent emergence of a transmissible genetically altered pathogen. The greatest concern attends the use of replication-competent viruses, especially vaccinia. To date, no reports have described transmission of a vector virus from a gene therapy recipient to another individual, but surveillance is ongoing. Recommendations for monitoring infection control issues throughout the course of gene therapy trials have been published.
I.F.2. Infections Transmitted Through Blood, Organs, and Other Tissues. The potential hazard of transmitting infectious pathogens through biologic products is a small but ever-present risk, despite donor screening. Reported infections transmitted by transfusion or transplantation include West Nile virus infection,529 cytomegalovirus infection,530 CJD,530 hepatitis C,531 infections with Clostridium spp552 and group A streptococcus,533 malaria,534 babesiosis,535 Chagas disease,536 lymphocytic choriomeningitis,537 and rabies.538,539 Therefore, it is important to consider receipt of biologic products when evaluating patients for potential sources of infection.

I.F.3. Xenotransplantation. Transplantation of nonhuman cells, tissues, and organs into humans potentially exposes patients to zoonotic pathogens. Transmission of known zoonotic infections (eg, trichinosis from porcine tissue) is of concern. Also of concern is the possibility that transplantation of nonhuman cells, tissues, or organs may transmit previously unknown zoonotic infections (xenozoonoses) to immunosuppressed human recipients. Potential infections that potentially could accompany transplantation of porcine organs have been described previously.540 Guidelines from the US Public Health Service address many infectious diseases and infection control issues that surround the developing field of xenotransplantation,541 work in this area is ongoing.

PART II: FUNDAMENTAL ELEMENTS NEEDED TO PREVENT TRANSMISSION OF INFECTIOUS AGENTS IN HEALTH CARE SETTINGS

II.A. Health Care System Components That Influence the Effectiveness of Precautions to Prevent Transmission

II.A.1. Administrative Measures. Health care 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.542-546 An infrastructure designed to guide, support, and monitor adherence to Standard Precautions and Transmission-Based Precautions544,547,548 will facilitate fulfillment of the organization’s mission and achievement of the Joint Commission on Accreditation of Health Care Organizations’ patient safety goal to decrease HAIs.549 Policies and procedures that explain how Standard Precautions and Transmission-Based Precautions are applied, including systems used to identify and communicate information on patients with potentially transmissible infectious agents, are essential to ensure the success of these measures. These policies and procedures may vary according to the characteristics of the organization.

A key administrative measure is the provision of fiscal and human resources for maintaining infection control and occupational health programs that are responsive to emerging needs. Specific components include bedside nurse550 and infection prevention and control professional (ICP) staffing levels,551 inclusion of ICPs in facility construction and design decisions,11 clinical microbiology laboratory support,562,555 adequate supplies and equipment including facility ventilation systems,11 adherence monitoring,554 assessment and correction of system failures that contribute to transmission,555,556 and provision of feedback to HCWs and senior administrators.533,547,548,557 The positive influence of institutional leadership has been demonstrated repeatedly in studies of HCWs’ adherence to recommended hand hygiene practices.176,177 Several administrative factors may affect the transmission of infectious agents in health care settings, including the institutional culture, individual HCW behavior, and the work environment. Each of these areas is suitable for performance improvement monitoring and incorporation into the organization’s patient safety goals.542,543,545,564

II.A.1.a. Scope of Work and Staffing Needs for Infection Control Professionals. The effectiveness of infection surveillance and control programs in preventing nosocomial infections in US hospitals was assessed by the CDC through the Study on the Efficacy of Nosocomial Infection Control (SENIC Project) conducted between 1970 and 1976.565 In a representative sample of US general hospitals, those with a trained infection control physician or microbiologist involved in an infection control program and at least 1 infection control nurse per 250 beds were associated with a 32% lower rate of the 4 infections studied (CVC-associated bloodstream infections, ventilator-associated pneumonias, catheter-related urinary tract infections, and surgical site infections).

Since the publication of that landmark study, responsibilities of ICPs have expanded commensurate with the growing complexity of the health care system, the patient populations served, and the increasing numbers of medical procedures and devices used in all types of health care settings. The scope of work of ICPs was first assessed in 1982566,567 by the Certification Board of Infection Control, and has been reassessed every 5 years since that time.557,569-571 The findings of these analyses have been used to develop and update the Infection Control Certification Examination, which was first offered in 1983. With each new survey, it becomes
increasingly apparent that the role of the ICP is growing in complexity and scope beyond traditional infection control activities in acute care hospitals. Activities currently assigned to ICPs in response to emerging challenges include (1) surveillance and infection prevention at facilities other than acute care hospitals (eg, ambulatory clinics, day surgery centers, LTCFs, rehabilitation centers, home care); (2) oversight of employee health services related to infection prevention (eg, assessment of risk and administration of recommended treatment after exposure to infectious agents, tuberculosis screening, influenza vaccination, respiratory protection fit testing, and administration of other vaccines as indicated, such as smallpox vaccine in 2003); (3) preparedness planning for annual influenza outbreaks, pandemic influenza, SARS, and bioweapons attacks; (4) adherence monitoring for selected infection control practices; (5) oversight of risk assessment and implementation of prevention measures associated with construction and renovation; (6) prevention of transmission of MDROs; (7) evaluation of new medical products that could be associated with increased infection risk (eg, intravenous infusion materials); (8) communication with the public, facility staff, and state and local health departments concerning infection control–related issues; and (9) participation in local and multicenter research projects.533,548,551,557,572,573

None of the Certification Board of Infection Control job analyses addressed specific staffing requirements for the identified tasks, although the surveys did include information about hours worked; the 2001 survey included the number of ICPs assigned to the responding facilities.557 There is agreement in the literature that a ratio of 1 ICP per 250 acute care beds is no longer adequate to meet current infection control needs; a Delphi project that assessed staffing needs of infection control programs in the 21st century concluded that a ratio of 0.8 to 1.0 ICP per 100 occupied acute care beds is an appropriate staffing level.551 A survey of participants in the NNIS system found an average daily patient census of 115 per ICP.315 Results of other studies have been similar: 3 per 500 beds for large acute care hospitals, 1 per 150 to 250 beds in LTCFs, and 1.56 per 250 in small rural hospitals.572,574 The foregoing demonstrates that infection control staffing no longer can be based on patient census alone, but rather must be determined by the scope of the program, characteristics of the patient population, complexity of the health care system, tools available to assist personnel to perform essential tasks (eg, electronic tracking and laboratory support for surveillance), and unique or urgent needs of the institution and community.551 Furthermore, appropriate training is required to optimize the quality of work performed.557,571,573

II.A.1.a.i. Infection Control Nurse Liaison. Designating a bedside nurse on a patient care unit as an infection control liaison or “link nurse” is reported to be an effective adjunct to enhance infection control at the unit level.576-581 Such individuals receive training in basic infection control and have frequent communication with ICPs, but maintain their primary role as bedside caregiver on their units. The infection control nurse liaison increases the awareness of infection control at the unit level. He or she is especially effective in implementing new policies or control interventions because of the rapport with individuals on the unit, an understanding of unit-specific challenges, and ability to promote strategies that are most likely to be successful in that unit. This position is an adjunct to, not a replacement for, fully trained ICPs. Furthermore, the infection control liaison nurses should not be counted when considering ICP staffing.

II.A.1.b. Bedside Nurse Staffing. There is increasing evidence that the level of bedside nurse staffing influences the quality of patient care.582,583 Adequate nursing staff makes it more likely that infection control practices, including hand hygiene, Standard Precautions, and Transmission-Based Precautions, will be given appropriate attention and applied correctly and consistently.551 A national multicenter study reported strong and consistent inverse relationships between nurse staffing and 5 adverse outcomes in medical patients, 2 of which were HAIs (urinary tract infections and pneumonia).582 The association of nursing staff shortages with increased rates of HAI has been demonstrated in several outbreaks in hospitals and LTCFs, and with increased transmission of hepatitis C virus in dialysis units.22,417,550,584-596 In most cases, when staffing was improved as part of a comprehensive control intervention, the outbreak ended or the HAI rate declined. In 2 studies,589,595 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 regular nurses decreased and that of pool nurses increased.

II.A.1.c. Clinical Microbiology Laboratory Support. The critical role of the clinical microbiology laboratory in infection control and health care epidemiology has been well described552,553,597-599 and is supported by the Infectious Disease Society of America’s policy statement on the consolidation of clinical microbiology laboratories published in 2001.552 The clinical microbiology laboratory contributes to preventing transmission of infectious diseases in health care settings by promptly detecting and reporting epidemiologically important organisms, identifying emerging patterns of antimicrobial resistance, and assessing the effectiveness of recommended precautions to limit transmission during outbreaks.597 Outbreaks of infections may be
recognized first by laboratorians. Health care organizations need to ensure the availability of the recommended scope and quality of laboratory services, a sufficient number of appropriately trained laboratory staff members, and systems to promptly communicate epidemiologically important results to those who will take action (eg, providers of clinical care, infection control staff, health care epidemiologists, and infectious disease consultants). As concerns about emerging pathogens and bioterrorism grow, the role of the clinical microbiology laboratory assumes ever-greater importance. For health care organizations that outsource microbiology laboratory services (eg, ambulatory care, home care, LTCFs, smaller acute care hospitals), it is important to specify by contract the types of services (eg, periodic institution-specific aggregate susceptibility reports) required to support infection control.

Several key functions of the clinical microbiology laboratory are relevant to this guideline:

- Antimicrobial susceptibility by testing and interpretation in accordance with current guidelines developed by the National Committee for Clinical Laboratory Standards, known as the Clinical and Laboratory Standards Institute since 2005, for the detection of emerging resistance patterns and for the preparation, analysis, and distribution of periodic cumulative antimicrobial susceptibility summary reports. Although not required, clinical laboratories ideally should have access to rapid genotypic identification of bacteria and their antibiotic resistance genes.

- Performance of surveillance cultures when appropriate (including retention of isolates for analysis), to assess patterns of infection transmission and effectiveness of infection control interventions at the facility or organization. Microbiologists assist in decision making regarding the indications for initiating and discontinuing active surveillance programs and optimizing the use of laboratory resources.

- Molecular typing, onsite or outsourced, to investigate and control health care–associated outbreaks.

- Application of rapid diagnostic tests to support clinical decisions involving patient treatment, room selection, and implementation of control measures, including barrier precautions and use of vaccine or chemoprophylaxis agents (eg, influenza, B pertussis, RSV, and enteroviruses). The microbiologist provides guidance to limit rapid testing to clinical situations in which rapid results influence patient management decisions, and also provides oversight of point-of-care testing performed by non-laboratory HCWs.

- Detection and rapid reporting of epidemiologically important organisms, including those that are reportable to public health agencies.

- Implementation of a quality control program to ensure that testing services are appropriate for the population being served and are stringently evaluated for sensitivity, specificity, applicability, and feasibility.

- Participation in a multidisciplinary team to develop and maintain an effective institutional program for the judicious use of antimicrobial agents.

II.A.2. Institutional Safety Culture and Organizational Characteristics. Safety culture (or safety climate) refers to a work environment in which a shared commitment to safety on the part of management and the workforce is understood and maintained. The authors of the Institute of Medicine’s report titled To Err is Human acknowledged that causes of medical error are multifaceted but emphasized the pivotal role of system failures and the benefits of a safety culture. A safety culture is created through (1) the actions that management takes to improve patient and worker safety, (2) worker participation in safety planning, (3) the availability of appropriate PPE, (4) the influence of group norms regarding acceptable safety practices, and (5) the organization’s socialization process for new personnel. Safety and patient outcomes can be enhanced by improving or creating organizational characteristics within patient care units, as demonstrated by studies of surgical ICUs. Each of these factors has a direct bearing on adherence to transmission prevention recommendations. Measurement of an institution’s culture of safety is useful in designing improvements in health care. Several hospital-based studies have linked measures of safety culture with both employee adherence to safe practices and reduced exposures to blood and body fluids. One study of hand hygiene practices concluded that improved adherence requires integration of infection control into the organization’s safety culture. Several hospitals that are part of the Veterans Administration health care system have taken specific steps toward improving the safety culture, including error-reporting mechanisms, root cause analyses of identified problems, safety incentives, and employee education.

II.A.3. Adherence of Health Care Workers to Recommended Guidelines. HCW’s adherence to recommended infection control practices decreases the transmission of infectious agents in health care settings. Several observational studies have shown limited adherence to recommended practices by HCWs. Observed adherence to universal precautions ranged from 43% to 89%. The degree of adherence often depended on the specific practice that was assessed and, for glove use, the circumstance in which the practice was applied. Observed rates of appropriate glove use have ranged from a low of 15% to a high of 82%. However, 92%
and 98% adherence with glove use have been reported during arterial blood gas collection and resuscitation, respectively, procedures in which considerable blood contact may occur. Differences in observed adherence have been reported among occupational groups in the same health care facility and between experienced and nonexperienced professionals. In surveys of HCWs, self-reported adherence was generally higher than actual adherence found in observational studies. Furthermore, where an observational component was included with a self-reported survey, self-perceived adherence was often greater than observed adherence. Among nurses and physicians, increasing years of experience is a negative predictor of adherence. Education to improve adherence is the primary intervention that has been studied. Whereas positive changes in knowledge and attitude have been demonstrated, no or only limited accompanying changes in behavior often have been found. Self-reported adherence is higher in groups that received an educational intervention. In one study, educational interventions that incorporated videotaping and performance feedback were successful in improving adherence during the study period, but the long-term effect of such interventions is not known. The use of videotaping also served to identify system problems (eg, communication and access to PPE) that otherwise may not have been recognized.

Interest is growing in the use of engineering controls and facility design concepts for improving adherence. Whereas the introduction of automated sinks was found to have a negative impact on consistent adherence to handwashing in one study, the use of electronic monitoring and voice prompts to remind HCWs to perform hand hygiene and improving accessibility to hand hygiene products increased adherence and contributed to a decrease in HAIs in another study. More information is needed regarding ways in which technology might improve adherence.

Improving adherence to infection control practices requires a multifaceted approach that incorporates continuous assessment of both the individual and the work environment. Using several behavioral theories, Kretzer and Larson concluded that a single intervention (eg, a handwashing campaign or putting up new posters about transmission precautions) likely would be ineffective in improving HCWs adherence. Improvement requires the organizational leadership to make prevention an institutional priority and integrate infection control practices into the organization’s safety culture. A recent review of the literature concluded that variations in organizational factors (eg, safety climate, policies and procedures, education and training) and individual factors (eg, knowledge, perceptions of risk, past experience) were determinants of adherence to infection control guidelines for protection against SARS and other respiratory pathogens.

II.B. Surveillance for Health Care-Associated Infections

Surveillance is an essential tool for case finding of single patients or clusters of patients who are infected or colonized with epidemiologically important organisms (eg, susceptible bacteria such as S aureus, S pyogenes [group A streptococcus] or Enterobacter-Klebsiella spp; MRSA, VRE, and other MDROs; C difficile; RSV, influenza virus) for which transmission-based precautions may be required. Surveillance is defined as the ongoing systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health. The work of Ignaz Semmelweis delineating the role of person-to-person transmission in puerperal sepsis is the earliest example of the use of surveillance data to reduce transmission of infectious agents. Surveillance of both process measures and the infection rates to which they are linked is important in evaluating the effectiveness of infection prevention efforts and identifying indications for change.

The Study on the Efficacy of Nosocomial Infection Control (SENIC) found that different combinations of infection control practices resulted in reduced rates of nosocomial surgical site infections, pneumonia, urinary tract infections, and bacteremia in acute care hospitals; however, surveillance was the only component essential for reducing all 4 types of HAIs. Although a similar study has not been conducted in other health care settings, a role for surveillance and the need for novel strategies in LTCFs and in home care have been described. The essential elements of a surveillance system are (1) standardized definitions, (2) identification of patient populations at risk for infection, (3) statistical analysis (eg, risk adjustment, calculation of rates using appropriate denominators, trend analysis using such methods as statistical process control charts), and (4) feedback of results to the primary caregivers. Data gathered through surveillance of high-risk populations, device use, procedures, and facility locations (eg, ICUs) are useful in detecting transmission trends. Identification of clusters of infections should be followed by a systematic epidemiologic investigation to determine commonalities in persons, places, and time and to guide implementation of interventions and evaluation of the effectiveness of those interventions.

Targeted surveillance based on the highest-risk areas or patients has been preferred over facility-wide
surveillance for the most effective use of resources. However, for certain epidemiologically important organisms, surveillance may need to be facility-wide. Surveillance methods will continue to evolve as health care delivery systems change and user-friendly electronic tools for electronic tracking and trend analysis become more widely available. Individuals with experience in health care epidemiology and infection control should be involved in selecting software packages for data aggregation and analysis, to ensure that the need for efficient and accurate HAI surveillance will be met. Effective surveillance is increasingly important as legislation requiring public reporting of HAI rates is passed and states work to develop effective systems to support such legislation.

II.C. Education of Health Care Workers, Patients, and Families

The education and training of HCWs is a prerequisite for ensuring that policies and procedures for Standard and Transmission-Based Precautions are understood and practiced. Understanding the scientific rationale for the precautions will allow HCWs to apply procedures correctly, as well as to safely modify precautions based on changing requirements, resources, or health care settings. One study found that the likelihood of HCWs developing SARS was strongly associated with less than 2 hours of infection control training and poor understanding of infection control procedures. Education regarding the important role of vaccines (eg, influenza, measles, varicella, pertussis, pneumococcal) in protecting HCWs, their patients, and family members can help improve vaccination rates.

Education on the principles and practices for preventing transmission of infectious agents should begin during training in the health professions and be provided to anyone who has an opportunity for contact with patients or medical equipment (eg, nursing and medical staff; therapists and technicians, including respiratory, physical, occupational, radiology, and cardiology personnel; phlebotomists; housekeeping and maintenance staff; and students). In health care facilities, education and training on Standard and Transmission-Based Precautions are typically provided at the time of orientation and should be repeated as necessary to maintain competency; updated education and training are necessary when policies and procedures are revised or when a special circumstance occurs, such as an outbreak that requires modification of current practice or adoption of new recommendations. Education and training materials and methods appropriate to the HCW’s level of responsibility, individual learning habits, and language needs can improve the learning experience.

Education programs for HCWs have been associated with sustained improvement in adherence to best practices and a related decrease in device-associated HAIs in teaching and nonteaching settings and in medical and surgical ICUs (Coopersmith, 2002 #2149; Babcock, 2004 #2126; Berenholtz, 2004 #2289; http://www.ihi.org/IHI/Programs/Campaign, #2563). Several studies have shown that in addition to targeted education to improve specific practices, periodic assessment and feedback of the HCW’s knowledge and adherence to recommended practices are necessary to achieve the desired changes and identify continuing education needs. The effectiveness of this approach for isolation practices has been demonstrated in the control of RSV.

Patients, family members, and visitors can be partners in preventing transmission of infections in health care settings. Information on Standard Precautions, especially hand hygiene, respiratory hygiene/cough etiquette, vaccination (especially against influenza), and other routine infection prevention strategies, may be incorporated into patient information materials provided on admission to the health care facility. Additional information on Transmission-Based Precautions is best provided when these precautions are initiated. Fact sheets, pamphlets, and other printed material may include information on the rationale for the additional precautions, risks to household members, room assignment for Transmission-Based Precautions purposes, explanation of the use of PPE by HCWs, and directions for use of such equipment by family members and visitors. Such information may be particularly helpful in the home environment, where household members often have the primary responsibility for adherence to recommended infection control practices. HCWs must be available and prepared to explain this material and answer questions as needed.

II.D. Hand Hygiene

Hand hygiene has been frequently cited as the single most important practice to reduce the transmission of infectious agents in health care settings 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 the use of alcohol-based products (gels, rinses, foams) that do not require 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. Improved hand hygiene practices
have been associated with a sustained decrease in the incidence of MRSA and VRE infections primarily in ICUs.\textsuperscript{300,361,713-716} The scientific rationale, indications, methods, and products for hand hygiene have been summarized in previous publications.\textsuperscript{558,716}

The effectiveness of hand hygiene can be reduced by the type and length of fingernails.\textsuperscript{558,717,718} Individuals wearing artificial nails have been shown to harbor more pathogenic organisms, especially gram-negative bacilli and candidal infections as confirmed by molecular typing association with outbreaks of gram-negative bacillus and yeasts, on the nails and in the subungual area compared with individuals with native nails.\textsuperscript{719,720} In 2002, the CDC/HICPAC recommended (Category IA) that artificial fingernails and extenders not be worn by HCWs who have contact with high-risk patients (eg, those in ICUs and operating rooms), due to the association with outbreaks of gram-negative bacillus and candidal infections as confirmed by molecular typing of isolates.\textsuperscript{30,31,558,721-724} The need to restrict the wearing of artificial fingernails by all HCWs who provide direct patient care and those who have contact with other high-risk groups (eg, oncology and cystic fibrosis patients) has not been studied but has been recommended by some experts.\textsuperscript{20} Currently, such decisions are at the discretion of an individual facility’s infection control program. There is less evidence indicating that jewelry affects the quality of hand hygiene. Although hand contamination with potential pathogens is increased by the type and length of fingernails.\textsuperscript{558,717,718} Indiv-

duals wearing artificial nails have been shown to harbor more pathogenic organisms, especially gram-negative bacilli and candidal infections as confirmed by molecular typing association with outbreaks of gram-negative bacillus and yeasts, on the nails and in the subungual area compared with individuals with native nails.\textsuperscript{719,720} In 2002, the CDC/HICPAC recommended (Category IA) that artificial fingernails and extenders not be worn by HCWs who have contact with high-risk patients (eg, those in ICUs and operating rooms), due to the association with outbreaks of gram-negative bacillus and candidal infections as confirmed by molecular typing of isolates.\textsuperscript{30,31,558,721-724} The need to restrict the wearing of artificial fingernails by all HCWs who provide direct patient care and those who have contact with other high-risk groups (eg, oncology and cystic fibrosis patients) has not been studied but has been recommended by some experts.\textsuperscript{20} Currently, such decisions are at the discretion of an individual facility’s infection control program. There is less evidence indicating that jewelry affects the quality of hand hygiene. Although hand contamination with potential pathogens is increased with ring-wearing.\textsuperscript{558,725} No studies have related this practice to HCW-to-patient transmission of pathogens.

II.E. Personal Protective Equipment for Health Care Workers

PPE refers to various barriers and respirators used alone or in combination to protect mucous membranes, airways, skin, and clothing from contact with infectious agents. The choice of PPE is based on the nature of the patient interaction and/or the likely mode(s) of transmission. Specific guidance on the use of PPE is provided in Part III of this guideline. A suggested procedure for donning and removing PPE aimed at preventing skin or clothing contamination is presented in Figure 1. Designated containers for used disposable or reusable PPE should be placed in a location convenient to the site of removal, to facilitate disposal and containment of contaminated materials. Hand hygiene is always the final step after removing and disposing of PPE. The following sections highlight the primary uses of and criteria for selecting this equipment.

II.E.1. Gloves. Gloves are used to prevent contamination of HCW hands when (1) anticipating direct contact with blood or body fluids, mucous membranes, nonintact skin and other potentially infectious material; (2) having direct contact with patients who are colonized or infected with pathogens transmitted by the contact route (eg, VRE, MRSA, RSV\textsuperscript{558,726,727}); or (3) handling or touching visibly or potentially contaminated patient care equipment and environmental surfaces.\textsuperscript{72,73,558} Gloves can protect both patients and HCWs from exposure to infectious material that may be carried on hands.\textsuperscript{73} The extent to which gloves will protect HCWs from transmission of bloodborne pathogens (eg, HIV, HBV, HCV) after a needlestick or other puncture that penetrates the glove barrier has not yet been determined. Although gloves may reduce the volume of blood on the external surface of a sharp by 46% to 86%,\textsuperscript{728} the residual blood in the lumen of a hollow-bore needle would not be affected; therefore, the effect on transmission risk is unknown. Gloves manufactured for health care purposes are subject to FDA evaluation and clearance.\textsuperscript{729} Nonsterile disposable medical gloves made of various materials (eg, latex, vinyl, nitrile) are available for routine patient care.\textsuperscript{730} The selection of glove type for nonsurgical use is based on various factors, including the task to be performed, anticipated contact with chemicals and chemotherapeutic agents, latex sensitivity, sizing, and facility policies for creating a latex-free environment.\textsuperscript{17,731-733} For contact with blood and body fluids during nonsurgical patient care, a single pair of gloves generally provides adequate barrier protection.\textsuperscript{733} However, there is considerable variability among gloves; both the quality of the manufacturing process and type of material influence their barrier effectiveness.\textsuperscript{734} Whereas there is little difference in the barrier properties of unused intact gloves,\textsuperscript{735} studies have shown repeatedly that vinyl gloves have higher failure rates than latex or nitrile gloves when tested under simulated and actual clinical conditions.\textsuperscript{730,734-737} For this reason, either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity or will involve more than brief patient contact. A facility may need to stock gloves in several sizes. Heavier, reusable utility gloves are indicated for non–patient care activities, such as handling or cleaning contaminated equipment or surfaces.\textsuperscript{11,14,738}

During patient care, transmission of infectious organisms can be reduced by adhering to the principles of working from “clean” to “dirty” and confining or limiting contamination to those surfaces 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.\textsuperscript{558,739} It also may be necessary to change gloves if the patient interaction also involves touching portable computer keyboards or other mobile equipment transported from room to room. Discarding gloves between patients is necessary to prevent transmission of infectious material. Gloves must not be washed for subsequent reuse, because microorganisms cannot be removed reliably from glove surfaces, and
continued glove integrity cannot be ensured. Furthermore, glove reuse has been associated with transmission of MRSA and gram-negative bacilli.\textsuperscript{740-742}

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. Proper glove removal will prevent hand contamination (Fig 1). Hand hygiene after glove removal further ensures that the hands will not carry potentially infectious material that might have penetrated through unrecognized tears or that could have contaminated the hands during glove removal.\textsuperscript{558,727,740}

II.E.2. Isolation Gowns. Isolation gowns are used as specified by Standard and Transmission-Based Precautions to protect the HCW’s arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material.\textsuperscript{24,88,261,743-745} The need for and the type of isolation gown selected is based on the nature of the patient interaction, including the anticipated degree of contact with infectious material and potential for blood and body fluid penetration of the barrier. The wearing of isolation gowns and other protective apparel is mandated by the Occupational Safety and Health Administration’s (OSHA) Bloodborne Pathogens Standard.\textsuperscript{738} Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered PPE.

When applying Standard Precautions, an isolation gown is worn only if contact with blood or body fluid is anticipated. However, when Contact Precautions are used (ie, to prevent transmission of an infectious agent that is not interrupted by Standard Precautions alone and is associated with environmental

\textbf{Fig 1.} Example of safe donning and removal of PPE.
contamination), donning of both gown and gloves on room entry is indicated, to prevent unintentional contact with contaminated environmental surfaces. The routine donning of isolation gowns on entry into an ICU or other high-risk area does not prevent or influence potential colonization or infection of patients in those areas, however.

Isolation gowns are always worn in combination with gloves, and with other PPE when indicated. Gowns are usually the first piece of PPE to be donned. Full coverage of the arms and body front, from neck to the mid-thigh or below, will ensure protection of clothing and exposed upper body areas. Several gown sizes should be available in a health care facility to ensure appropriate coverage for staff members. Isolation gowns should be removed in a manner that prevents contamination of the environment outside the patient’s room. Isolation gowns should be removed in a manner that prevents contamination of clothing or skin (Fig 1); the outer, “contaminated” side of the gown is turned inward and rolled into a bundle, and then discarded into a designated container for waste or linen to contain contamination.

II.E.3. Face Protection: Masks, Goggles, and Face Shields.

II.E.3.a. Masks. Masks are used for 3 primary purposes in health care settings: (1) placed on HCWs to protect them from contact with infectious material from patients (eg, respiratory secretions and sprays of blood or body fluids), consistent with Standard Precautions and Droplet Precautions; (2) placed on HCWs engaged in procedures requiring sterile technique, to protect patients from exposure to infectious agents carried in the HCW’s mouth or nose; and (3) placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others (ie, respiratory hygiene/cough etiquette). Masks may be used in combination with goggles to protect the mouth, nose, and eyes, or, alternatively, a face shield may be used instead of a mask and goggles to provide more complete protection for the face, as discussed below. Masks should not be confused with particulate respirators used to prevent inhalation of small particles that may contain infectious agents transmitted through the airborne route, as described below.

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

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

Two mask types are available for use in health care settings: surgical masks that are cleared by the FDA and required to have fluid-resistant properties, and procedure or isolation masks. To date, no studies comparing mask types to determine whether one mask type provides better protection than another have been published. Because procedure/isolation masks are not regulated by the FDA, they may be more variable in terms of quality and performance than surgical masks. Masks come in various shapes (eg, molded and nonmolded), sizes, filtration efficiency, and method of attachment (eg, ties, elastic, ear loops). Health care facilities may find that different types of masks are needed to meet individual HCW needs.

II.E.3.b. Goggles and Face Shields. Guidance on eye protection for infection control has been published. The eye protection chosen for specific work situations (eg, goggles or face shield) depends on the circumstances of exposure, other PPE used, and personal vision needs. Personal eyeglasses and contact lenses are not considered adequate eye protection (see http://www.cdc.gov/niosh/topics/eye/eye-infectious.html). NIOSH guidelines specify that eye protection must be comfortable, allow for sufficient peripheral vision, and adjustable to ensure a secure fit. A health care facility may need to provide several different types, styles, and sizes of eye protection equipment. Indirectly vented goggles with a manufacturer’s antifog coating may provide the most reliable practical eye protection from splashes, sprays, and respiratory droplets from multiple angles. Newer styles of goggles may provide better indirect airflow properties to reduce fogging, as well as better peripheral vision and more size options for fitting goggles to different workers. Many styles of goggles fit adequately over prescription glasses with minimal gaps. Although effective as eye protection, goggles do not provide splash or spray protection to other parts of the face.

The role of goggles in addition to a mask in preventing exposure to infectious agents transmitted through respiratory droplets has been studied only for RSV. Reports published in the mid-1980s demonstrated that eye protection reduced occupational transmission of RSV. Whether this was due to the prevention hand–eye contact or the prevention of respiratory droplet–eye contact has not been determined. However, subsequent studies demonstrated that RSV transmission is effectively prevented by
adherence to Standard Precautions plus Contact Precautions and that routine use of goggles is not necessary for this virus.24,116,117,683,761 It is important to remind HCWs that even if Droplet Precautions are not recommended for a specific respiratory tract pathogen, protection for the eyes, nose, and mouth using a mask and goggles or a face shield alone is necessary when a splash or spray of any respiratory secretions or other body fluids is likely to occur, as defined in Standard Precautions.

Disposable or nondisposable face shields may be used as an alternative to goggles.758 Compared with goggles, a face shield can provide protection to other facial areas besides the eyes. Face shields extending from the chin to crown provide better face and eye protection from splashes and sprays; face shields that wrap around the sides may reduce splashes around the edge of the shield.

Removal of a face shield, goggles, and mask can be performed safely after gloves have been removed and hand hygiene performed. The ties, earpieces, and/or headband used to secure the equipment to the head are considered “clean” and thus safe to touch with bare hands. The front of a mask, goggles, and face shield are considered contaminated (Fig 1).

II.E.4. Respiratory Protection. The subject of respiratory protection as it applies to preventing transmission of airborne infectious agents, including the need for and frequency of fit testing is under scientific review and was the subject of a 2004 CDC workshop.762 Respiratory protection currently requires the use of a respirator with N95 or higher-level filtration to prevent inhalation of infectious particles. Information about respirators and respiratory protection programs is summarized in the Guideline for Preventing Transmission of Mycobacterium tuberculosis in Health Care Settings.12

Respiratory protection is broadly regulated by OSHA under the general industry standard for respiratory protection (29 CFR 1910.134).763 which requires that US employers in all employment settings implement a program to protect employees from inhalation of toxic materials. OSHA program components include medical clearance to wear a respirator; provision and use of appropriate respirators, including fit-tested NIOSH-certified N95 and higher-level particulate filtering respirators; education on respirator use, and periodic reevaluation of the respiratory protection program. When selecting particulate respirators, models with inherently good fit characteristics (ie, those expected to provide protection factors of ≥10% to 95% of wearers) are preferred and theoretically could preclude the need for fit testing.764,765 Issues pertaining to respiratory protection remain the subject of ongoing debate. Information on various types of respirators is available at http://www.cdc.gov/niosh/npptl/respirators/respsars.html and in several previously published studies.764,766,767 A user-seal check (formerly called a “fit check”) should be performed by the wearer of a respirator each time that the respirator is donned, to minimize air leakage around the face piece.768 The optimal frequency of fit testing has not been determined; retesting may be indicated if there is a change in wearer’s facial features, onset of a medical condition that would affect respiratory function in the wearer, or a change in the model or size of the respirator that was initially assigned.12

Respiratory protection was first recommended for protection of US HCWs from exposure to M tuberculosis in 1989. That recommendation has been maintained in 2 successive revisions of the Guidelines for Prevention of Transmission of Tuberculosis in Hospitals and Other Health Care Settings.12,126 The incremental benefit from respirator use, in addition to administrative and engineering controls (ie, AIIRs, early recognition of patients likely to have tuberculosis and prompt placement in an AIIR, and maintenance of a patient with suspected tuberculosis in an AIIR until no longer infectious), for preventing transmission of airborne infectious agents (eg, M tuberculosis) remains undetermined. Although some studies have demonstrated effective prevention of M tuberculosis transmission in hospitals in which surgical masks instead of respirators were used in conjunction with other administrative and engineering controls,636,769,770 the CDC currently recommends N95 or higher-level respirators for personnel exposed to patients with suspected or confirmed tuberculosis. Currently, this recommendation also holds for other diseases that could be transmitted through the airborne route, including SARS261 and smallpox,108,129,771 until inhalational transmission is better defined or health care-specific PPE more suitable for preventing infection is developed. Wearing of respirators is also currently recommended during the performance of aerosol-generating procedures (eg, intubation, bronchoscopy, suctioning) in patients with SARS-CoV infection, avian influenza, and pandemic influenza (see Appendix A).

Although Airborne Precautions are recommended for preventing airborne transmission of measles and varicella-zoster viruses, no data are available on which to base a recommendation for respiratory protection to protect susceptible personnel against these 2 infections. Transmission of varicella-zoster virus has been prevented among pediatric patients using negative-pressure isolation alone.772 Whether respiratory protection (ie, wearing a particulate respirator) will enhance protection from these viruses has not yet been studied. Because most HCWs have natural or acquired immunity to these viruses, only immune personnel
generally care for patients with these infections. Although there is no evidence suggesting that masks are not adequate to protect HCWs in these settings, for purposes of consistency and simplicity, or because of difficulties in ascertaining immunity, some facilities may require the use of respirators for entry into all AIIRs, regardless of the specific infectious agent present.

Procedures for safe removal of respirators are provided in Figure 1. In some health care settings, particular respirators used to provide care for patients with *M. tuberculosis* are reused by the same HCW. This is an acceptable practice providing that the respirator is not damaged or soiled, the fit is not compromised by a change in shape, and the respirator has not been contaminated with blood or body fluids. No data are available on which to base a recommendation regarding the length of time that a respirator may be safely reused.

### II.F. Safe Work Practices to Prevent Health Care Worker Exposure to Bloodborne Pathogens

#### II.F.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. The prevention of sharps injuries has always been an essential element of Universal Precautions and is now an aspect of Standard Precautions. These include 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. These measures apply to routine patient care and do not address the prevention of sharps injuries and other blood exposures during surgical and other invasive procedures addressed elsewhere.

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

#### II.F.2. Prevention of Mucous Membrane Contact

Exposure of mucous membranes of the eyes, nose, and mouth to blood and body fluids has been associated with the transmission of bloodborne viruses and other infectious agents to HCWs. The prevention of mucous membrane exposures has always been an element of Universal Precautions and is now an element of Standard Precautions for routine patient care and is subject to OSHA bloodborne pathogen regulations. Safe work practices, in addition to wearing PPE, are designed to protect mucous membranes and nonintact skin from contact with potentially infectious material. These include keeping contaminated gloved and ungloved hands from touching the mouth, nose, eyes, or face and positioning patients to direct sprays and splatter away from the caregiver’s face. Careful placement of PPE before patient contact will help avoid the need to make adjustments to PPE and prevent possible face or mucous membrane contamination during use.

In areas where the need for resuscitation is unpredictable, mouthpieces, pocket resuscitation masks with 1-way valves, and other ventilation devices provide an alternative to mouth-to-mouth resuscitation, preventing exposure of the caregiver’s nose and mouth to oral and respiratory fluids during the procedure.

#### II.F.2.a. Precautions During Aerosol-Generating Procedures

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

### II.G. Patient Placement

#### II.G.1. Hospitals and Long-Term Care Facilities

Options for patient placement include single-patient rooms, 2-patient rooms, and multibed wards. Of these, single-patient rooms are preferred when transmission of an infectious agent is of concern. Although some studies have failed to demonstrate the efficacy of single-patient rooms in preventing HAIs, other published studies, including one commissioned by the AIA and the Facility Guidelines Institute, have documented a beneficial relationship between private rooms and reduced infectious and noninfectious adverse patient outcomes. The AIA notes that private rooms are the trend in hospital planning and design. However, most hospitals and LTCFs have multibed rooms and must consider many competing priorities when determining the appropriate room placement for patients.
(eg, reason for admission; patient characteristics, such as age, gender, and mental status; staffing needs; family requests; psychosocial factors; reimbursement concerns). In the absence of obvious infectious diseases that require specified airborne infection isolation rooms (eg, tuberculosis, SARS, chickenpox), the risk of transmission of infectious agents is not always considered when making placement decisions.

When only a limited number of single-patient rooms is available, it is prudent to prioritize room assignments for those patients with conditions that facilitate transmission of infectious material to other patients (eg, draining wounds, stool incontinence, uncontained secretions) and those at increased risk of acquisition and adverse outcomes resulting from HAIs (due to, eg, immunosuppression, open wounds, indwelling catheters, anticipated prolonged length of stay, total dependence on HCWs for activities of daily living).15,24,43,429,793,794

Single-patient rooms are always indicated for patients placed on Airborne Precautions in a PE and are preferred for patients requiring Contact or Droplet Precautions.23,24,409,434,795,796 During a suspected or proven outbreak caused by a pathogen whose reservoir is the gastrointestinal tract, the use of single-patient rooms with private bathrooms limits opportunities for transmission, especially when the colonized or infected patient has poor personal hygiene habits or fecal incontinence, or cannot be expected to assist in maintaining procedures that prevent transmission of microorganisms (eg, infants, children, and patients with altered mental status or developmental delay). In the absence of continued transmission, it is not necessary to provide a private bathroom for patients colonized or infected with enteric pathogens as long as personal hygiene practices and Standard Precautions (especially hand hygiene and appropriate environmental cleaning) are maintained. Assignment of a dedicated commode to a patient, and cleaning and disinfecting fixtures and equipment that may have fecal contamination (eg, bathrooms, commodes, scales used for weighing diapers) and the adjacent surfaces with appropriate agents may be especially important when a single-patient room cannot be assigned, because environmental contamination with intestinal tract pathogens is likely from both continent and incontinent patients.54,797 The results of several studies that investigated the benefit of a single-patient room in preventing transmission of C difficile were inconclusive.167,799-801 Some studies have shown that being in the same room with a colonized or infected patient is not necessarily a risk factor for transmission,790,802-804 however, for children, the risk of health care–associated diarrhea is increased with the increased number of patients per room.805 These findings demonstrate that patient factors are important determinants of infection transmission risks. The need for a single-patient room and/or private bathroom for any patient is best determined on a case-by-case basis.

Cohorting is the practice of grouping together patients who are colonized or infected with the same organism to confine their care to a single area and prevent contact with other patients. Cohorts are created based on clinical diagnosis, microbiologic confirmation (when available), epidemiology, and mode of transmission of the infectious agent. Avoiding placing severely immunosuppressed patients in rooms with other patients is generally preferred. Cohorting has been extensively used for managing outbreaks of MDROs, including MRSA,806 VRE,807 MDR-ESBL,809 P aeruginosa,26 MSSA,810 RSV,811,812 adenovirus keratoconjunctivitis,813 rotavirus,814 and SARS.815 Modeling studies provide additional support for cohorting patients to control outbreaks,816-818 however, cohorting is often implemented only after routine infection control measures have failed to control an outbreak.

Assigning or cohorting HCWs to care only for patients infected or colonized with a single target pathogen limits further transmission of the target pathogen to uninfected patients,739,818 but is difficult to achieve in the face of current staffing shortages in hospitals.582 and residential health care sites.819-821 However, cohorting of HCWs may be beneficial when transmission continues after implementing routine infection control measures and creating patient cohorts.

During periods when RSV, human metapneumovirus,822 parainfluenza, influenza, other respiratory viruses,823 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.824 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 before room placement and the predominance of RSV during most of the season. However, when available, single-patient rooms are always preferred, because a common clinical presentation (eg, bronchiolitis), can be caused by more than 1 infectious agent.822,823,825 Furthermore, the inability of infants and children to contain body fluids, and the close physical contact associated with their care, increases the risk of infection transmission for patients and personnel in this setting.24,794

II.G.2. Ambulatory Care Settings. Patients actively infected with or incubating transmissible infectious diseases are frequently seen in ambulatory settings (eg, outpatient clinics, physicians’ offices, emergency departments) and potentially expose HCWs and other patients, family members, and visitors.21,54,127,135,142,826
In response to the global outbreak of SARS in 2003 and in preparation for pandemic influenza, HCWs working in outpatient settings are urged to implement source containment measures (eg, asking coughing patients to wear a surgical mask or cover coughing with tissues) to prevent transmission of respiratory infections, beginning at the initial patient encounter,\(^9,261,827\) as described in Section III.A.1.a. Signs can be posted at the facility’s entrance or at the reception or registration desk requesting that the patient or individuals accompanying the patient promptly inform the receptionist of any symptoms of respiratory infection (eg, cough, flu-like illness, increased production of respiratory secretions). The presence of diarrhea, skin rash, or known or suspected exposure to a transmissible disease (eg, measles, pertussis, chickenpox, tuberculosis) also could be added. Prompt placement of a potentially infectious patient in an examination room limits the number of exposed individuals in the common waiting area.

In waiting areas, maintaining a distance between symptomatic and nonsymptomatic patients (eg, > 3 feet), in addition to source control measures, may limit exposures. However, infections transmitted through the airborne route (eg, \(M\) tuberculosis, measles, chickenpox) require additional precautions.\(^12,125,828\) Patients suspected of having such an infection can wear a surgical mask for source containment, if tolerated, and should be placed in an examination room (preferably an AIIR) as soon as possible. If this is not possible, then having the patient wear a mask and segregating the patient from other patients in the waiting area will reduce the risk of exposing others. Because the person(s) accompanying the patient also may be infectious, application of the same infection control precautions may be extended to these persons if they are symptomatic.\(^21,251,829\) Family members accompanying children admitted with suspected \(M\) tuberculosis have been found to have unsuspected pulmonary tuberculosis with cavitary lesions, even when asymptomatic.\(^32,830\)

Patients with underlying conditions that increase their susceptibility to infection (eg, immunocompromised status\(^33,44\) or cystic fibrosis\(^26\)) require special efforts to protect them from exposure to infected patients in common waiting areas. Informing the receptionist of their infection risk on arrival allows appropriate steps to further protect these patients from infection. In some cystic fibrosis clinics, to avoid exposure to other patients who could be colonized with \(B\) cepacia, patients have been given beepers on registration so that they may leave the area and receive notification to return when an examination room becomes available.\(^831\)

II.G.3. Home Care. In home care, patient placement concerns focus on protecting others in the home from exposure to an infectious household member. For individuals who are especially vulnerable to adverse outcomes associated with certain infections, it may be beneficial to either remove them from the home or segregate them within the home. Persons who are not part of the household may need to be prohibited from visiting during the period of infectivity. For example, in a situation where a patient with pulmonary tuberculosis is contagious and being cared for at home, very young children (age under 4 years)\(^832\) and immunocompromised persons who have not yet been infected should be removed or excluded from the household. During the SARS outbreak of 2003, segregation of infected persons during the communicable phase of the illness was found to be beneficial in preventing household transmission.\(^249,833\)

II.H. Transport of Patients

Several principles guide the transport of patients requiring Transmission-Based Precautions. In the inpatient and residential settings, these include the following:

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

For tuberculosis, additional precautions may be needed in a small shared air space, such as in an ambulance.\(^12\)

II.I. Environmental Measures

Cleaning and disinfecting noncritical surfaces in patient care areas is an aspect of Standard Precautions. In general, these procedures do not need to be changed for patients on Transmission-Based Precautions. The cleaning and disinfection of all patient care areas is important for frequently touched surfaces, especially those closest to the patient, which are most likely to be contaminated (eg, bedrails, bedside tables, commodes, doorknobs, sinks, surfaces and equipment in close proximity to the patient).\(^11,72,73,834\) The frequency or intensity of cleaning may need to be changed, based on the patient’s level of hygiene and the degree of environmental contamination and for certain infectious agents with reservoirs in the
intestinal tract. This may be particularly important in LTCFs and pediatric facilities, where patients with stool and urine incontinence are encountered more frequently. In addition, 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 previously. In all health care settings, including administrative, staffing, and scheduling activities should prioritize the proper cleaning and disinfection of surfaces that could be implicated in transmission. During a suspected or proven outbreak in which an environmental reservoir is suspected, routine cleaning procedures should be reviewed, and the need for additional trained cleaning staff should be assessed. Adherence should be monitored and reinforced to promote consistent and correct cleaning.

US Environmental Protection Agency–registered disinfectants or detergents/disinfectants that best meet the overall needs of the health care facility for routine cleaning and disinfection should be selected. In general, use of the existing facility detergent/disinfectant according to the manufacturer’s recommendations for amount, dilution, and contact time is sufficient. This includes those pathogens that are resistant to multiple classes of antimicrobial agents (eg, C difficile, VRE, MRSA, MDR-GNB). Most often, environmental reservoirs of pathogens during outbreaks are related to a failure to follow recommended procedures for cleaning and disinfection, rather than to the specific cleaning and disinfectant agents used.

Certain pathogens (eg, rotavirus, noroviruses, C difficile) may be resistant to hospital disinfectants. The role of specific disinfectants in limiting transmission of rotavirus has been demonstrated experimentally. Also, because C difficile may display increased levels of spore production when exposed to non–chlorine-based cleaning agents, and because these 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. One study found an association between the use of a hypochlorite solution and decreased rates of C difficile infections. The need to change disinfectants based on the presence of these organisms can be determined in consultation with the infection control committee.

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, are available in the Guidelines for Environmental Infection Control in Health Care Facilities and in the Guideline for Disinfection and Sterilization.

II.J. Patient Care Equipment and Instruments/Devices

Medical equipment and instruments/devices must be cleaned and maintained according to the manufacturers’ instructions to prevent patient-to-patient transmission of infectious agents. Cleaning to remove organic material always must precede high-level disinfection and sterilization of critical and semicritical instruments and devices, because residual proteinaceous material reduces the effectiveness of the disinfection and sterilization processes. Noncritical equipment, such as commodes, intravenous pumps, and ventilators, must be thoroughly cleaned and disinfected before being used on another patient. All such equipment and devices should be handled in a manner that will prevent HCW and environmental contact with potentially infectious material. It is important to include computers and personal digital assistants used in patient care in policies for cleaning and disinfection of noncritical items. The literature on contamination of computers with pathogens has been summarized, and 2 reports have linked computer contamination to colonization and infections in patients. Although keyboard covers and washable keyboards that can be easily disinfected are available, the infection control benefit of these items and their optimal management have not yet been determined.

In all health care settings, providing patients who are on Transmission-Based Precautions with dedicated noncritical medical equipment (eg, stethoscope, blood pressure cuff, electronic thermometer) has proven beneficial for preventing transmission. When this is not possible, disinfection of this equipment after each use is recommended. Other previously published 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.

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

II.K. Textiles and Laundry

Although soiled textiles, including bedding, towels, and patient or resident clothing, may be contaminated
with pathogenic microorganisms, the risk of disease transmission is negligible if these textiles are handled, transported, and laundered in a safe manner. Key principles for handling soiled laundry are (1) avoiding shaking the items or handling them in any way that may aerosolize infectious agents, (2) avoiding contact of one’s body and personal clothing with the soiled items being handled, and (3) containing soiled items in a laundry bag or designated bin. If a laundry chute is used, it must be maintained to minimize dispersion of aerosols from contaminated items. Methods of handling, transporting, and laundering soiled textiles are determined by organizational policy and any applicable regulations. Guidance is provided in the Guidelines for Environmental Infection Control in Health Care Facilities. Rather than rigid rules and regulations, hygienic and common sense storage and processing of clean textiles is recommended. When laundering is done outside of a health care facility, the clean items must be packaged or completely covered and placed in an enclosed space during transport to prevent contamination with outside air or construction dust that could contain infectious fungal spores that pose a risk for immunocompromised patients.

Institutions are required to launder garments used as PPE and uniforms visibly soiled with blood or infective material. Little data exist on the safety of home laundering of HCW uniforms, but no increase in infection rates was observed in the one published study and no pathogens were recovered from home- or hospital-laundered scrubs in another study. In the home, textiles and laundry from patients with potentially transmissible infectious pathogens do not require special handling or separate laundering and may be washed with warm water and detergent. Consistent with principles of good personal hygiene and to help prevent transmission of respiratory viruses, herpes simplex virus, and infectious agents that infect the gastrointestinal tract and are transmitted by the fecal/oral route (eg, hepatitis A virus, noroviruses). If adequate resources for cleaning utensils and dishes are not available, then disposable products may be used.

II.N. Adjunctive Measures

Important adjunctive measures that are not considered primary components of programs to prevent transmission of infectious agents but nonetheless improve the effectiveness of such programs include (1) antimicrobial management programs, (2) postexposure chemoprophylaxis with antiviral or antibacterial agents, (3) vaccines used both for pre-exposure and postexposure prevention, and (4) screening and restricting visitors with signs of transmissible infections. Detailed discussion of judicious use of antimicrobial agents is beyond the scope of this document; however, this topic has been addressed in a previous CDC guideline.

II.N.1. Chemoprophylaxis. Antimicrobial agents and topical antiseptics may be used to prevent infection and potential outbreaks of selected agents. Infections for which postexposure chemoprophylaxis is recommended under defined conditions include B pertussis, N meningitides, B anthracis after environmental exposure to aerosolizable material, influenza virus, HIV, and group A streptococcus. Orally administered antimicrobials also may be used under defined circumstances for MRSA decolonization of patients or HCWs.

Another form of chemoprophylaxis involves the use of topical antiseptic agents. For example, triple dye is routinely used 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. Extension of the use of triple dye to low birth weight infants in a NICU was one component of a program that controlled a long-standing MRSA outbreak. Topical antiseptics (eg, mupirocin) also are used for decolonization of HCWs or selected patients colonized with MRSA, as discussed in the MDRO guideline.

II.N.2. Immunoprophylaxis. Certain immunizations recommended for susceptible HCWs have decreased the risk of infection and the potential for transmission in health care facilities. The OSHA mandate requiring employers to offer HBV vaccination to HCWs has played a substantial role in the sharp decline in incidence of occupational HBV infection. The routine administration of varicella vaccine to HCWs has
decreased the need to place susceptible HCWs on administrative leave after exposure to patients with varicella. In addition, reports of health care–associated transmission of rubella in obstetric clinics and measles in acute care settings demonstrate the importance of immunization of susceptible HCWs against childhood diseases. Many states have requirements for vaccination of HCWs for measles and rubella in the absence of evidence of immunity. Annual influenza vaccine campaigns targeted at patients and HCWs in LTCFs and acute care settings have been instrumental in preventing or limiting institutional outbreaks; consequently, increasing attention is being directed toward improving influenza vaccination rates in HCWs.

Transmission of B. pertussis in health care facilities has been associated with large and costly outbreaks that include both HCWs and patients. HCWs in close contact with infants with pertussis are at particularly high risk because of waning immunity and, until 2005, the absence of a vaccine appropriate for adults. But 2 acellular pertussis vaccines were licensed in the United States in 2005, 1 for use in individuals age 11 to 18 years and the other for use in those age 10 to 64 years. Current Advisory Committee on Immunization Practices provisional recommendations include immunization of adolescents and adults, especially those in contact with infants under age 12 months and HCWs with direct patient contact.

Immunization of children and adults will help prevent the introduction of vaccine-preventable diseases into health care settings. The recommended immunization schedule for children is published annually in the January issues of the Morbidity and Mortality Weekly Report, with interim updates as needed. An adult immunization schedule also is available for healthy adults and those with special immunization needs due to high-risk medical conditions.

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

Immune globulin preparations also are used for postexposure prophylaxis of certain infectious agents under specified circumstances (eg, varicella-zoster virus, HBV, rabies, measles and hepatitis A virus). The RSV monoclonal antibody preparation palivizumab may have contributed to controlling a nosocomial outbreak of RSV in one NICU, but there is insufficient evidence to support a routine recommendation for its use in this setting.


II.N.3.a. Visitors as Sources of Infection. Visitors have been identified as the source of several types of HAI (eg, pertussis, M. tuberculosis, influenza and other respiratory viruses, and SARS). Effective methods for visitor screening in health care settings have not yet been studied, however. Visitor screening is especially important during community outbreaks of infectious diseases and for high-risk patient units. Sibling visits are often encouraged in birthing centers, postpartum rooms, pediatric inpatient units, PICUs, and residential settings for children; in hospital settings, a child visitor should visit only his or her own sibling. Screening of visiting siblings and other children before they are allowed into clinical areas is necessary to prevent the introduction of childhood illnesses and common respiratory infections. Screening may be passive, through the use of signs to alert family members and visitors with signs and symptoms of communicable diseases not to enter clinical areas. More active screening may include the completion of a screening tool or questionnaire to elicit information related to recent exposures or current symptoms. This information is reviewed by the facility staff, after which the visitor is either permitted to visit or is excluded.

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

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

II.N.3.b. Use of Barrier Precautions by Visitors. The use of gowns, gloves, and masks by visitors in health care settings has not been addressed specifically in the scientific literature. Some studies included the use of gowns and masks by visitors in the control of MDROs but did not perform a separate analysis to determine whether their use by visitors had a measurable effect.
PART III: PRECAUTIONS TO PREVENT TRANSMISSION OF INFECTIOUS AGENTS

There are 2 tiers of HICPAC/CDC precautions to prevent transmission of infectious agents, Standard Precautions and Transmission-Based Precautions. Standard Precautions are intended to be applied to the care of all patients in all health care settings, regardless of the suspected or confirmed presence of an infectious agent. Implementation of Standard Precautions constitutes the primary strategy for the prevention of health care–associated transmission of infectious agents among patients and HCWs. Transmission-Based Precautions are for patients who are known or suspected to be infected or colonized with infectious agents, including certain epidemiologically important pathogens, which require additional control measures to effectively prevent transmission. Because the infecting agent often is not known at the time of admission to a health care facility, Transmission-Based Precautions are used empirically, according to the clinical syndrome and the likely etiologic agents at the time, and then modified when the pathogen is identified or a transmissible infectious etiology is ruled out. Examples of this syndromic approach are presented in Table 2. The HICPAC/CDC Guidelines also include recommendations for creating a Protective Environment for allogeneic HSCT patients.

The specific elements of Standard and Transmission-Based Precautions are discussed in Part II of this guideline. In Part III, the circumstances in which Standard Precautions, Transmission-Based Precautions, and a Protective Environment are applied are discussed. Tables 4 and 5 summarize the key elements of these sets of precautions.

III.A. Standard Precautions

Standard Precautions combine the major features of Universal Precautions and Body Substance Isolation and are based on the principle that all blood, body fluids, secretions, excretions except sweat, intact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions include a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which health care is delivered (Table 4). These include hand hygiene; use of gloves, gown, mask, eye protection, or face shield, depending on the anticipated exposure; and safe injection practices. Also, equipment or items in the patient environment likely to have been contaminated with infectious body fluids must be handled in a manner to prevent transmission of infectious agents (eg, wear gloves for direct contact, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient).

The application of Standard Precautions during patient care is determined by the nature of the HCW–patient interaction and the extent of anticipated blood, body fluid, or pathogen exposure. For some interactions (eg, performing venipuncture), only gloves may be needed; during other interactions (eg, intubation), use of gloves, gown, and face shield or mask and goggles is necessary. Education and training on the principles and rationale for recommended practices are critical elements of Standard Precautions because they facilitate appropriate decision-making and promote adherence when HCWs are faced with new circumstances.

An example of the importance of the use of Standard Precautions is intubation, especially under emergency circumstances when infectious agents may not be suspected, but later are identified (eg, SARS-CoV, N meningitides). The application of Standard Precautions is described below and summarized in Table 4. Guidance on donning and removing gloves, gowns and other PPE is presented in Figure 1.

Standard Precautions are also intended to protect patients by ensuring that HCWs do not carry infectious agents to patients on their hands or via equipment used during patient care.

III.A.1. New Elements of Standard Precautions. Infection control problems that are identified in the course of outbreak investigations often indicate the need for new recommendations or reinforcement of existing infection control recommendations to protect patients. Because such recommendations are considered a standard of care and may not be included in other guidelines, they are added here to Standard Precautions. Three such areas of practice that have been added are respiratory hygiene/cough etiquette, safe injection practices, and use of masks for insertion of catheters or injection of material into spinal or epidural spaces through lumbar puncture procedures (eg, myelogram, spinal or epidural anesthesia). Although most elements of Standard Precautions evolved from Universal Precautions that were developed for protection of HCWs, these new elements of Standard Precautions focus on protection of patients.

III.A.1.a. Respiratory Hygiene/Cough Etiquette. The transmission of SARS-CoV in emergency departments by patients and their family members during
the widespread SARS outbreaks in 2003 highlighted the need for vigilance and prompt implementation of infection control measures at the first point of encounter within a health care setting (eg, reception and triage areas in emergency departments, outpatient clinics, and physician offices).21,254,896 The strategy proposed has been termed respiratory hygiene/cough etiquette9,827 and is intended to be incorporated into infection control practices as a new component of Standard Precautions. The strategy is targeted at patients and accompanying family members and friends with undiagnosed transmissible respiratory infections, and applies to any person with signs of illness including cough, congestion, rhinorrhea, or increased production of respiratory secretions when entering a health care facility.40,81,45 The term cough etiquette is derived from recommended source control measures for M tuberculosis.12,126

The elements of respiratory hygiene/cough etiquette include (1) education of health care facility staff, patients, and visitors; (2) posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends; (3) source control measures (eg, covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and appropriate); (4) hand hygiene after contact with respiratory secretions; and (5) spatial separation, ideally >3 feet, of persons with respiratory infections in common waiting areas when possible. Covering sneezes and coughs and placing masks on coughing patients are proven means of source containment that prevent infected persons from dispersing respiratory secretions into the air.107,145,897,898 Masking may be difficult in some settings, (eg, pediatrics), in which case the emphasis by necessity may be on cough etiquette.899 Physical proximity of < 3 feet has been associated with an increased risk for transmission of infections through the droplet route (eg, N meningitidis903 and group A streptococcus114) and thus supports the practice of distancing infected persons from dispersing respiratory secretions into the air.107,145,897,898 The effectiveness of good hygiene practices, especially hand hygiene, in preventing transmission of viruses and reducing the incidence of respiratory infections both within and outside900-902 health care settings is summarized in several reviews.568,716,905

These measures should be effective in decreasing the risk of transmission of pathogens contained in large respiratory droplets (eg, influenza virus,23 adenovirus,111 B pertussis,826 and M pneumoniae112). Although fever will be present in many respiratory infections, patients with pertussis and mild upper respiratory tract infections are often afebrile. Therefore, the absence of fever does not always exclude a respiratory infection. Patients who have asthma, allergic rhinitis, or chronic obstructive lung disease also may be coughing and sneezing. Although these patients often are not infectious, cough etiquette measures are prudent.

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

III.A.1.b. Safe Injection Practices. The investigation of 4 large outbreaks of HBV and HCV among patients in ambulatory care facilities in the United States identified a need to define and reinforce safe injection practices.452 The 4 outbreaks occurred in a private medical practice, a pain clinic, an endoscopy clinic, and a hematology/oncology clinic. The primary breaches in infection control practice that contributed to these outbreaks were reinsertion of used needles into a multiple-dose vial or solution container (eg, saline bag) and use of a single needle/syringe to administer intravenous medication to multiple patients. In 1 of these outbreaks, preparation of medications in the same workspace where used needle/syringes were dismantled also may have been a contributing factor. These and other outbreaks of viral hepatitis could have been prevented by adherence to basic principles of aseptic technique for the preparation and administration of parenteral medications.452,453 These include the use of a sterile, single-use, disposable needle and syringe for each injection given and prevention of contamination of injection equipment and medication. Whenever possible, use of single-dose vials is preferred over multiple-dose vials, especially when medications will be administered to multiple patients.

Outbreaks related to unsafe injection practices indicate that some HCWs are unaware of, do not understand, or do not adhere to basic principles of infection control and aseptic technique. A survey of US health care workers who provide medication through injection found that 1% to 3% reused the same needle and/or syringe on multiple patients.904 Among the deficiencies identified in recent outbreaks were a lack of oversight of personnel and failure to follow up on reported breaches in infection control practices in ambulatory settings. Therefore, to ensure that all HCWs understand and adhere to recommended practices, principles of infection control and aseptic technique need to be reinforced in training programs and incorporated into institutional polices that are monitored for adherence.453

III.A.1.c. Infection Control Practices for Special Lumbar Puncture Procedures. In 2004, the CDC investigated 8 cases of postmyelography meningitis that
either were reported to the CDC or identified through a survey of the Emerging Infections Network of the Infectious Disease Society of America. Blood and/or cerebrospinal fluid of all 8 cases yielded streptococcal species consistent with oropharyngeal flora and there were changes in the CSF indices and clinical status indicative of bacterial meningitis. Equipment and products used during these procedures (eg, contrast media) were excluded as probable sources of contamination. Procedural details available for 7 cases determined that antiseptic skin preparations and sterile gloves had been used. However, none of the clinicians wore a face mask, giving rise to the speculation that droplet transmission of oropharyngeal flora was the most likely explanation for these infections. Bacterial meningitis after myelography and other spinal procedures (eg, lumbar puncture, spinal anesthesia, intrathecal chemotherapy) has been reported previously.905-914 As a result, the question of whether face masks should be worn to prevent droplet spread of oral flora during spinal procedures (eg, myelography, lumbar puncture, spinal anesthesia) has been debated.915, 916 Face masks are effective in limiting the dispersal of oropharyngeal droplets917 and are recommended for the placement of central venous catheters.918 In October 2005, HICPAC reviewed the evidence and concluded that there is sufficient experience to warrant the additional protection of a face mask for the individual placing a catheter or injecting material into the spinal or epidural space.

III.B. Transmission-Based Precautions

There are 3 categories of Transmission-Based Precautions: Contact Precautions, Droplet Precautions, and Airborne Precautions. Transmission-Based Precautions are used when the route(s) of transmission is (are) not completely interrupted using Standard Precautions alone. For some diseases that have multiple routes of transmission (eg, SARS), more than 1 Transmission-Based Precautions category may be used. When used either singly or in combination, they are always used in addition to Standard Precautions. See Appendix A for recommended precautions for specific infections. When Transmission-Based Precautions are indicated, efforts must be made to counteract possible adverse effects on patients (ie, anxiety, depression and other mood disturbances,919-921 perceptions of stigma,922 reduced contact with clinical staff,923-925 and increases in preventable adverse events564) to improve acceptance by the patients and adherence by HCWs.

III.B.1. Contact Precautions. Contact Precautions are intended to prevent transmission of infectious agents, including epidemiologically important microorganisms, which are spread by direct or indirect contact with the patient or the patient’s environment as described in Section I.B.3.a. The specific agents and circumstance for which Contact Precautions are indicated are found in Appendix A. The application of Contact Precautions for patients infected or colonized with MDROs is described in the 2006 HICPAC/CDC MDRO guideline.926 Contact Precautions also apply where the presence of excessive wound drainage, fecal incontinence, or other discharges from the body suggest an increased potential for extensive environmental contamination and risk of transmission. A single-patient room is preferred for patients who require Contact Precautions. When a single-patient room is not available, consultation with infection control personnel is recommended to assess the various risks associated with other patient placement options (eg, cohorting, keeping the patient with an existing roommate). In multipatient rooms, ≥ 3 feet spatial separation between beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients. HCWs caring for patients on Contact Precautions wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient’s environment. Donning PPE on room entry and discarding before exiting the patient room is done to contain pathogens, especially those that have been implicated in transmission through environmental contamination (eg, VRE, C difficile, noroviruses and other intestinal tract pathogens, RSV).54,72,73,78,273,274,739

III.B.2. Droplet Precautions. Droplet Precautions are intended to prevent transmission of pathogens spread through close respiratory or mucous membrane contact with respiratory secretions as described in Section I.B.3.b. Because these pathogens do not remain infectious over long distances in a health care facility, special air handling and ventilation are not required to prevent droplet transmission. Infectious agents for which Droplet Precautions are indicated are listed in Appendix A and include B pertussis, influenza virus, adenovirus, rhinovirus, N meningitides, and group A streptococcus (for the first 24 hours of antimicrobial therapy). A single-patient room is preferred for patients who require Droplet Precautions. When a single-patient room is not available, consultation with infection control personnel is recommended to assess the various risks associated with other patient placement options (eg, cohorting, keeping the patient with an existing roommate). Spatial separation of ≥ 3 feet and drawing the curtain between patient beds is especially important for patients in multibed rooms with infections transmitted by the droplet route. HCWs wear a mask (a respirator is not necessary) for close contact with infectious patient; the mask is generally donned on room entry. Patients on Droplet Precautions who
must be transported outside of the room should wear a mask if tolerated and follow respiratory hygiene/cough etiquette.

III.B.3. Airborne Precautions. Airborne Precautions prevent transmission of infectious agents that remain infectious over long distances when suspended in the air (eg, rubeola virus [measles], varicella virus [chickenpox], \textit{M tuberculosis}, and possibly SARS-CoV), as described in Section I.B.3.c and Appendix A. The preferred placement for patients who require Airborne Precautions is in an AIIR, a single-patient room equipped with special air handling and ventilation capacity that meet the AIA/Facility Guidelines Institute standards for AIIRs (ie, monitored negative pressure relative to the surrounding area; 12 air exchanges per hour for new construction and renovation and 6 air exchanges per hour for existing facilities; air exhausted directly to the outside or recirculated through HEPA filtration before return).

Some states require the availability of such rooms in hospitals, emergency departments, and nursing homes that care for patients with \textit{M tuberculosis}. A respiratory protection program that includes education about use of respirators, fit testing, and user seal checks is required in any facility with AIIRs. In settings where Airborne Precautions cannot be implemented due to limited engineering resources (eg, physician offices), masking the patient, placing the patient in a private room (eg, office examination room) with the door closed, and providing N95 or higher-level respirators or masks if respirators are not available for HCWs will reduce the likelihood of airborne transmission until the patient is either transferred to a facility with an AIIR or returned to the home environment, as deemed medically appropriate. HCWs caring for patients on Airborne Precautions wear a mask or respirator, depending on the disease-specific recommendations (see Section II.E.4, Table 2, and Appendix A), that is donned before room entry. Whenever possible, non-immune HCWs should not care for patients with vaccine-preventable airborne diseases (eg, measles, chickenpox, smallpox).

III.C. Syndromic and Empiric Applications of Transmission-Based Precautions

Diagnosis of many infections requires laboratory confirmation. Because laboratory tests, especially those that depend on culture techniques, often require 2 or more days for completion, Transmission-Based Precautions must be implemented while test results are pending, based on the clinical presentation and likely pathogens. Use of appropriate Transmission-Based Precautions at the time a patient develops symptoms or signs of transmissible infection, or arrives at a health care facility for care, reduces transmission opportunities. Although it is not possible to identify prospectively all patients needing Transmission-Based Precautions, certain clinical syndromes and conditions carry a sufficiently high risk to warrant their use empirically while confirmatory tests are pending (see Table 2). ICPs are encouraged to modify or adapt this table according to local conditions.

III.D. Discontinuation of Transmission-Based Precautions

Transmission-Based Precautions remain in effect for limited periods (ie, while the risk for transmission of the infectious agent persists or for the duration of the illness (see Appendix A). For most infectious diseases, this duration reflects known patterns of persistence and shedding of infectious agents associated with the natural history of the infectious process and its treatment. For some diseases (eg, pharyngeal or cutaneous diphtheria, RSV), Transmission-Based Precautions remain in effect until culture or antigen-detection test results document eradication of the pathogen and, for RSV, symptomatic disease is resolved. For other diseases (eg, \textit{M tuberculosis}), state laws and regulations and health care facility policies may dictate the duration of precautions.

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. Although early guidelines for VRE suggested discontinuation of Contact Precautions after 3 stool cultures obtained at weekly intervals proved negative, subsequent experiences have indicated that such screening may fail to detect colonization that can persist for >1 year.\textsuperscript{27,935-937} Likewise, available data indicate that colonization with VRE, \textit{MRSA},\textsuperscript{938} and possibly MDR-GNB can persist for many months, especially in the presence of severe underlying disease, invasive devices, and recurrent courses of antimicrobial agents.

It may be prudent to assume that MDRO carriers are colonized permanently and manage them accordingly. Alternatively, an interval free of hospitalizations, antimicrobial therapy, and invasive devices (eg, 6 or 12 months) before reculturing patients to document clearance of carriage may be used. Determination of the best strategy awaits the results of additional studies. See the
III. F. Protective Environment

A PE is designed for allogeneic HSCT patients to minimize fungal spore counts in the air and reduce the risk of invasive environmental fungal infections (see Table 5 for specifications). The need for such controls has been demonstrated in studies of aspergillosis outbreaks associated with construction. As defined by the AIA and presented in detail in the CDC’S 2005 Guideline for Environmental Infection Control in Health Care Facilities, 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 flow of air from the outside, (5) ventilation to provide ≥12 air changes per hour, (6) strategies to minimize dust (eg, scrubbable surfaces rather than upholstery and carpet, and routinely cleaning crevices and sprinkler heads), and (7) prohibiting dried and fresh flowers and potted plants in the rooms of HSCT patients. The latter is based on molecular typing studies that have found indistinguishable strains of Aspergillus terreus in patients with hemato logic malignancies and in potted plants in the vicinity of the patients. The desired quality of air may be achieved without incurring the inconvenience or expense of laminar airflow. To prevent inhalation of fungal spores during periods when construction, renovation, or other dust-generating activities that may be ongoing in and around the health care facility, it has been recommended that severely immunocompromised patients wear a high-efficiency respiratory protection device (eg, an N95 respirator) when they leave the PE. The use of masks or respirators by HSCT patients when they are outside of the PE 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 Precautions and Transmission-Based Precautions. No published reports support the benefit of placing patients undergoing solid organ transplantation or other immunocompromised patients in a PE.

PART IV: RECOMMENDATIONS

These recommendations are designed to prevent transmission of infectious agents among patients and HCWs in all settings where health care is delivered. 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

Health care organization administrators should ensure the implementation of recommendations specified in this section.

I.A. Incorporate preventing transmission of infectious agents into the objectives of the organization’s patient and occupational safety programs.

I.B. Make preventing transmission of infectious agents a priority for the health care organization. Provide administrative support, including fiscal and human resources for maintaining infection control programs.

I.B.1. Ensure that individuals with training in infection control are employed by or are
available by contract to all health care facilities, so that the infection control program is managed by 1 or more qualified individuals.315,551,565,572,574,945,946

I.B.1.a. Determine the specific infection control full-time equivalents according to the scope of the infection control program, the complexity of the health care facility or system, the characteristics of the patient population, the unique or urgent needs of the facility and community, and proposed staffing levels based on survey results and recommendations from professional organizations. 315,433,548,551,565,568,572,574,947,948

I.B.2. Include prevention of HAIs as a determinant of bedside nurse staffing levels and composition, especially in high-risk units.417,550,582,584-589,591-596

I.B.3. Delegate authority to infection control personnel or their designees (eg, patient care unit charge nurses) for making infection control decisions concerning patient placement and assignment of Transmission-Based Precautions.433,548,856,945

I.B.4. Involve infection control personnel in decisions on facility construction and design, determination of AIIR and PE capacity needs, and environmental assessments. 11-13, 949,950

I.B.4.a. Provide ventilation systems required for a sufficient number of AIIRs (as determined by a risk assessment) and PEs in health care facilities that provide care to patients for whom such rooms are indicated, according to published recommendations.11-13,15

I.B.5. Involve infection control personnel in the selection and postimplementation evaluation of medical equipment and supplies and changes in practice that could affect the risk of HAI.951,952

I.B.6. Ensure availability of human and fiscal resources to provide clinical microbiology laboratory support, including a sufficient number of medical technologists trained in microbiology, appropriate to the health care setting, for monitoring transmission of microorganisms, planning and conducting epidemiologic investigations, and detecting emerging pathogens. Identify resources for performing surveillance cultures, rapid diagnostic testing for viral and other selected pathogens, preparation of antimicrobial susceptibility summary reports, trend analysis, and molecular typing of clustered isolates (performed either onsite or in a reference laboratory) and use these resources according to facility-specific epidemiologic needs, in consultation with clinical microbiologists. 552,553,597,598,602,604-606,608,609,611,613-616,953

I.B.7. Provide human and fiscal resources to meet occupational health needs related to infection control (eg, HCWs immunization, postexposure evaluation and care, evaluation and management of HCWs with communicable infections). 12,17,134,689,738,878-880

I.B.8. In all areas where health care is delivered, provide supplies and equipment necessary for the consistent observance of Standard Precautions, including hand hygiene products and PPE (eg, gloves, gowns, face and eye protection). 558,738,945

I.B.9. Develop and implement policies and procedures to ensure that reusable patient care equipment is cleaned and reprocessed appropriately before use on another patient.11,87,856,954-959

I.C. Develop and implement processes to ensure oversight of infection control activities appropriate to the health care setting and assign responsibility for oversight of infection control activities to an individual or group within the health care organization that is knowledgeable about infection control.433,548,565

I.D. Develop and implement systems for early detection and management (eg, use of appropriate infection control measures, including isolation precautions, PPE) of potentially infectious persons at initial points of patient encounter in outpatient settings (eg, triage areas, emergency departments, outpatient clinics, physician offices) and at the time of admission to hospitals and LTCFs.9,122,134,253,826

I.E. Develop and implement policies and procedures to limit patient visitation by persons with signs or symptoms of a communicable infection. Screen visitors to high-risk patient care areas (eg, oncology units, HSCT units, intensive care units, other severely immunocompromised patients) for possible infection.24,41,43,960,961

I.F. Identify performance indicators of the effectiveness of organization-specific measures to prevent transmission of infectious agents (Standard Precautions and Transmission-Based Precautions), establish processes to monitor adherence to those
II. Education and Training

II.A. Provide job- or task-specific education and training on preventing transmission of infectious agents associated with health care during orientation to the health care facility; update information periodically during ongoing education programs. Target all HCWs for education and training, including but not limited to medical, nursing, clinical technicians, and laboratory staff; property service (housekeeping), laundry, maintenance and dietary workers; students; contract staff; and volunteers. Document competency initially and repeatedly, as appropriate, for the specific staff positions. Develop a system to ensure that HCWs employed by outside agencies meet these education and training requirements through programs offered by the agencies or by participation in the health care facility’s program designed for full-time personnel.

II.A.1. Include in education and training programs, information concerning use of vaccines as an adjunctive infection control measure.

II.A.2. Enhance education and training by applying principles of adult learning, using reading level and language appropriate material for the target audience, and using online educational tools available to the institution.

II.B. Provide instructional materials for patients and visitors on recommended hand hygiene and respiratory hygiene/cough etiquette practices and the application of Transmission-Based Precautions.

III. Surveillance

III.A. Monitor the incidence of epidemiologically important organisms and targeted HAIs that have a substantial impact on outcome and for which effective preventive interventions are available. Use information collected through surveillance of high-risk populations, procedures, devices, and highly transmissible infectious agents to detect transmission of infectious agents in the health care facility.

III.B. Apply the following epidemiologic principles of infection surveillance.

- Use standardized definitions of infection.
- Use laboratory-based data (when available).
- Collect epidemiologically important variables (e.g., patient locations and/or clinical service in hospitals and other large multiunit facilities, population-specific risk factors [e.g., low birth weight neonates], underlying conditions that predispose to serious adverse outcomes).
- Analyze data to identify trends that may indicated increased rates of transmission.
- Feedback information on trends in the incidence and prevalence of HAIs, probable risk factors, and prevention strategies and their impact to the appropriate health care providers, organization administrators, and as required by local and state health authorities.

III.C. Develop and implement strategies to reduce risks for transmission and evaluate effectiveness.

III.D. When transmission of epidemiologically important organisms continues despite implementation and documented adherence to infection prevention and control strategies, obtain consultation from persons knowledgeable in infection control and health care epidemiology to review the situation and recommend additional measures for control.

III.E. Periodically review information on community or regional trends regarding the incidence and prevalence of epidemiologically important organisms (e.g., influenza, RSV, pertussis, invasive group A streptococcal disease, MRSA, VRE) (including in other health care facilities) that may affect transmission of organisms within the facility.

IV. Standard Precautions

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

IVA. Hand Hygiene

IVA.1. During the delivery of health care, avoid unnecessary touching of surfaces in close proximity to the patient to prevent both contamination of clean hands from environmental surfaces and transmission of pathogens from contaminated hands to surfaces.

IVA.2. When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with either a nonantimicrobial soap...
and water or an antimicrobial soap and water.\textsuperscript{558} \textit{Category IA}

\textbf{IV.A.3.} If hands are not visibly soiled, or after removing visible material with nonantimicrobial soap and water, decontaminate hands in the clinical situations described in IV.A.2.a–f. The preferred method of hand decontamination is with an alcohol-based hand rub.\textsuperscript{561,974} Alternatively, hands may be washed with an antimicrobial soap and water. Frequent use of an alcohol-based hand rub immediately after handwashing with nonantimicrobial soap may increase the frequency of dermatitis.\textsuperscript{558} \textit{Category IB}

Perform hand hygiene:

\textbf{IV.A.3.a.} Before having direct contact with patients.\textsuperscript{663,975} \textit{Category IB}

\textbf{IV.A.3.b.} After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings.\textsuperscript{663} \textit{Category IA}

\textbf{IV.A.3.c.} After contact with a patient’s intact skin (eg, when measuring pulse or blood pressure or lifting a patient).\textsuperscript{167,976-978} \textit{Category IB}

\textbf{IV.A.3.d.} If hands will be moving from a contaminated body site to a clean body site during patient care. \textit{Category II}

\textbf{IV.A.3.e.} After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient.\textsuperscript{72,73,88,799,979,980} \textit{Category II}

\textbf{IV.A.3.f.} After removing gloves.\textsuperscript{727,740,741} \textit{Category IB}

\textbf{IV.A.4.} Wash hands with nonantimicrobial soap and water or with antimicrobial soap and water if contact with spores (eg, \textit{C difficile} or \textit{B anthracis}) is likely to have occurred. 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.\textsuperscript{558,954,981} \textit{Category II}

\textbf{IV.A.5.} Do not wear artificial fingernails or extenders if duties include direct contact with patients at high risk for infection and associated adverse outcomes (eg, those in ICUs or operating rooms).\textsuperscript{30,31,558,721-723} \textit{Category IA}

\textbf{IV.A.5.a.} Develop an organizational policy on the wearing of nonnatural nails by HCWs who have direct contact with patients outside of the groups specified above.\textsuperscript{982} \textit{Category II}

\textbf{IV.B. Personal protective equipment (see Fig 1)}

\textbf{IV.B.1.} Observe the following principles of use:

\begin{itemize}
  \item \textbf{IV.B.1.a.} Wear PPE, as described in IV.B.2–4, when the nature of the anticipated patient interaction indicates that contact with blood or body fluids may occur.\textsuperscript{738,779,895} \textit{Category IB/IC}
  \item \textbf{IV.B.1.b.} Prevent contamination of clothing and skin during the process of removing PPE (see Fig 1). \textit{Category II}
  \item \textbf{IV.B.1.c.} Before leaving the patient’s room or cubicle, remove and discard PPE.\textsuperscript{18,758} \textit{Category IB/IC}
\end{itemize}

\textbf{IV.B.2.} Gloves

\begin{itemize}
  \item \textbf{IV.B.2.a.} Wear gloves when it can be reasonably anticipated that contact with blood or other potentially infectious materials, mucous membranes, nonintact skin, or potentially contaminated intact skin (eg, of a patient incontinent of stool or urine) could occur.\textsuperscript{18,727,738,740,779,983} \textit{Category IB/IC}
  \item \textbf{IV.B.2.b.} Wear gloves with fit and durability appropriate to the task.\textsuperscript{558,730,731,738,984,985} \textit{Category IB}
    \begin{itemize}
      \item \textbf{IV.B.2.b.i.} Wear disposable medical examination gloves for providing direct patient care.
      \item \textbf{IV.B.2.b.ii.} Wear disposable medical examination gloves or reusable utility gloves for cleaning the environment or medical equipment.
    \end{itemize}
  \item \textbf{IV.B.2.c.} Change gloves during patient care if the hands will move from a contaminated body site (eg, perineal area) to a clean body site (eg, face). \textit{Category II}
\end{itemize}

\textbf{IV.B.3.} Gowns

\begin{itemize}
  \item \textbf{IV.B.3.a.} Wear a gown appropriate to the task to protect skin and prevent soiling
or contamination of clothing during procedures and patient care activities when contact with blood, body fluids, secretions, or excretions is anticipated. Category IB/IC

IV.B.3.a.i. Wear a gown for direct patient contact if the patient has uncontained secretions or excretions. Category IB/IC

IV.B.3.a.ii. Remove gown and perform hand hygiene before leaving the patient’s environment. Category IB/IC

IV.B.3.b. Do not reuse gowns, even for repeated contacts with the same patient. Category II

IV.B.3.c. Routine donning of gowns on entrance into a high-risk unit (eg, ICU, NICU, HSCT unit) is not indicated. Category IB

IV.B.4. Mouth, nose, and eye protection

IV.B.4.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. Select masks, goggles, face shields, and combinations of these according to the need anticipated by the task to be performed. Category IB/IC

IV.B.5. During aerosol-generating procedures (eg, bronchoscopy, suctioning of the respiratory tract [if not using in-line suction catheters], endotracheal intubation) in patients who are not suspected of being infected with an agent for which respiratory protection is otherwise recommended (eg, M tuberculosis, SARS, or hemorrhagic fever viruses), wear one of the following: a face shield that fully covers the front and sides of the face, a mask with attached shield, or a mask and goggles (in addition to gloves and gown). Category IB/IC

IV.C. Respiratory hygiene/cough etiquette

IV.C.1. Educate HCWs on the importance of source control measures to contain respiratory secretions, to prevent droplet and fomite transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections (eg, influenza, RSV, adenovirus, parainfluenza virus) in communities. Category IB

IV.C.2. Implement the following measures to contain respiratory secretions in patients and accompanying individuals who have signs and symptoms of a respiratory infection, beginning at the point of initial encounter in a health care setting (eg, triage, reception and waiting areas in emergency departments, outpatient clinics, and physicians’ offices). Category IB

IV.C.2.a. Post signs at entrances and in strategic places (eg, elevators, cafeterias) within ambulatory and inpatient settings with instructions to patients and other persons with symptoms of respiratory infection to cover their mouths and noses when coughing or sneezing, use and dispose of tissues, and perform hand hygiene after hands have been in contact with respiratory secretions. Category IB

IV.C.2.b. Provide tissues and no-touch receptacles (eg, foot pedal–operated lid or open, plastic-lined wastebasket) for disposal of tissues. Category II

IV.C.2.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. Category IB

IV.C.2.d. During periods of increased prevalence of respiratory infections in the community (as indicated by, eg, increased school absenteeism, increased number of patients seeking care for respiratory infection), offer masks to coughing patients and other symptomatic persons (eg, persons who accompany ill patients) on entry into the facility or medical office and encourage them to maintain special separation (ideally, at least 3 feet) from others in common waiting areas. Some facilities may find it logistically easier to institute this recommendation year-round as a standard of practice. Category II
IV.D. Patient placement

IV.D.1. Include the potential for transmission of infectious agents in patient placement decisions. Place patients who pose a risk for transmission to others (eg, those with uncontained secretions, excretions, or wound drainage; infants with suspected viral respiratory or gastrointestinal infections) in a single-patient room when available.24,409,429, 434,792,795,796,805,988

Category IB

IV.D.2. Determine patient placement based on the following factors:
- Route(s) of transmission of the known or suspected infectious agent
- Risk factors for transmission in the infected patient
- Risk factors for adverse outcomes resulting from an HAI in other patients in the area or room being considered for patient placement
- Availability of single-patient rooms
- Patient options for room sharing (eg, cohorting patients with the same infection)

Category II

IV.E. Patient care equipment and instruments/devices

IV.E.1. Establish policies and procedures for containing, transporting, and handling patient care equipment and instruments/devices that may be contaminated with blood or body fluids18,738,973

Category IB/IC

IV.E.2. Remove organic material from critical and semicritical instrument/devices, using recommended cleaning agents before high-level disinfection and sterilization to enable effective disinfection and sterilization processes.835,989,990

Category IA

IV.E.3. Wear PPE (eg, gloves, gown), according to the level of anticipated contamination, when handling patient care equipment and instruments/devices that is visibly soiled or may have been in contact with blood or body fluids.18,738,973

Category IB/IC

IV.F. Care of the environment

IV.F.1. Establish policies and procedures for routine and targeted cleaning of environmental surfaces as indicated by the level of patient contact and degree of soiling.11

Category II

IV.F.2. Clean and disinfect surfaces likely to be contaminated with pathogens, including those in close proximity to the patient (eg, bed rails, over bed tables) and frequently touched surfaces in the patient care environment (eg, door knobs, surfaces in and surrounding toilets in patient rooms) on a more frequent schedule compared with that for other surfaces (eg, horizontal surfaces in waiting rooms).11,74,73,739,745, 799,835,991-993

Category IB

IV.F.3. Use EPA-registered disinfectants that have microbiocidal (ie, killing) activity against the pathogens most likely to contaminate the patient care environment. Use in accordance with manufacturer’s instructions.841- 843,954,994

Category IB/IC

IV.F.3.a. Review the efficacy of disinfectants in use when evidence of continuing transmission of an infectious agent (eg, rotavirus, C difficile, norovirus) may indicate resistance to the product and a change to a more effective disinfectant as indicated.274,841,846

Category II

IV.F.4. In facilities that provide health care to pediatric patients or that have waiting areas with children’s toys (eg, obstetric/gynecology offices and clinics), establish policies and procedures for cleaning and disinfecting toys at regular intervals.80,378

Category IB

Consider the following principles when developing this policy and procedures: Category II
- Select play toys that can be easily cleaned and disinfected.
- Do not permit use of stuffed furry toys if they will be shared.
- Clean and disinfect large stationary toys (eg, climbing equipment) at least weekly and whenever visibly soiled.
- If toys are likely to be mouthed, rinse with water after disinfection; alternatively, wash in a dishwasher.
- When a toy requires cleaning and disinfection, do so immediately or store in a designated labeled container separate from toys that are clean and ready for use.

IV.F.5. Include multiuse electronic equipment in policies and procedures for preventing contamination and for cleaning and disinfection, especially those items that are used by patients, those used during delivery of patient care, and mobile devices that are moved in and out of patient rooms frequently (eg, daily).849,850,851,995

Category IB

IV.F.5.a. No recommendation for use of removable protective covers or washable keyboards. Unresolved issue

IV.G. Textiles and laundry

IV.G.1. Handle used textiles and fabrics with minimum agitation to avoid contamination of
air, surfaces, and persons.\textsuperscript{738,996,997} Category IB/IC

IV.G.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.\textsuperscript{11,13,998,999} Category IB/IC

IV.H. Safe injection practices
The following recommendations apply to the use of needles, cannulas that replace needles, and, where applicable, intravenous delivery systems.\textsuperscript{453}

IV.H.1. Use aseptic technique to avoid contamination of sterile injection equipment\textsuperscript{1000,1001} Category IA

IV.H.2. Do not administer medications from a syringe to multiple patients, even if the needle or cannula on the syringe is changed. Needles, cannulas, and syringes are sterile, single-use items; they should not be reused for another patient or to access a medication or solution that might be used for a subsequent patient.\textsuperscript{452,918,1002,1003} Category IA

IV.H.3. Use fluid infusion and administration sets (ie, intravenous bags, tubing and connectors) for one patient only and dispose of appropriately after use. Consider a syringe or needle/cannula to be contaminated once it has been used to enter or connect to a patient’s intravenous infusion bag or administration set.\textsuperscript{452} Category IB

IV.H.4. Use single-dose vials for parenteral medications whenever possible.\textsuperscript{452} Category IA

IV.H.5. Do not administer medications from single-dose vials or ampules to multiple patients or combine leftover contents for later use.\textsuperscript{568,452,1003} Category IA

IV.H.6. If multidose vials must be used, both the needle or cannula and syringe used to access the multidose vial must be sterile.\textsuperscript{452,1000} Category IA

IV.H.7. Do not keep multidose vials in the immediate patient treatment area. Store in accordance with the manufacturer’s recommendations; discard if sterility is compromised or questionable.\textsuperscript{452,1001} Category IA

IV.H.8. Do not use bags or bottles of intravenous solution as a common source of supply for multiple patients.\textsuperscript{452,1004} Category IB

IV.I. Infection control practices for special lumbar puncture procedures
Wear a surgical mask when placing a catheter or injecting material into the spinal canal or subdural space (ie, during myelograms, lumbar puncture and spinal or epidural anesthesia).\textsuperscript{904-912,916,1005} Category IB

IV.J. Worker safety
Adhere to federal and state requirements for protection of HCWs from exposure to bloodborne pathogens.\textsuperscript{738} Category IC

V. Transmission-Based Precautions

V.A. General principles
V.A.1. In addition to Standard Precautions, use Transmission-Based 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).\textsuperscript{24,93,126,141,305,805,1006} Category IA

V.A.2. Extend the duration of Transmission-Based Precautions, (eg, Droplet, Contact) for immunosuppressed patients with viral infections due to prolonged shedding of viral agents that may be transmitted to others.\textsuperscript{927,930-932,1007-1009} Category IA

V.B. Contact Precautions
V.B.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. For specific recommendations for use of Contact Precautions for colonization or infection with MDROs, consult the MDRO guideline, available at http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf.\textsuperscript{869}

V.B.2. Patient placement
V.B.2.a. In acute care hospitals, place patients who require Contact Precautions in a single-patient room when available.\textsuperscript{24,686,792,795,796,805,836,892,1010,1011} Category IB

V.B.2.b. When single-patient rooms are in short supply, apply the following principles for making decisions on patient placement:

- Prioritize patients with conditions that may facilitate transmission (eg, uncontained drainage, stool incontinence) for single-patient room placement. Category II
- Place patients who are infected or colonized with the same pathogen and are suitable roommates together in the same room (cohort).\textsuperscript{29,637,807,810-812,814,817,818} Category IB
If it becomes necessary to place a patient requiring Contact Precautions in a room with a patient who is not infected or colonized with the same infectious agent:

- 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 (eg, those who are immunocompromised, have open wounds, or have anticipated prolonged lengths of stay). Category II
- Ensure that patients are physically separated (ie, >3 feet apart) from each other. Draw the privacy curtain between beds to minimize opportunities for direct contact. Category II
- Change protective attire and perform hand hygiene between contact with patients in the same room, regardless of whether or not either of the patients is on Contact Precautions.727,740,741,986,1012,1013 Category IB

V.B.2.c. In long-term care and other residential settings, make decisions regarding patient placement on a case-by-case basis, balancing infection risks to other patients in the room, the presence of risk factors that increase the likelihood of transmission, and the potential adverse psychological impact on the infected or colonized patient.919,920 Category II

V.B.2.d. In ambulatory settings, place patients who require Contact Precautions in an examination room or cubicle as soon as possible.20 Category II

V.B.3. Use of PPE

V.B.3.a. Gloves
Wear gloves whenever touching the patient’s intact skin24,89,134,558,745,836 or surfaces and articles in close proximity to the patient (eg, medical equipment, bed rails).72,73,88,836
Don gloves on entry into the room or cubicle. Category IB

V.B.3.b. Gowns

V.B.3.b.i. Wear a gown whenever it is anticipated that clothing will come in direct contact with the patient or potentially contaminated environmental surfaces or equipment in close proximity to the patient. Don a gown on entry into the room or cubicle. Remove the gown and observe hand hygiene before leaving the patient care environment.24,88,134,744,836 Category IB

V.B.3.b.ii. After gown removal, ensure that clothing and skin do not contact potentially contaminated environmental surfaces that could result in possible transfer of microorganism to other patients or environmental surfaces.72,73 Category II

V.B.4. Patient transport

V.B.4.a. In acute care hospitals and long-term care and other residential settings, limit transport and movement of patients outside of the room to medically necessary purposes. Category II

V.B.4.b. When transport or movement in any health care setting is necessary, ensure that infected or colonized areas of the patient’s body are contained and covered. Category II

V.B.4.c. Remove and dispose of contaminated PPE and perform hand hygiene before transporting patients on Contact Precautions. Category II

V.B.4.d. Don clean PPE to handle the patient at the transport destination. Category II

V.B.5. Patient care equipment and instruments/devices

V.B.5.a. Handle patient care equipment and instruments/devices according to Standard Precautions.738,835 Category IB/IC

V.B.5.b. In acute care hospitals and long-term care and other residential settings, use disposable noncritical patient care equipment (eg, blood pressure cuffs) or implement patient-dedicated use of such equipment. If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient.24,88,795,835,836,853,1014 Category IB

V.B.5.c. In-home care settings

V.B.5.c.i. Limit the amount of nondisposable patient care equipment
brought into the home of a patient on Contact Precautions. Whenever possible, leave patient care equipment in the home until discharge from home care services. **Category II**

V.B.5.c.ii. If noncritical patient care equipment (e.g., stethoscope) cannot remain in the home, clean and disinfect items before taking them from the home using a low- to intermediate-level disinfectant. Alternatively, place contaminated reusable items in a plastic bag for transport and subsequent cleaning and disinfection. **Category II**

V.B.5.d. In ambulatory settings, place contaminated reusable noncritical patient care equipment in a plastic bag for transport to a soiled utility area for reprocessing. **Category II**

V.B.6. Environmental measures

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

V.B.7. Discontinue Contact Precautions after signs and symptoms of the infection have resolved or according to pathogen-specific recommendations in Appendix A. **Category IB**

V.C. Droplet Precautions

V.C.1. Use Droplet Precautions as recommended in Appendix A for patients known or suspected infection with pathogens transmitted by respiratory droplets (i.e., droplets > 5 μm) generated by a patient who is coughing, sneezing, or talking. **Category IB**

V.C.2. Patient placement

V.C.2.a. In acute care hospitals, place patients who require Droplet Precautions in a single-patient room when available. **Category II**

When single-patient rooms are in short supply, apply the following principles when making decisions on patient placement:

- Prioritize patients who have excessive cough and sputum production for single-patient room placement. **Category II**
- Place patients who are infected the same pathogen and are suitable roommates together in the same room (cohort). **Category IB**
- If it becomes necessary to place patients who require Droplet Precautions in a room with a patient who does not have the same infection:
  - Avoid placing patients on Droplet 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 or have anticipated prolonged lengths of stay). **Category II**
  - Ensure that patients are physically separated (i.e., >3 feet apart) from each other. Draw the privacy curtain between beds to minimize opportunities for close contact. **Category IB**
  - Change protective attire and perform hand hygiene between contact with patients in the same room, regardless of whether or not either patient is on Droplet Precautions. **Category IB**

V.C.2.b. In long-term care and other residential settings, make decisions regarding patient placement on a case-by-case basis after considering infection risks to other patients in the room and available alternatives. **Category IB**

V.C.2.c. In ambulatory settings, place patients who require Droplet Precautions in an examination room or cubicle as soon as possible. Instruct patients to follow recommendations for respiratory hygiene/cough etiquette. **Category IB**

V.C.3. Use of PPE

V.C.3.a. Don a mask on entry into the patient’s room or cubicle. **Category IB**

V.C.3.b. No recommendation for routinely wearing eye protection (e.g., goggle or face shield) in addition to a mask, for close contact with patients.
who require Droplet Precautions. Unresolved issue

V.C.3.c. For patients with suspected or proven SARS, avian influenza or pandemic influenza, refer to the following websites for the most current recommendations: http://www.cdc.gov/ncidod/sars/; http://www.cdc.gov/flu/avian/; and http://www.pandemicflu.gov/.134,1016,1017

V.C.4. Patient transport

V.C.4.a. In acute care hospitals and long-term care and other residential settings, limit transport and movement of patients outside of the room to medically necessary purposes. Category II

V.C.4.b. If transport or movement in any health care setting is necessary, instruct the patient to wear a mask and follow respiratory hygiene/ cough etiquette (see http://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm). Category IB

V.C.4.c. No mask is required for persons transporting patients on Droplet Precautions. Category II

V.C.4.d. Discontinue Droplet Precautions after signs and symptoms have resolved or according to pathogen-specific recommendations in Appendix A. Category IB

V.D. Airborne Precautions

V.D.1. Use Airborne Precautions as recommended in Appendix A for patients known or suspected to be infected with infectious agents transmitted person to person by the airborne route (eg, M tuberculosis,12 measles,34,122,1018 chickenpox,123,772,1019 disseminated herpes zoster1020). Category IA/IC

V.D.2. Patient placement

V.D.2.a. In acute care hospitals and long-term care settings, place patients who require Airborne Precautions in an AIIR that has been constructed in accordance with current guidelines.11-13 Category IA/IC

V.D.2.a.i. Provide at least 6 (in an existing facility) or 12 (in new construction/renovation) air changes per hour.

V.D.2.a.ii. Direct exhaust of air to the outside. If it is not possible to exhaust air from an AIIR directly to the outside, the air may be returned to the air-handling system or adjacent spaces if all air is directed through HEPA filters.

V.D.2.a.iii. Whenever an AIIR is in use for a patient on Airborne Precautions, monitor air pressure daily with visual indicators (eg, smoke tubes, flutter strips), regardless of the presence or absence of differential pressure-sensing devices (eg, manometers).11,12,1021,1022

V.D.2.a.iv. Keep the AIIR door closed when not required for entry and exit.

V.D.2.b. When an AIIR is not available, transfer the patient to a facility that has an available AIIR. Category II

V.D.2.c. In the event of an outbreak or exposure involving large numbers of patients who require Airborne Precautions:

- Consult an ICP before patient placement to determine the safety of an alternative room that does not meet engineering requirements for an AIIR.

- Place patients who are presumed to have the same infection (based on clinical presentation and diagnosis when known) together (cohort) in areas of the facility away from other patients, especially patients at increased risk for infection (eg, immunocompromised patients).

- Use temporary portable solutions (eg, exhaust fan) to create a negative-pressure environment in the converted area of the facility. Discharge air directly to the outside, away from people and air intakes, or direct all of the air through HEPA filters before it is introduced to other air spaces.12 Category II

V.D.2.d. In ambulatory settings:

V.D.2.d.i. Develop systems (eg, triage, signage) to identify patients with known or suspected infections who require Airborne Precautions on entry into ambulatory settings.9,12,24,127,134 Category IA

V.D.2.d.ii. Place the patient in an AIIR as soon as possible. If an AIIR is
not available, place a surgical mask on the patient and place the patient in an examination room. Once the patient leaves, the room should remain vacant for the appropriate time (generally 1 hour) to allow for a full exchange of air.\textsuperscript{11,12,122} \textit{Category IB/IC}

V.D.2.d.iii. Instruct a patient with a known or suspected airborne infection to wear a surgical mask and observe respiratory hygiene/cough etiquette. Once in an AIIR, the mask may be removed; the mask should remain on if the patient is not in an AIIR.\textsuperscript{12,107,145,898} \textit{Category IB/IC}

V.D.3. Personnel restrictions

Restrict susceptible HCWs from entering the rooms of patients known or suspected to have measles (rubeola), varicella (chickenpox), disseminated zoster, or smallpox if other immune HCWs are available.\textsuperscript{17,774} \textit{Category IB}

V.D.4. Use of PPE

V.D.4.a. Wear a fit-tested NIOSH-approved N95 or higher-level respirator for respiratory protection when entering the room or home of a patient when the following diseases are suspected or confirmed:

- Infectious pulmonary or laryngeal tuberculosis, or when infectious tuberculosis skin lesions are present and procedures that would aerosolize viable organisms (eg, irrigation, incision and drainage, whirlpool treatments) are performed.\textsuperscript{12,1023,1024} \textit{Category IB}

- Smallpox (vaccinated and unvaccinated). Respiratory protection is recommended for all HCWs, including those 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 (from, eg, high-risk aerosol-generating procedures, immunocompromised patients, hemorrhagic or flat smallpox).\textsuperscript{108,129} \textit{Category II}

V.D.4.b. No recommendation is made regarding the use of PPE by HCWs who are presumed to be immune to measles (rubeola) or varicella-zoster based on history of disease, vaccine, or serologic testing when caring for an individual with known or suspected measles, chickenpox, or disseminated zoster due to difficulties in establishing definite immunity.\textsuperscript{1025,1026} \textit{Unresolved issue}

V.D.4.c. No recommendation is made regarding the type of PPE (ie, surgical mask or respiratory protection with a N95 or higher-level respirator) to be worn by susceptible HCWs who must have contact with patients with known or suspected measles, chickenpox, or disseminated herpes zoster. \textit{Unresolved issue}

V.D.5. Patient transport

V.D.5.a. In acute care hospitals and long-term care and other residential settings, limit transport and movement of patients outside of the room to medically necessary purposes. \textit{Category II}

V.D.5.b. If transport or movement outside an AIIR is necessary, instruct the patient to wear a surgical mask, if possible, and to observe respiratory hygiene/cough etiquette.\textsuperscript{12} \textit{Category II}

V.D.5.c. For a patient with skin lesions associated with varicella or smallpox or draining skin lesions caused by \textit{M tuberculosis}, cover the affected areas to prevent aerosolization or contact with the infectious agent in skin lesions.\textsuperscript{108,1023,1024,1027-1029} \textit{Category IB}

V.D.5.d. An HCW transporting a patient on Airborne Precautions does not need to wear a mask or respirator during transport if the patient is wearing a mask and infectious skin lesions are covered. \textit{Category II}

V.D.6. Exposure management

Immunize or provide the appropriate immune globulin to susceptible persons as soon as possible after unprotected contact (ie, exposure) to a patient with measles, varicella, or smallpox: \textit{Category IA}

- Administer measles vaccine to exposed susceptible persons within 72 hours after the exposure or administer immune globulin within 6 days of the exposure event for high-risk persons in whom vaccine is contraindicated.\textsuperscript{17,1030-1033}
- Administer varicella vaccine to exposed susceptible persons within 120 hours after the exposure or administer varicella immune globulin (VZIG or an alternative product), when available, within 96 hours for high-risk persons in whom vaccine is contraindicated (eg, immunocompromised patients, pregnant women, newborns whose mother’s varicella onset was < 5 days before or within 48 hours after delivery).887,1033-1035

- Administer smallpox vaccine to exposed susceptible persons within 4 days after exposure.108,1036-1038

V.D.7. Discontinue Airborne Precautions according to pathogen-specific recommendations in Appendix A. Category IB

V.D.8. Consult the Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Settings, 200512 and the Guideline for Environmental Infection Control in Health Care Facilities11 for additional guidance on environment strategies for preventing transmission of tuberculosis in health care settings. The environmental recommendations in these guidelines may be applied to patients with other infections that necessitate Airborne Precautions.

VI. Protective Environment (see Table 4)

VI.A. Place allogeneic HSCT patients in a PE as described in the Guideline to Prevent Opportunistic Infections in HSCT Patients,15 Guideline for Environmental Infection Control in Health Care Facilities,11 and Guidelines for Preventing Health Care–Associated Pneumonia, 200314 to reduce exposure to environmental fungi (eg, Aspergillus spp).157,158 Category IB

VI.B. No recommendation for placing patients with other medical conditions associated with increased risk for environmental fungal infections (eg, aspergillosis) in a PE.11 Unresolved issue

VI.C. For patients who require a PE, implement the following (see Table 5).11,15

VI.C.1. Environmental controls

VI.C.1.a. Filtered incoming air using central or point-of-use HEPA filters capable of removing 99.97% of particles ≥ 0.3 μm in diameter.13 Category IB

VI.C.1.b. Directed room airflow with the air supply on one side of the room that moves air across the patient bed and out through an exhaust on the opposite side of the room.15 Category IB

VI.C.1.c. Positive air pressure in room relative to the corridor (pressure differential of ≥ 12.5 Pa0.01-in water gauge).15 Category IB

VI.C.1.c.i. Monitor air pressure daily with visual indicators (eg, smoke tubes, flutter strips).11,1022 Category IA

VI.C.1.d. Well-sealed rooms that prevent infiltration of outside air.15 Category IB

VI.C.1.e. At least 12 air changes per hour.15 Category IB

VI.C.2. Lower dust levels by using smooth, nonporous surfaces and finishes that can be scrubbed, rather than textured material (eg, upholstery). Wet dust horizontal surfaces whenever dust detected and routinely clean crevices and sprinkler heads where dust may accumulate.939,940 Category II

VI.C.3. Avoid carpeting in hallways and patient rooms in areas.940 Category IB

VI.C.4. Prohibit dried and fresh flowers and potted plants.940-942 Category II

VI.D. Minimize the time that patients who require a PE are outside their rooms for diagnostic procedures and other activities.11,158,944 Category IB

VI.E. During periods of construction, to prevent inhalation of respirable particles that could contain infectious spores, provide respiratory protection (eg, N95 respirator) to patients who are medically fit to tolerate a respirator when they are required to leave the PE.158,944 Category II

VI.E.1.a. No recommendation for fit testing of patients who are using respirators. Unresolved issue

VI.E.1.b. No recommendation for use of particulate respirators when leaving the PE in the absence of construction. Unresolved issue

VI.F. Use of Standard and Transmission-Based Precautions in a PE

VI.F.1. Use Standard Precautions as recommended for all patient interactions. Category IA

VI.F.2. Implement Droplet and Contact Precautions as recommended for diseases listed in Appendix A. Transmission-Based precautions for viral infections may need to be prolonged because of the patient’s immunocompromised state and prolonged shedding of viruses.927,929,931,1008,1009 Category IB

VI.F.3. Barrier precautions, (eg, masks, gowns, gloves) are not required for HCWs in the absence of suspected or confirmed infection
VI.F.4. Implement Airborne Precautions for patients who require a PE and who also have an airborne infectious disease (eg, pulmonary or laryngeal tuberculosis, acute varicella-zoster). Category IA

VI.F.4.a. Ensure that the PE is designed to maintain positive pressure.\textsuperscript{35} Category IB

VI.F.4.b. Use an anteroom to further support the appropriate air balance relative to the corridor and the PE; 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.\textsuperscript{13,1039} Category IB

VI.F.4.c. If an anteroom is not available, place the patient in an AIIR and use portable, industrial-grade HEPA filters in the room to enhance filtration of spores.\textsuperscript{1040} Category II

GLOSSARY

**Airborne infection isolation room (AIIR).** Formerly known as a negative-pressure isolation room, an AIIR is a single-occupancy patient care room used to isolate persons with a suspected or confirmed airborne infectious disease. Environmental factors are controlled in AIIRs to minimize the transmission of infectious agents that are usually transmitted from person to person by droplet nuclei associated with coughing or aerosolization of contaminated fluids. AIIRs should provide negative pressure in the room (so that air flows under the door gap into the room), an air flow rate of 6 to 12 air changes per hour (ACH) (6 ACH for existing structures, 12 ACH for new construction or renovation), and direct exhaust of air from the room to the outside of the building or recirculation of air through a high-efficiency particulate air filter before returning to circulation. (MMWR 2003; 52 [RR-10]; MMWR 1994; 43 [RR-13].)

**American Institute of Architects (AIA).** A professional organization that has developed standards for building ventilation, the 2001Guidelines for Design and Construction of Hospital and Health Care Facilities, the development of which was supported by the AIA, Academy of Architecture for Health, and Facilities Guideline Institute, with assistance from the US Department of Health and Human Services and the National Institutes of Health, is the primary source of guidance for creating airborne infection isolation rooms and protective environments (http://www.aia.org/aah).

**Ambulatory care setting.** A facility that provides health care to patients who do not remain overnight; examples include hospital-based outpatient clinics, non–hospital-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.

**Bioaerosol.** An airborne dispersion of particles containing whole or parts of biological entities, including bacteria, viruses, dust mites, fungal hyphae, and fungal spores. Such aerosols usually consist of a mixture of monodispersed and aggregate cells, spores, or viruses carried by other materials, such as respiratory secretions and/or inert particles. Infectious bioaerosols (ie, those containing biological agents capable of causing an infectious disease) can be generated from human sources (eg, expulsion from the respiratory tract during coughing, sneezing, talking, singing, suctioning, or wound irrigation), wet environmental sources (eg, high-volume air conditioning and cooling tower water with *Legionella* or dry sources (eg, construction dust with spores produced by *Aspergillus* spp). Bioaerosols include large respiratory droplets and small droplet nuclei (Cole EC. AJIC 1998;26: 453-64).

**Caregiver.** Any person who is not an employee of an organization, is not paid, and provides or assists in providing health care to a patient (eg, family member, friend) and acquire technical training as needed based on the tasks that must be performed.

**Cohorting.** In the context of this guideline, this term applies to the practice of grouping patients infected or colonized with the same infectious agent together to confine their care to one area and prevent contact with susceptible patients (cohorting patients). During outbreaks, health care personnel may be assigned to a cohort of patients to further limit opportunities for transmission (cohorting staff).

**Colonization.** Proliferation of microorganisms on or within body sites without detectable host immune response, cellular damage, or clinical expression. The presence of a microorganism within a host may occur with varying durations but may become a source of potential transmission. In many instances, colonization and carriage are synonymous.

**Droplet nuclei.** Microscopic particles \(<5\ \mu\text{m}\) in size that are the residue of evaporated droplets and are produced when a person coughs, sneezes, shouts, or sings. These particles can remain suspended in the air for prolonged periods and can be carried on normal air currents in a room or beyond, to adjacent spaces or areas receiving exhaust air.
Engineering controls. Removal or isolation of a workplace hazard through technology. An airborne infection isolation room, a protective environment, engineered sharps injury prevention device, and a sharps container are examples of engineering controls.

Epidemiologically important pathogen. An infectious agent that has one or more of the following characteristics: (1) readily transmissible, (2) a proclivity toward causing outbreaks, (3) possible association with a severe outcome, and (4) difficult to treat. Examples include *Acinetobacter* spp, *Aspergillus* spp, *Burkholderia cepacia*, *Clostridium difficile*, *Klebsiella* or *Enterobacter* spp, extended-spectrum beta-lactamase–producing gram-negative bacilli, methicillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa*, vancomycin-resistant enterococci, vancomycin-resistant *Staphylococcus aureus*, influenza virus, respiratory syncytial virus, rotavirus, severe acute respiratory syndrome coronavirus, noroviruses, and the hemorrhagic fever viruses.

Hand hygiene. A general term that applies to any one of the following: (1) handwashing with plain (non-antimicrobial) soap and water, (2) antiseptic handwashing (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 handrub performed preoperatively by surgical personnel to eliminate transient hand flora).558

Health care–associated infection (HAI). An infection that develops in a patient who is cared for in any setting where health care is delivered (eg, acute care hospital, chronic care facility, ambulatory clinic, dialysis center, surgicenter, home) and is related to receiving health care (ie, was not incubating or present at the time health care was provided). In ambulatory and home settings, HAI refers to any infection that is associated with a medical or surgical intervention. Because the geographic location of infection acquisition is often uncertain, the preferred term is considered to be health care–associated rather than health care–acquired.

Healthcare epidemiologist. A person whose primary training is medical (MD, DO) and/or masters- or doctorate-level epidemiology who has received advanced training in health care epidemiology. Typically these professionals direct or provide consultation to an infection control program in a hospital, long-term care facility, or health care delivery system (also see Infection control professional).

Health care personnel, health care worker (HCW). Any paid or unpaid person who works in a health care setting (eg, any person who has professional or technical training in a health care–related field and provides patient care in a health care setting or any person who provides services that support the delivery of health care such as dietary, housekeeping, engineering, maintenance personnel).

Hematopoietic stem cell transplantation (HSCT). Any transplantation of blood- or bone marrow–derived hematopoietic stem cells, regardless of donor type (eg, allogeneic or autologous) or cell source (eg, 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 (MMWR 2000; 49: RR-10).

High-efficiency particulate air (HEPA) filter. An air filter that removes >99.97% of particles > 0.3 μm (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 (MMWR 2003; 52: RR-10).

Home care. A wide range of medical, nursing, rehabilitation, hospice, and social services delivered to patients in their place of residence (eg, private residence, senior living center, assisted living facility). Home health care services include care provided by home health aides and skilled nurses, respiratory therapists, dieticians, physicians, chaplains, and volunteers; provision of durable medical equipment; home infusion therapy; and physical, speech, and occupational therapy.

Immunocompromised patient. A patient whose immune mechanisms are deficient because of a congenital or acquired immunologic disorder (eg, human immunodeficiency virus infection, congenital immune deficiency syndromes), chronic diseases such as diabetes mellitus, cancer, emphysema, or cardiac failure, intensive care unit care, malnutrition, and immunosuppressive therapy of another disease process [eg, radiation, cytotoxic chemotherapy, anti–graft rejection medication, corticosteroids, monoclonal antibodies directed against a specific component of the immune system]). The type of infections for which an immunocompromised patient has increased susceptibility is determined by the severity of immunosuppression and the specific component(s) of the immune system that is affected. Patients undergoing allogeneic hematopoietic stem cell transplantation and those with chronic graft versus host disease are considered the most vulnerable to health care–associated infections. Immunocompromised states also make it more difficult to diagnose certain infections (eg, tuberculosis) and are associated with more severe clinical disease states than persons with the same infection and a normal immune system.

Infection. The transmission of microorganisms into a host after evading or overcoming defense...
mechanisms, resulting in the organism’s proliferation and invasion within host tissue(s). Host responses to infection may include clinical symptoms or may be subclinical, with manifestations of disease mediated by direct organisms pathogenesis and/or a function of cell-mediated or antibody responses that result in the destruction of host tissues.

**Infection control and prevention 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, analysis, and feedback of infection data and trends; infection control: this may include: (1) infection control: this may include: (1) surveillance: monitoring patients and health care 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 laws and regulations (see [http://www.jcaho.org](http://www.jcaho.org)). The infection control program staff has the ultimate authority to determine infection control policies for a health care organization with the approval of the organization’s governing body.

Long-term care facility (LTCF). A residential or outpatient facility 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.

**Mask.** A term that applies collectively to items used to cover the nose and mouth and includes both procedure masks and surgical masks (see [http://www.fda.gov/cdrh/ode/guidance/094.html#4](http://www.fda.gov/cdrh/ode/guidance/094.html#4)).

**Multidrug-resistant organism (MDRO).** In general, a bacterium (excluding *Mycobacterium tuberculosis*) that is resistant to 1 or more classes of antimicrobial agents and usually is resistant to all but 1 or 2 commercially available antimicrobial agents (eg, methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant enterococci, extended-spectrum beta-lactamase–producing or intrinsically resistant gram-negative bacilli).176

**Nosocomial infection.** Derived from 2 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.

**Procedure mask.** A covering for the nose and mouth that is intended for use in general patient care situations. These masks generally attach to the face with ear loops rather than ties or elastic. Unlike surgical masks, procedure masks are not regulated by the Food and Drug Administration.

**Protective environment.** A specialized patient care area, usually in a hospital, with a positive air flow relative to the corridor (ie, air flows from the room to the outside adjacent space). The combination of high-efficiency particulate air filtration, high numbers (>12) of air changes per hour, and minimal leakage of air into the room creates an environment that can safely accommodate patients with a severely compromised immune system (eg, those who have received allogeneic hemopoietic stem cell transplantation) and decrease the risk of exposure to spores produced by environmental fungi. Other components include use of scrubbable surfaces instead of materials such as upholstery or carpeting, cleaning to prevent dust accumulation, and prohibition of fresh flowers or potted plants.

**Quasi-experimental study.** A study undertaken to evaluate interventions but do not use randomization
as part of the study design. These studies are also referred to as nonrandomized, pre-/postintervention study designs. These studies aim to demonstrate causality between an intervention and an outcome but cannot achieve the level of confidence concerning an attributable benefit obtained through a randomized controlled trial. In hospitals and public health settings, randomized control trials often cannot be implemented due to ethical, practical, and urgency reasons; therefore, quasi-experimental design studies are commonly used. However, even if an intervention appears to be effective statistically, the question can be raised as to the possibility of alternative explanations for the result. Such a study design is used when it is not logistically feasible or ethically possible to conduct a randomized controlled trial, (eg, during outbreaks).

Within the classification of quasi-experimental study designs, there is a hierarchy of design features that may contribute to validity of results (Harris et al. CID 2004:38: 1586).

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 health care personnel over the nose and mouth to protect them from acquiring airborne infectious diseases due to inhalation of infectious airborne particles < 5 μm in size. These include infectious droplet nuclei from patients with Mycobacterium tuberculosis, variola virus [smallpox], or severe acute respiratory syndrome and dust particles that contain infectious particles, such as spores of environmental fungi (eg, Aspergillus spp). The Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH) certifies respirators used in health care settings (see http://www.cdc.gov/niosh/topics/respirators/).

The N95 disposable particulate, air-purifying respirator is the type used most commonly by health care personnel. Other respirators used include N-99 and N-100 particulate respirators, powered air-purifying respirators with high-efficiency filters, and nonpowered full-facepiece elastomeric negative pressure respirators. A listing of NIOSH-approved respirators can be found at http://www.cdc.gov/niosh/topics/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, which 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 through droplet or airborne routes in health care 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 health care setting (eg, reception/triage in emergency departments, ambulatory clinics, health care provider offices).126 (Srinivasan A ICHE 2004; 25: 1020; http://www.cdc.gov/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 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.618

Source control. The process of containing an infectious agent either at the portal of exit from the body or within a confined space. The term is applied most frequently to containment of infectious agents transmitted by the respiratory route but could apply to other routes of transmission, (eg, a draining wound, vesicular or bullous skin lesions). Respiratory hygiene/cough etiquette that encourages individuals to “cover your cough” and/or wear a mask is a source control measure. The use of enclosing devices for local exhaust ventilation (eg, booths for sputum induction or administration of aerosolized medication) is another example of source control.

Standard precautions. A group of infection prevention practices that apply to all patients, regardless of suspected or confirmed diagnosis or presumed infection status. Standard precautions represents a combination and expansion of universal precautions and body substance isolation.1109 Standard precautions are 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 include hand hygiene and, depending on the anticipated exposure, use of gloves, gown, mask, eye protection, or face shield. In addition, 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 (eg, 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 health care personnel from contact with large infectious droplets (> 5 μm 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 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 (http://www.fda.gov/cdrh/ode/guidance/094.html#4). Surgical masks do not protect against inhalation of small particles or droplet nuclei and should not be confused with particulate respirators that are recommended for protection against selected airborne infectious agents (eg, *Mycobacterium tuberculosis*).

The authors and HICPAC gratefully acknowledge Dr Larry Strausbaugh for his many contributions and valued guidance in the preparation of this guideline.

**References**


200. Muto CA, Jernigan JA, Ostrowsky BE, et al. SHEA guideline for preven-
ting nosocomial transmission of multidrug-resistant strains of Staph-
ylococcus aureus and enterococcus. Infect Control Hosp Epidemiol

201. Tammelin A, Klotz F, Hambraeus A, Stahle E, Ransjo U. Nasal and
hand carriage of Staphylococcus aureus in staff at a Department for
Thoracic and Cardiovascular Surgery: endogenous or exogenous

202. Centers for Disease Control and Prevention. Biological and chem-
ical terrorism: strategic plan for preparedness and response. Rec-
ommendations of the CDC Strategic Planning Workgroup.

203. Inglesby TV, O’Toole T, Henderson DA, et al. Anthrax as a biological
weapon. 2002: updated recommendations for management. JAMA
2002;287:2236-52.

204. Henderson DA, Inglesby TV, Bartlett JG, et al. Smallpox as a biological:
weapon: medical and public health management. Working Group


206. Centers for Disease Control and Prevention. Notice to
readers update: management of patients with suspected viral

207. Johnson RT, Gibbs CJ Jr. Creutzfeldt-Jakob disease and related

208. Lang CJ, Heckmann JG, Neundorfer B. Creutzfeldt-Jakob disease via

209. el Hachimi KH, Chaunu MP, Cervenakova L, Brown P, Foncin JF. Pu-
tative neurosurgical transmission of Creutzfeldt-Jakob disease with
analysis of donor and recipient: agent strains. C R Acad Sci Ser III
1999;328:1165-70.

210. Will RG, Matthews WB. Evidence for case-to-case transmission of


biological weapons: medical and public health management. JAMA

213. Dennis DT, Inglesby TV, Henderson DA, et al. Plague as a biological
weapon: medical and public health management. Working Group

214. Arnon SS, Schechter R, Inglesby TV, et al. Botulinum toxin as a bi-
ological weapon: medical and public health management. JAMA

215. Collinge J, Sidle KC, Meads J, Ironside J, Hill AF. Molecular analysis
of donor and recipient: agent strains. C R Acad Sci Ser III
1999;328:1165-70.

216. Centers for Disease Control and Prevention. Notice to
readers update: management of patients with suspected viral

217. Sieloff BM, Gayfuk DC, Gibbs CJ Jr, Asher DM. Potential epidemic of

218. Frasier SD, Foley TP Jr. Clinical review 5B: Creutzfeldt-Jakob disease
in recipients of pituitary hormones. J Clin Endocrinol Metab 1994;
78:1277-9.

219. Centers for Disease Control and Prevention. Update: Creutzfeldt-
Jakob disease associated with cadaveric dura mater grafts. Japan,

220. Lang CJ, Heckmann JG, Neundorfer B. Creutzfeldt-Jakob disease via

and adverse reactions: guidance for clinicians. MMWR Morb Mortal

222. Centers for Disease Control and Prevention. Surveillance for Crea-
tivefild-Jakob disease, United States. MMWR Morb Mortal

and evolution of vaccinia-specific CD8+ cytotoxic T-lymphocyte
(CTL) responses in revaccines [abstract 823]. Presented at the In-
fected Diseases Society of America 41st annual meeting, San
Diego, CA, October 2003.

smallpox vaccine in a pre-event vaccination program: supplemen-
tal recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Healthcare Infection Con-
trol Practices Advisory Committee (HICPAC). MMWR Recomm

225. Muto CA, Jernigan JA, Ostrowsky BE, et al. SHEA guideline for pre-
vention of smallpox vaccination in primary vaccinees. Clin Infect

226. Centers for Disease Control and Prevention. Update: Creutzfeldt-
Jakob disease associated with cadaveric dura mater grafts. Japan,

227. Centers for Disease Control and Prevention. Update: Creutzfeldt-
Jakob disease associated with cadaveric dura mater grafts. Japan,

228. Lang CJ, Heckmann JG, Neundorfer B. Creutzfeldt-Jakob disease via

229. el Hachimi KH, Chaunu MP, Cervenakova L, Brown P, Foncin JF. Pu-
tative neurosurgical transmission of Creutzfeldt-Jakob disease with
analysis of donor and recipient: agent strains. C R Acad Sci Ser III
1999;328:1165-70.

230. Will RG, Matthews WB. Evidence for case-to-case transmission of
Creutzfeldt-Jakob disease. J Neurol Neurosurg Psychiatry 1982;45:
235-8.

231. Lang CJ, Heckmann JG, Neundorfer B. Creutzfeldt-Jakob disease via

232. Belay ED, Maddox RA, Williams ES, Miller MW, Gambetti P, Schon-
berger LB. Chronic wasting disease and potential transmission to

233. Belay ED, Maddox RA, Williams ES, Miller MW, Gambetti P, Schon-
berger LB. Chronic wasting disease and potential transmission to

234. Belay ED, Maddox RA, Williams ES, Miller MW, Gambetti P, Schon-
berger LB. Chronic wasting disease and potential transmission to

235. Siegel et al

and evolution of vaccinia-specific CD8+ cytotoxic T-lymphocyte
(CTL) responses in revaccines [abstract 823]. Presented at the In-
fected Diseases Society of America 41st annual meeting, San
Diego, CA, October 2003.

237. Belay ED, Schonberger LB. Variant Creutzfeldt-Jakob disease and

238. Belay ED, Schonberger LB. Variant Creutzfeldt-Jakob disease and

239. Belay ED, Schonberger LB. Variant Creutzfeldt-Jakob disease and

240. Belay ED, Schonberger LB.Variant Creutzfeldt-Jakob disease and

241. Belay ED, Schonberger LB. Variant Creutzfeldt-Jakob disease and

242. Belay ED, Schonberger LB. Variant Creutzfeldt-Jakob disease and

S134

Vol. 35 No. 10 Supplement 2


295. National Center for Infectious Diseases, Division of Viral and Rickettsial Diseases. Available from. Accesseds.


329. Fridkin SK, Edwards JR, Courval JM, et al. The effect of vancomycin- and third-generation cephalosporins on prevalence of vancomycin-


Staphylococcus aureus


678. Jodra VM, Rodela AR, Martinez EM, Fresena NL. Standardized in-
fection ratios for three general surgery procedures: a comparison be-
tween Spanish hospitals and US centers participating in the Na-
tional Nosocomial Infections Surveillance System. Infect Control 

healthcare-associated infections: recommendations of the 
Healthcare Infection Control Practices Advisory Committee. Am 

680. Gould D, Chamberlain A. The use of a ward-based educational 
teaching package to enhance nurses’ compliance with infection con-

681. Calabro K, Welte A, Parnell S, Kouzelenan K, Ramirez E. Inter-
vention for medical students: effective infection control. Am J Infect 

682. Haiduven DJ, Hench CP, Simpkins SM, Stevens DA. Standardized 
management of patients and employees exposed to pertussis. Infect 

683. Macartney KK, Gorelick MH, Manning ML, Hodinka RL, Bell LM. 
Nosocomial respiratory syncytial virus infections: the cost-effect-
iveness and cost benefit of infection control. Pediatrics 2000;106: 
520-6.


685. Sokas RK, Simmens S, Scott J. A training program in universal pre-
cautions for second-year medical students. Acad Med 1993;68: 
374-6.

686. Ostrowsky BE, Trick WE, Sohn AH, et al. Control of vancomycin-
resistant enterococcus in health care facilities in a region. N Engl J 

pneumonia: from epidemiology to patient management. Clin Infect 


689. Talbot TR, Bradley SE, Cosgrove SE, Ruel C, Siegel JD, Weber DJ. 
Influenza vaccination of healthcare workers and vaccine allocation 
for healthcare workers during vaccine shortages. Infect Control 

690. Harbarth S, Siegrist CA, Schira JC, Wunderli W, Pittet D. Influenza 
immunization: improving compliance of healthcare workers. Infect 

691. Bryant KA, Stover B, Cain L, Levine GL, Siegel J, Jarvis WR. Improv-
ing influenza immunization rates among healthcare workers caring 
for high-risk pediatric patients. Infect Control Hosp Epidemiol 

692. Martinello RA, Jones L, Topal JE. Correlation between healthcare 
workers’ knowledge of influenza vaccine and vaccine receipt. Infect 

693. Goldrick B, Gruendemann B, Larson E. Learning styles and teach-
ing/learning strategy preferences: implications for educating nurses in 
critical care, the operating room, and infection control. Heart Lung 

694. Davis D, O’Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-
Vaisey A. Impact of formal continuing medical education: do confer-
ences, workshops, rounds, and other traditional continuing educa-
tion activities change physician behavior or health care outcomes? 

695. Carr H, Hinson P. Education and training. In APIC Infection Control 
and Epidemiology. 2nd edition Washington, DC: Association for 
Professionals in Infection Control and Epidemiology; 2005. p II-1.

696. Caffarella RS. Planning programs for adult learners: a practical guide 
for educators, trainers, and staff developers. 2nd ed. San Francisco: 

697. Sargeant J, Curran V, Jarvis-Selinger S, et al. Interactive on-line con-
tinuing medical education: physicians’ perceptions and experiences. 
J Contin Educ Health Prof 2004;24:227-36.

698. Van Harrison R. Systems-based framework for continuing medical 
education and improvements in translating new knowledge into 
S50-62.

699. Cole TB, Glass RM. Learning associated with participation in jour-
Prof 2004;24:205-12.

700. Diekema DJ, Albanese MA, Schuldt SS, Doebbeling BN. Blood and 
body fluid exposures during clinical training: relation to knowledge of 

701. Diekema DJ, Schuldt SS, Albanese MA, Doebbeling BN. Universal 
precautions training of preclinical students: impact on knowledge, 

702. Warren DK, Zack JE, Cox MJ, Cohen MM, Fraser VJ. An educa-
tional intervention to prevent catheter-associated bloodstream in-
fecions in a nonteaching, community medical center. Crit Care 

703. Dubbert PM, Dolce J, Richter W, Miller M, Chapman SW. Increasing 
ICU staff handwashing: effects of education and group feedback. In-

704. Avila-Aguero ML, Umama MA, Jimenez AL, Faigezicht I, Paris MM. 
Handwashing practices in a tertiary-care, pediatric hospital and the 
effect on an educational program. Clin Perform Qual Health Care 

705. Lai KK, Fontecchio SA, Kelley AL, Melvin ZS. Knowledge of the transmis-
sion of tuberculosis and infection control measures for tu-
berculosis among healthcare workers. Infect Control Hosp Epidemi 

706. Koening S, Chu J. Senior medical students’ knowledge of universal 

vension to reduce ventilator-associated pneumonia in an inte-
grated health system: a comparison of effects. Chest 2004;125: 
2224-31.

patient education model for increasing hand hygiene compliance in 
an inpatient rehabilitation unit. Am J Infect Control 2004;32: 
235-8.


710. Chase TM. Learning styles and teaching strategies: enhancing the 


712. Daniels IR, Rees BI. Handwashing: simple, but effective. Ann R Coll 

713. Webster J, Faagall JL, Cartwright D. Elimination of meticillin-re-
istant Staphylococcus aureus from a neonatal intensive care unit af-
ter hand washing with triclosan. J Paediatr Child Health 1994;30: 
59-64.

714. Zafar AB, Butler RC, Reese DJ, Gaydos LA, Mennonna PA. Use of 
0.3% triclosan (Bacti-Stat) to eradicate an outbreak of meticillin-
resistant 
Staphylococcus aureus from a neonatal intensive care nursery. Am J Infect 

715. Malik RK, Montecalvo MA, Reale MR, et al. Epidemiology and con-
trol of vancomycin-resistant enterococci in a regional neonatal in-

716. Pittet D, Boyce JM. Hand hygiene and patient care: pursuing the 


753. Weaver GH. Value of the face mask and other measures. JAMA 1918;70:76.


919. Catalano G, Houston SH, Catalano MC, et al. Anxiety and depres- 
sion in hospitalized patients in resistant organism isolation. South 

920. Tarzi S, Kennedy P, Stone S, Evans M. Methillin-resistant Staphylo-
coccus aureus: psychological impact of hospitalization and isolation in 

921. Kelly-Rossini L, Perlman DC, Mason DJ. The experience of respira-
tory isolation for HIV-infected persons with tuberculosis. J Assoc 
Nurses AIDS Care 1996;7:29-36.

922. Knowles HE. The experience of infectious patients in isolation. 
Nurs Times 1993;89:53-6.

923. Evans HL, Shaffer MM, Hughes MG, et al. Contact isolation in sur-

924. Kirkland KB, Weinstein JM. Adverse effects of contact isolation. 

925. Saint S, Higgins LA, Nahmutho BK, Chenoweth C. Do physicians 
examine patients in contact isolation less frequently? A brief report. 

926. Management of multidrug-resistant organisms in healthcare settings. 
2006.pdf.

927. Hall CB, Powell KR, MacDonald NE, et al. Respiratory syncytial 
viral infection in children with compromised immune function. N Engl J 
Med 1986;315:77-81.

928. Liu SL, Luk WK, Cheung CY, Chan TM, Lai KN, Peiris JS. Nosoco-
mmial outbreak of parvovirus B19 infection in a renal transplant unit. 
Transplantation 2001;71:59-64.

929. Weinstock DM, Gubareva LV, Zuccotti G. Prolonged shedding of 
multidrug-resistant influenza A virus in an immunocompromised pa-

930. van Tol MJ, Claas EC, Heemskerk B, et al. Adenovirus infection in chil-
dren after allogeneic stem cell transplantation: diagnosis, treatment and 

931. Wood DJ, David TJ, Chrystie IL, Totterdell B. Chronic enteric virus 
24:435-44.

932. Mori I, Matsumoto K, Sugimoto K, et al. Prolonged shedding of 

933. Cederna JE, Terpenning MS, Ensberg M, Bradley SF, Kauffman CA. 
Staphylococcus aureus nasal colonization in a nursing home: eradic-

934. Kauffman CA, Terpenning MS, He X, et al. Attempts to eradicate 
methillin-resistant Staphylococcus aureus from a long-term-care fac-

of colonization with vancomycin-resistant Enterococcus faecium. In-

936. D’Agata EM, et al. High rate of false-negative results of the rectal swab 
culture method in detection of gastrointestinal colonization with van-

937. Donskey Cj, Hoyen CK, Das SM, Helland MS, Hecker MT. Recur-
rence of vancomycin-resistant Enterococcus stool colonization during 

938. Scanvic A, Denic L, Gaillon S, Gir P, Andremon A, Lucej JC. Du-
rination of colonization by methillin-resistant Staphylococcus aureus 
after hospital discharge and risk factors for prolonged carriage. 

939. Noskin GA, Bednarz P, Suriano T, Reiner S, Peterson LR. Persistent 
contamination of fabric-covered furniture by vancomycin-resistant 
enterococci: implications for upholstery selection in hospitals. Am J 

940. Gerson SL, Parker P, Jacobs MR, Creger R, Lazarus HM. Aspergil-
losis due to carpet contamination. Infect Control Hosp Epidemiol 

941. Taplin D, Mertz PM. Flower vases in hospitals as reservoirs of path-


945. www.cms.hhs.gov/CLIA.


948. Anderson DJ, Kirkland KB, McDonald Jr, et al. Results of a survey of work duties of 56 infection control professionals (ICPs): are new guidelines needed for the staffing of infection control (IC) programs? [abstract 146]. Presented at the 16th annual meeting of the Society for Healthcare Epidemiology of America, Chicago, IL, 2006.


959. www.fda.gov/cdrh/reprocessing/.


**APPENDIX A: TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS**

**Preamble**

The mode(s) and risk of transmission for each specific disease agent listed in this appendix were reviewed. Principle sources consulted for the development of disease-specific recommendations for the appendix included infectious disease manuals and textbooks. The published literature was searched for evidence of person-to-person transmission in health care and non–health care settings with a focus on reported outbreaks that would assist in developing recommendations for all settings where health care is delivered. The following criteria were used to assign transmission-based precautions categories:

- A transmission-based precautions category was assigned if there was strong evidence for person-to-person transmission via droplet, contact, or airborne routes in health care or non–health care settings and/or if patient factors (eg, diapered infants, diarrhea, draining wounds) increased the risk of transmission.

- Transmission-based precautions category assignments reflect the predominant mode(s) of transmission.

- If there was no evidence for person-to-person transmission by droplet, contact, or airborne routes, then Standard Precautions were assigned.

- If there was a low risk for person-to-person transmission and no evidence of health care-associated transmission, then Standard Precautions were assigned.

- Standard precautions were assigned for bloodstream pathogens (eg, HBV, HCV, HIV) in accordance with CDC recommendations for universal precautions issued in 1988. Subsequent experience has confirmed the efficacy of Standard Precautions to prevent exposure to infected blood and body fluid.

Additional information relevant to use of precautions was added in the comments column to assist the caregiver in decision-making. Citations were added as needed to support a change in or provide additional evidence for recommendations for a specific disease and for new infectious agents (eg, SARS-CoV, avian influenza) that have been added to Appendix A. The reader may refer to more detailed discussion concerning modes of transmission and emerging pathogens in the background text and for MDRO control in the MDRO Guideline.
### Appendix A. Continued.

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type</th>
<th>Duration</th>
<th>Precaution</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess Draining, major</td>
<td>C</td>
<td>DI</td>
<td>No dressing or containment of drainage; until drainage stops or can be contained by dressing.</td>
<td></td>
</tr>
<tr>
<td>Abscess Draining, minor or limited</td>
<td>S</td>
<td></td>
<td>Dressing to cover and contain drainage.</td>
<td></td>
</tr>
<tr>
<td>AIDS/HIV</td>
<td>S</td>
<td></td>
<td>Postexposure chemoprophylaxis for some blood exposures.</td>
<td></td>
</tr>
<tr>
<td>Actinomycosis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Adenovirus infection (see agent-specific guidance under gastroenteritis, conjunctivitis, pneumonia)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amebiasis</td>
<td>S</td>
<td></td>
<td>Person-to-person transmission is rare. Transmission in settings for the mentally challenged and in a family group has been reported. Use care when handling diapered infants and mentally challenged persons.</td>
<td></td>
</tr>
<tr>
<td>Anthrax Cutaneous</td>
<td>S</td>
<td></td>
<td>Infected patients do not generally pose a transmission risk.</td>
<td></td>
</tr>
<tr>
<td>Anthrax Pulmonary</td>
<td>S</td>
<td></td>
<td>Transmission through nonintact skin contact with draining lesions possible; thus, use Contact Precautions if a large amount of uncontained drainage is present. Handwashing with soap and water is preferable to the use of waterless alcohol-based antiseptics, because alcohol does not have sporicidal activity.</td>
<td></td>
</tr>
<tr>
<td>Aspergillosis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Ascariasis</td>
<td>S</td>
<td></td>
<td>Aspergillosis</td>
<td></td>
</tr>
<tr>
<td>Avian influenza (see influenza, avian below)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely by transfusion, and for West Nile virus by organ transplant, breastmilk or transplacentally.</td>
<td></td>
</tr>
<tr>
<td>Babesiosis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely by transfusion.</td>
<td></td>
</tr>
<tr>
<td>Blastomyces, North American, cutaneous or pulmonary</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Botulism Bronchiolitis (see respiratory infections in infants and young children)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely through banked spermatozoa and sexual contact.</td>
<td></td>
</tr>
<tr>
<td>Brucellosis (undulant, Malta, Mediterranean fever)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely through banked spermatozoa and sexual contact.</td>
<td></td>
</tr>
<tr>
<td>Campylobacter gastroenteritis (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Candidiasis, all forms, including mucocutaneous</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Cat-scratch fever (benign inoculation lymphoreticulosis)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chancroid (soft chancre) <em>(Haemophilus ducreyi)</em></td>
<td>S</td>
<td></td>
<td>Transmitted sexually from person to person.</td>
</tr>
<tr>
<td>Chickenpox (see varicella)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydia trachomatis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjunctivitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genital (lymphogranuloma venereum)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia (infants ≤ 3 mos. of age)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>S</td>
<td></td>
<td>Outbreaks in institutionalized populations are rarely reported.1047,1048</td>
</tr>
<tr>
<td>Cholera (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed-cavity infection</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open drain in place; limited or minor drainage</td>
<td>S</td>
<td></td>
<td>Contact Precautions if copious uncontained drainage is present.</td>
</tr>
<tr>
<td>No drain or closed drainage system in place</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clostridium</em> spp</td>
<td>C</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td><em>C botulinum</em></td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td><em>C difficile</em> (see gastroenteritis, <em>C difficile</em>)</td>
<td>C</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td><em>C perfringens</em></td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Food poisoning</td>
<td>S</td>
<td></td>
<td>Transmission from person to person is rare; 1 outbreak in a surgical setting has been reported.1053 Use Contact Precautions if wound drainage is extensive.</td>
</tr>
<tr>
<td>Gas gangrene</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coccidioidomycosis (valley fever)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draining lesions</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except under extraordinary circumstances, because the infectious arthroconidial form of <em>Coccidioides immitis</em> is not produced in humans.1050</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except under extraordinary circumstances (eg, inhalation of aerosolized tissue phase endospores during necropsy, transplantation of infected lung), because the infectious arthroconidial form of <em>C immitis</em> is not produced in humans.1050,1051</td>
</tr>
<tr>
<td>Colorado tick fever</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Congenital rubella</td>
<td>C</td>
<td>Until age 1 year</td>
<td>Standard Precautions if nasopharyngeal and urine cultures are repeatedly negative after age 3 months.</td>
</tr>
<tr>
<td>Conjunctivitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute bacterial</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydial</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gonococcal</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute viral (acute hemorrhagic)</td>
<td>C</td>
<td>DI</td>
<td>Adenovirus most common; enterovirus 70,1052 Coxackie virus A21054 also associated with community outbreaks. Highly contagious; outbreaks in eye clinics, pediatric and neonatal settings, institutional settings reported. Eye clinics should follow Standard Precautions when handling patients with conjunctivitis. Routine use of infection control measures in the handling of instruments and equipment will prevent the occurrence of outbreaks in this and other settings.458,459,812,1054-1056</td>
</tr>
<tr>
<td>Corona virus associated with SARS (SARS-CoV) (see severe acute respiratory syndrome)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coxsackie virus disease (see enteroviral infection)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creutzfeldt-Jakob disease (CJD, vCJD)</td>
<td>S</td>
<td></td>
<td>Use disposable instruments or special sterilization/disinfection for surfaces and objects contaminated with neural tissue if CJD or vCJD has not been ruled out; no special burial procedures.1057</td>
</tr>
<tr>
<td>Croup (see respiratory infections in infants and young children)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection/Condition</td>
<td>Type*</td>
<td>Duration†</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>Crimean-Congo Fever (see viral hemorrhagic fever)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptococcosis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidiosis (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cysticercosis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytomegalovirus infection, including in neonates and immunosuppressed patients</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decubitus ulcer (see Pressure ulcer)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dengue fever</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea, acute-infective etiology suspected (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphtheria</td>
<td>C</td>
<td>CN</td>
<td>Until 2 cultures obtained 24 hours apart are negative.</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>CN</td>
<td>Until 2 cultures obtained 24 hours apart are negative.</td>
</tr>
<tr>
<td>Ebola virus (see viral hemorrhagic fevers)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echinococcosis (hydatidosis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echovirus (see enteroviral infection)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encephalitis or encephalomyelitis (see specific etiologic agents)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endometritis (endomyometritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterobiasis (pinworm disease, oxyuriasis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterococcus spp (see multidrug-resistant organisms if epidemiologically significant or vancomycin-resistant)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterocolitis, Clostridium difficile (see C difficile, gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enteroviral infections (ie, group A and B Coxsackie viruses and Echo viruses) (excludes polio virus)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epiglottitis, due to Haemophilus influenzae type b</td>
<td>D</td>
<td>U 24 hours</td>
<td>(See specific disease agents for epiglottitis due to other etiologies.)</td>
</tr>
<tr>
<td>Epstein-Barr virus infection, including infectious mononucleosis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erythema infectiosum (also see parvovirus B19)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escherichia coli gastroenteritis (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food poisoning</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botulism</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Clostridium perfringens or C welchii</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Staphylococcal</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Furunculosis, staphylococcal</td>
<td>S</td>
<td></td>
<td>Contact if drainage not controlled. Follow institutional policies if MRSA.</td>
</tr>
<tr>
<td>Infants and young children</td>
<td>C</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td>Gangrene (gas gangrene)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
</tbody>
</table>
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type</th>
<th>Duration</th>
<th>Precaution</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastroenteritis</td>
<td>S</td>
<td></td>
<td>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 listed below.</td>
<td></td>
</tr>
<tr>
<td>Adenovirus</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Campylobacter spp</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Cholera (Vibrio cholerae)</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Clostridium difficile</td>
<td>C</td>
<td>DI</td>
<td>Discontinue antibiotics if appropriate. Do not share electronic thermometers,851,852 ensure consistent environmental cleaning and disinfection. Hypochlorite solutions may be required for cleaning if transmission continues.845 Handwashing with soap and water is preferred because of the absence of sporicidal activity of alcohol in waterless antiseptic handrubs.979</td>
<td></td>
</tr>
<tr>
<td>Cryptosporidium spp</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Escherichia coli</td>
<td></td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Enteropathogenic O157:H7 and other shiga toxin-producing strains</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Other species</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Giardia lamblia</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Noroviruses</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks. Persons who clean areas heavily contaminated with feces or vomitus may benefit from wearing masks, because virus can be aerosolized from these body substances;142,147,148 ensure consistent environmental cleaning and disinfection with focus on restrooms even when apparently unsoiled.272,1060 Hypochlorite solutions may be required when there is continued transmission.289-291 Alcohol is less active, but there is no evidence that alcohol antiseptic handrubs are not effective for hand decontamination.293 Cohorting of affected patients to separate airs paces and toilet facilities may help interrupt transmission during outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Rotavirus</td>
<td>C</td>
<td>DI</td>
<td>Ensure consistent environmental cleaning and disinfection and frequent removal of soiled diapers. Prolonged shedding may occur in both immunocompetent and immunocompromised children and the elderly.930, 931</td>
<td></td>
</tr>
<tr>
<td>Salmonella species (including S typhi)</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Shigella species (bacillary dysentery)</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Vibrio parahaemolyticus</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Viral (if not covered elsewhere)</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>Yersinia enterocolitica</td>
<td>S</td>
<td></td>
<td>Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks.</td>
<td></td>
</tr>
<tr>
<td>German measles (see rubella; see congenital rubella)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Giardiasis (see gastroenteritis)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gonococcal ophthalmia neonatorum (gonorrheal ophthalmia, acute conjunctivitis of newborn)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gonorrhea</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granuloma inguinale (donovanosis, granuloma venerenum)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guillain-Barré syndrome</td>
<td>S</td>
<td></td>
<td>Not an infectious condition.</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type</th>
<th>Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Haemophilus influenzae</em> (see disease-specific recommendations)</td>
<td></td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Hand, foot, and mouth disease (see enteroviral infection)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hansen's disease (see leprosy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hantavirus pulmonary syndrome</em></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Helicobacter pylori</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis, viral Type A</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diapered or incontinent patients</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B-HBsAg positive; acute or chronic (Type C and other unspecified non-A, non-B Type D (seen only with hepatitis B) Type E)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Herpangina</em> (see enteroviral infection)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hookworm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Herpes simplex</em> (<em>Herpesvirus hominis</em>) Encephalitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mucocutaneous, disseminated or primary, severe</td>
<td>C</td>
<td>Until lesions dry and crusted</td>
<td></td>
</tr>
<tr>
<td>Mucocutaneous, recurrent (skin, oral, genital)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal</td>
<td>C</td>
<td>Until lesions dry and crusted</td>
<td>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 hours until infant surface cultures obtained at 24 to 36 hours of age negative after 48 hours of incubation.</td>
</tr>
<tr>
<td><em>Herpes zoster</em> (varicella-zoster) (shingles) Disseminated disease in any patient</td>
<td>A,C</td>
<td>DI</td>
<td>Susceptible HCWs should not enter room if immune caregivers are available; no recommendation for protection of immune HCWs; no recommendation for type of protection (ie surgical mask or respirator) for susceptible HCWs.</td>
</tr>
<tr>
<td>Localized disease in immunocompromised patient until disseminated infection ruled out</td>
<td>S</td>
<td>DI</td>
<td>Susceptible HCWs should not provide direct patient care when other immune caregivers are available.</td>
</tr>
<tr>
<td>Localized in patient with intact immune system with lesions that can be contained/covered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Histoplasmosis</em></td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Human immunodeficiency virus (HIV)</td>
<td>S</td>
<td></td>
<td>Postexposure chemoprophylaxis for some blood exposures.</td>
</tr>
<tr>
<td>Human metapneumovirus</td>
<td>C</td>
<td>DI</td>
<td>HAI reported, but the route of transmission is not established. Assumed to be contact transmission as for RSV since the viruses are closely related and have similar clinical manifestations and epidemiology. Wear masks according to Standard Precautions.</td>
</tr>
<tr>
<td>Impetigo</td>
<td>C</td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td>Infectious mononucleosis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Infection/Condition

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Influenza</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human (seasonal influenza)</td>
<td>D</td>
<td>5 days except DI in immuno-compromised persons</td>
<td>Single patient room when available or cohort; avoid placement with high-risk patients; mask patient when transported out of room; chemoprophylaxis/vaccine to control/prevent outbreaks. Use of gown and gloves according to Standard Precautions may be especially important in pediatric settings. Duration of precautions for immunocompromised patients cannot be defined; prolonged duration of viral shedding (ie for several weeks) has been observed; implications for transmission are unknown. See <a href="http://www.cdc.gov/flu/avian/professional/infect-control.htm">http://www.cdc.gov/flu/avian/professional/infect-control.htm</a> for current avian influenza guidance.</td>
</tr>
<tr>
<td>Avian (eg, H5N1, H7, H9 strains)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pandemic influenza (also a human influenza virus)</td>
<td>D</td>
<td>5 days from onset of symptoms</td>
<td>See <a href="http://www.pandemicflu.gov">http://www.pandemicflu.gov</a> for current pandemic influenza guidance.</td>
</tr>
<tr>
<td>Kawasaki syndrome</td>
<td>S</td>
<td></td>
<td>Not an infectious condition.</td>
</tr>
<tr>
<td>Lassa fever (see viral hemorrhagic fevers)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Legionnaires’ disease</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person; see <a href="http://www.cdc.gov/ncidod/dpd/parasites/lice/default.htm">http://www.cdc.gov/ncidod/dpd/parasites/lice/default.htm</a>.</td>
</tr>
<tr>
<td>Leprosy</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head (pediculosis)</td>
<td>C</td>
<td>U 4 hours</td>
<td>Transmitted person to person through infested clothing. Wear gown and gloves when removing clothing; bag and wash clothes according to CDC guidance.</td>
</tr>
<tr>
<td>Body</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pubic</td>
<td>S</td>
<td></td>
<td>Person-to-person transmission rare; cross-transmission in neonatal settings reported.</td>
</tr>
<tr>
<td>Listeriosis (Listeria monocytogenes)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Lymphocytic choriomeningitis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Lymphogranuloma venereum</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely through transfusion and due to failure to follow Standard Precautions during patient care. Install screens in windows and doors in endemic areas. Use DEET-containing mosquito repellants and clothing to cover extremities.</td>
</tr>
<tr>
<td>Malaria</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Marburg virus disease (see viral hemorrhagic fevers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measles (rubeola)</td>
<td>A</td>
<td>4 days after onset of rash; DI in immune compromised</td>
<td>Susceptible HCWs should not enter room if immune care providers are available; no recommendation for face protection for immune HCW; no recommendation for type of face protection for susceptible HCWs (ie, mask or respirator). For exposed susceptible HCWs, postexposure vaccine within 72 hours or immune globulin within 6 days when available. Place exposed susceptible patients on Airborne Precautions and exclude susceptible HCWs from duty from day 5 after first exposure to day 21 after last exposure, regardless of postexposure vaccine.</td>
</tr>
<tr>
<td>Melioidosis, all forms</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Meningitis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aseptic (nonbacterial or viral; also see enteroviral infections)</td>
<td>S</td>
<td></td>
<td>Contact for infants and young children.</td>
</tr>
<tr>
<td>Bacterial, gram-negative enteric, in neonates</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemophilus influenzae, type b known or suspected</td>
<td>S</td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td>Listeria monocytogenes (See listeriosis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neisseria meningitidis (meningococcal) known or suspected</td>
<td>D</td>
<td>U 24 hours</td>
<td>See meningococcal disease below.</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Continued</strong></td>
<td></td>
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</tbody>
</table>
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td>S</td>
<td></td>
<td>Concurrent, active pulmonary disease or draining cutaneous lesions may necessitate addition of Contact and/or Airborne Precautions. For children, airborne precautions until active tuberculosis ruled out in visiting family members (see tuberculosis below).¹²</td>
</tr>
<tr>
<td>Other diagnosed bacterial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meningococcal disease: sepsis,</td>
<td>S</td>
<td>D</td>
<td>Postexposure chemoprophylaxis for household contacts, HCWs exposed to respiratory secretions; postexposure vaccine only to control outbreaks.¹⁵,¹⁷</td>
</tr>
<tr>
<td>pneumonia, meningitis</td>
<td></td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td><em>Molluscum contagiosum</em></td>
<td>A,C</td>
<td></td>
<td>See <a href="http://www.cdc.gov/ncidod/monkeypox">http://www.cdc.gov/ncidod/monkeypox</a> for most current recommendations. Transmission in hospital settings unlikely.¹²⁷ Preexposure and postexposure smallpox vaccine recommended for exposed HCWs.</td>
</tr>
<tr>
<td><em>Mucormycosis</em></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multidrug-resistant organisms</td>
<td>S/C</td>
<td></td>
<td>MDROs judged by the infection control program, based on local, state, regional, or national recommendations, to be of clinical and epidemiologic significance. Contact Precautions recommended 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 for management options in *Management of Multidrug-Resistant Organisms In Health care Settings, 2006.*¹⁸⁶ Contact state health department for guidance regarding new or emerging MDROs.</td>
</tr>
<tr>
<td>(MDROs), infection or colonization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(eg, MRSA, VRE, VISA/VRSA, ESBLs,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resistant <em>S. pneumoniae</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Mumps (infectious parotitis)</em></td>
<td>D</td>
<td>U 9 days</td>
<td>After onset of swelling; susceptible HCWs should not provide care if immune caregivers are available. (Note: Recent assessment of outbreaks in healthy 18- to 24-year-olds has indicated that salivary viral shedding occurred early in the course of illness and that 5 days of isolation after onset of parotitis may be appropriate in community settings; however, the implications for health care personnel and high-risk patient populations remain to be clarified.) Not transmitted person-to-person.</td>
</tr>
<tr>
<td><em>Mycobacteria, nontuberculosis</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(atypical)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Mycoplasma pneumonia</em></td>
<td>D</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td><em>Necrotizing enterocolitis</em></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Nocardiosis, draining lesions, or</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other presentations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norovirus (see gastroenteritis)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Norwalk agent gastroenteritis (see</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gastroenteritis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Orf</em></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Parainfluenza virus infection,</td>
<td>C</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td>respiratory in infants and young</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Parvovirus B19 (Erythema infectiosum)</em></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pediculosis (lice)</em></td>
<td>C</td>
<td>U 24 hours after treatment</td>
<td>Single patient room preferred. Cohorting an option. Postexposure chemoprophylaxis for household contacts and HCWs with prolonged exposure to respiratory secretions.¹⁶¹ Recommendations for Tdap vaccine in adults under development.</td>
</tr>
<tr>
<td><em>Pertussis (whooping cough)</em></td>
<td>D</td>
<td>U 5 days</td>
<td></td>
</tr>
<tr>
<td><em>Pinworm infection</em> (Enterobiasis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Plague (Yersinia pestis)</em></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bubonic Pneumonia</em></td>
<td>D</td>
<td>U 48 hours</td>
<td>Antimicrobial prophylaxis for exposed HCW.¹²⁷</td>
</tr>
<tr>
<td><em>Pneumonia</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continued
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration †</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Adenovirus          | D, C  | DI         | Outbreaks in pediatric and institutional settings reported. In immunocompromised hosts, extend duration of Droplet and Contact Precautions due to prolonged shedding of virus. 
| Bacterial not listed elsewhere (including gram-negative bacterial) | S     |            |          |
| B cepacia 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 the Cystic Fibrosis Foundation guidelines. |
| B cepacia in patients without CF (see multidrug-resistant organisms) |        |            |          |
| Chlamydia           | S     |            |          |
| Fungal              | S     |            |          |
| Haemophilus influenzae, type b |        |            |          |
| Adults              | S     |            |          |
| Infants and children| D     | U 24 hours |          |
| Legionella spp      | S     |            |          |
| Meningococcal Multidrug-resistant bacterial (see multidrug-resistant organisms) | D     | U 24 hours | See meningococcal disease above. |
| Mycoplasma (primary atypical pneumonia) | D     | DI         |          |
| Pneumococcal pneumonia | S   |            | Use Droplet Precautions if evidence of transmission within a patient care unit or facility. |
| Pneumocystis jiroveci (Pneumocystis carinii) | S     |            | Avoid placement in the same room with an immunocompromised patient. |
| Staphylococcus aureus | S     |            | For MRSA, see MDROs. |
| Streptococcus, group A Adults | D     | U 24 hours | See streptococcal disease (group A streptococcus) below. Contact precautions if skin lesions present. |
| Infants and young children Varicella-zoster (see varicella-zoster) | D     | U 24 hours | Contact Precautions if skin lesions present. |
| Viral Adults Infants and young children (see respiratory infectious disease, acute, or specific viral agent) | S     |            |          |
| Poliomyelitis Pressure ulcer (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 Prion disease (See Creutzfeldt-Jacob Disease) | S     |            | If dressing covers and contains drainage. |
| Psittacosis (ornithosis) (Chlamydia psittaci) | S     |            | Not transmitted from person to person. |
| Q fever Rabies | S     |            | Person-to-person transmission is rare; transmission via corneal, tissue and organ transplants has been reported. If patient has bitten another individual or saliva has contaminated an open wound or mucous membrane, wash exposed area thoroughly and administer postexposure prophylaxis. |
| Poliomyelitis | C     | DI         |          |
| Pressure ulcer (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 Prion disease (See Creutzfeldt-Jacob Disease) | S     |            | If dressing covers and contains drainage. |
| Psittacosis (ornithosis) (Chlamydia psittaci) | S     |            | Not transmitted from person to person. |
| Q fever Rabies | S     |            | Person-to-person transmission is rare; transmission via corneal, tissue and organ transplants has been reported. If patient has bitten another individual or saliva has contaminated an open wound or mucous membrane, wash exposed area thoroughly and administer postexposure prophylaxis. |

Continued
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Precaution</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat-bite fever (Streptobacillus moniliformis disease, Spirillum minus disease)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Relapsing fever</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Resistant bacterial infection or colonization (see multidrug-resistant organisms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory infectious disease, acute (if not covered elsewhere)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants and young children</td>
<td>C</td>
<td>DI</td>
<td></td>
<td>Also see syndromes or conditions listed in Table 2.</td>
</tr>
<tr>
<td>Respiratory syncytial virus infection, in infants, young children and immunocompromised adults</td>
<td>C</td>
<td>DI</td>
<td>Wear mask according to Standard Precautions(^{24,116,117}) In immunocompromised patients, extend the duration of Contact Precautions due to prolonged shedding. (^{956}) Reliability of antigen testing to determine when to remove patients with prolonged hospitalizations from Contact Precautions uncertain.</td>
<td></td>
</tr>
<tr>
<td>Reye's syndrome</td>
<td>S</td>
<td></td>
<td>Not an infectious condition.</td>
<td></td>
</tr>
<tr>
<td>Rheumatic fever</td>
<td>S</td>
<td></td>
<td>Not an infectious condition.</td>
<td></td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>D</td>
<td>DI</td>
<td>Droplet most important route of transmission. (^{104,1086}) Outbreaks have occurred in NICUs and LTCFs. (^{411,1087,1088}) Add Contact Precautions if copious moist secretions and close contact likely to occur (eg, young infants). (^{111,831})</td>
<td></td>
</tr>
<tr>
<td>Rickettsial fevers, tickborne (Rocky Mountain spotted fever, tickborne typhus fever)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely through transfusion.</td>
<td></td>
</tr>
<tr>
<td>Rickettsialpox (vesicular rickettsiosis)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Ringworm (dermatophytosis, dermatomyositis, tinea)</td>
<td>S</td>
<td></td>
<td>Rarely, outbreaks have occurred in health care settings, (eg, NICU,(^{1089}) rehabilitation hospital(^{1095}). Use Contact Precautions for outbreak.</td>
<td></td>
</tr>
<tr>
<td>Ritter's disease (staphylococcal scalded skin syndrome)</td>
<td>C</td>
<td>DI</td>
<td>See staphylococcal disease and scalded skin syndrome below.</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain spotted fever</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person except rarely through transfusion.</td>
<td></td>
</tr>
<tr>
<td>Roseola infantum (exanthem subitum; caused by HHV-6)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotavirus infection (see gastroenteritis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubella (German measles) (also see congenital rubella)</td>
<td>D</td>
<td>U 7 days after onset of rash</td>
<td>Susceptible HCWs should not enter room if immune caregivers are available. No recommendation for wearing face protection (eg, a surgical mask) if immune. Pregnant women who are not immune should not care for these patients. (^{17,33}) Administer vaccine within 3 days of exposure to nonpregnant susceptible individuals. Place exposed susceptible patients on Droplet Precautions; exclude susceptible health care personnel from duty from day 5 after first exposure to day 21 after last exposure, regardless of postexposure vaccine.</td>
<td></td>
</tr>
<tr>
<td>Rubeola (see measles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonellosis (see gastroenteritis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scabies</td>
<td>C</td>
<td>U 24</td>
<td>See staphylococcal disease and scalded skin syndrome below.</td>
<td></td>
</tr>
<tr>
<td>Scalded skin syndrome, staphylococcal</td>
<td>C</td>
<td>DI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schistosomiasis (bilharziasis)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe acute respiratory syndrome (SARS)</td>
<td>A, D, C</td>
<td>DI plus 10 days after resolution of fever, provided respiratory symptoms are absent or improving</td>
<td>Airborne Precautions preferred. D if AIIR unavailable. N95 or higher-level respiratory protection; surgical mask if N95 is unavailable; eye protection (goggles, face shield); aerosol-generating procedures and &quot;supershedders&quot; are at highest risk for transmission through small droplet nuclei and large droplets. (^{93,94,96}) Vigilant environmental disinfection necessary (see <a href="http://www.cdc.gov/ncidod/sars">http://www.cdc.gov/ncidod/sars</a>).</td>
<td></td>
</tr>
<tr>
<td>Shigellosis (see gastroenteritis)</td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>
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<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallpox (variola; see vaccinia for management of vaccinated persons)</td>
<td>A,C</td>
<td>DI</td>
<td>Until all scabs have crusted and separated (3 to 4 weeks). Nonvaccinated HCWs should not provide care when immune HCWs are available; N95 or higher-level respiratory protection for susceptible and successfully vaccinated individuals; postexposure vaccine within 4 days of exposure protective. 108,1034-1036</td>
</tr>
<tr>
<td>Sporotrichosis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Spirillum minor disease (rat-bite fever)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococcal disease (S. aureus)</td>
<td>C</td>
<td>DI</td>
<td>No dressing, or dressing does not adequately contain drainage. Dressing adequately cover and contain drainage. Use Contact Precautions for diapered or incontinent children for duration of illness.</td>
</tr>
<tr>
<td>Skin, wound, or burn</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td>C,D</td>
<td>U 24 hours</td>
<td>No dressing, or dressing does not adequately contain drainage. Dressing covers and adequately contains drainage.</td>
</tr>
<tr>
<td>Minor or limited</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterocolitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multidrug-resistant (see multidrug-resistant organisms)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>S</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td>Scalded skin syndrome</td>
<td>C</td>
<td>DI</td>
<td>Consider health care personnel as potential source of nursery, NICU outbreak. 1091</td>
</tr>
<tr>
<td>Toxic shock syndrome</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptobacillus moniliformis disease (rat-bite fever)</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Streptococcal disease (group A streptococcus)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin, wound, or burn</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td>C,D</td>
<td>U 24 hours</td>
<td>Outbreaks of serious invasive disease have occurred secondary to transmission among patients and HCWs. 162,992-1094 Contact Precautions for draining wound as above; follow recommendations for antimicrobial prophylaxis in selected conditions. 160</td>
</tr>
<tr>
<td>Minor or limited</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endometritis (puerperal sepsis)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharyngitis in infants and young children</td>
<td>D</td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>D</td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td>Scarlet fever in infants and young children</td>
<td>D</td>
<td>U 24 hours</td>
<td></td>
</tr>
<tr>
<td>Serious invasive disease</td>
<td>D</td>
<td>U24 hours</td>
<td></td>
</tr>
<tr>
<td>Streptococcal disease (group B streptococcus), neonatal</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcal disease (not group A or B) unless covered elsewhere</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multidrug-resistant (see multidrug-resistant organisms)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongyloidiasis</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Syphilis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latent (tertiary) and seropositivity without lesions</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin and mucous membrane, including congenital, primary, secondary</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tapeworm disease</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hymenolepis nana</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Taenia solium (pork)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetanus</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
</tr>
<tr>
<td>Tinea (eg, dermatophytosis, dermatomycosis, ringworm)</td>
<td>S</td>
<td></td>
<td>Rare episodes of person-to-person transmission.</td>
</tr>
</tbody>
</table>
### Appendix A. Continued

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Precaution</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxoplasmosis</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic shock syndrome (staphylococcal disease, streptococcal disease)</td>
<td>S</td>
<td></td>
<td>Transmission from person to person is rare; vertical transmission from mother to child, transmission through organs and blood transfusion rare.</td>
<td></td>
</tr>
<tr>
<td>Trachoma, acute</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmissible spongiform encephalopathy (see Creutzfeld-Jacob disease, CJD, vCJD)</td>
<td>S</td>
<td></td>
<td>Droplet Precautions for the first 24 hours after implementation of antibiotic therapy if group A streptococcus is a likely etiology.</td>
<td></td>
</tr>
<tr>
<td>Trench mouth (Vincent’s angina)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichinosis</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichomoniasis</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichuriasis (whipworm disease)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberculosis (M. tuberculosis)</td>
<td>A,C</td>
<td></td>
<td>Discontinue precautions only when patient is improving clinically and drainage has ceased or there are 3 consecutive negative cultures of continued drainage.</td>
<td>Examine for evidence of active pulmonary tuberculosis.</td>
</tr>
<tr>
<td>Tuberculosis, extrapulmonary, draining lesion</td>
<td>A,C</td>
<td></td>
<td>Examine for evidence of pulmonary tuberculosis. For infants and children, use Airborne Precautions until active pulmonary tuberculosis in visiting family members ruled out.</td>
<td></td>
</tr>
<tr>
<td>Tuberculosis, extrapulmonary, no draining lesion, meningitis</td>
<td>S</td>
<td></td>
<td>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 (see <a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm?s_cid=rr5417a1_e">http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm?s_cid=rr5417a1_e</a>).</td>
<td></td>
</tr>
<tr>
<td>Pulmonary or laryngeal disease, confirmed</td>
<td>A</td>
<td></td>
<td>Discontinue precautions only when the likelihood of infectious TB disease is deemed negligible, and either there is another diagnosis that explains the clinical syndrome or the results of three sputum smears for AFB are negative. The 3 sputum specimens should be collected 8 to 24 hours apart, and at least 1 specimen should be an early-morning specimen.</td>
<td></td>
</tr>
<tr>
<td>Pulmonary or laryngeal disease, suspected</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin-test positive with no evidence of current active disease</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typhemia</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typhoid (Salmonella typhi) fever (see gastroenteritis)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typhus</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rickettsia prowazekii (Epidemic or Louse-borne typhus)</td>
<td>S</td>
<td></td>
<td>Transmitted from person to person through close personal or clothing contact.</td>
<td></td>
</tr>
<tr>
<td>Rickettsia typhi</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection (including pyelonephritis), with or without urinary catheter</td>
<td>S</td>
<td></td>
<td>Not transmitted from person to person.</td>
<td></td>
</tr>
<tr>
<td>Vaccinia (vaccination site, adverse events after vaccination)*</td>
<td>S</td>
<td></td>
<td>Only vaccinated HCWs have contact with active vaccination sites and care for persons with adverse vaccinia events; if unvaccinated, only HCWs without contraindications to vaccine may provide care.</td>
<td></td>
</tr>
<tr>
<td>Vaccination site care (including autoinoculated areas)</td>
<td>S</td>
<td></td>
<td>Vaccination recommended for vaccinators; for newly vaccinated HCWs: semipermeable dressing over gauze until scab separates, with dressing change as fluid accumulates. ~ 3 to 5 days; gloves, hand hygiene for dressing change; vaccinated HCW or HCW without contraindication to vaccine for dressing changes.</td>
<td></td>
</tr>
<tr>
<td>Eczema vaccinatum</td>
<td>C</td>
<td>Until lesions dry and crusted, scabs separated</td>
<td>For contact with virus-containing lesions and exudative material.</td>
<td></td>
</tr>
<tr>
<td>Fetal vaccinia</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generalized vaccinia</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progressive vaccinia</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Type: S = Standard, P = Precautions, V = Vaccination, A = Airborne, C = Contact, E = Engineering<br>†Duration: F = Few days, S = Several days, W = Weeks, M = Months
### Precaution

<table>
<thead>
<tr>
<th>Infection/Condition</th>
<th>Type*</th>
<th>Duration†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postvaccinia encephalitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blepharitis or conjunctivitis</td>
<td>S/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iritis or keratitis</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccinia-associated erythema multiforme (Stevens-Johnson syndrome)</td>
<td>S</td>
<td></td>
<td>Not an infectious condition.</td>
</tr>
<tr>
<td>Secondary bacterial infection (eg, S. aureus, group A beta hemolytic streptococcus)</td>
<td>S/C</td>
<td>Follow organism-specific (streptococcal and staphylococcal most frequent) recommendations and consider magnitude of drainage.</td>
<td></td>
</tr>
<tr>
<td>Varicella zoster</td>
<td>A,C</td>
<td>Until lesions dry and crusted</td>
<td>Susceptible HCWs should not enter room if immune caregivers are available; no recommendation for face protection of immune HCWs; no recommendation for type of protection (ie, surgical mask or respirator) for susceptible HCWs. In an immunocompromised host with varicella pneumonia, prolong the duration of precautions for duration of illness. Postexposure prophylaxis: Provide postexposure vaccine as soon as possible but within 120 hours; for susceptible exposed persons for whom vaccine is contraindicated (immunocompromised persons, pregnant women, newborns whose mother’s varicella onset is ≥ 5 days before delivery or within 48 hours after delivery) provide VZIG, when available, within 96 hours; if unavailable, use IVIG. Provide Airborne Precautions for exposed susceptible persons and exclude exposed susceptible health care workers beginning 8 days after first exposure until 21 days after last exposure or 28 if received VZIG, regardless of postexposure vaccination.</td>
</tr>
<tr>
<td>Variola (see smallpox)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibrio parahaemolyticus (see gastroenteritis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vincent’s angina (trench mouth)</td>
<td>S</td>
<td>DI</td>
<td></td>
</tr>
<tr>
<td>Viral hemorrhagic fevers due to Lassa, Ebola, Marburg, Crimean-Congo fever viruses</td>
<td>S, D, C</td>
<td>DI</td>
<td>Single-patient room preferred. Emphasize: use of sharps safety devices and safe work practices, hand hygiene; barrier protection against blood and body fluids on entry into room (single gloves and fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields), and appropriate waste handling. Use N95 or higher-level respirator when performing aerosol-generating procedures. Largest viral load in final stages of illness when hemorrhage may occur; additional PPE, including double gloves, leg and shoe coverings may be used, especially in resource-limited settings where options for cleaning and laundry are limited. Notify public health officials immediately if Ebola is suspected.</td>
</tr>
<tr>
<td>Viral respiratory diseases (not covered elsewhere)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants and young children (see respiratory infectious disease, acute)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whooping cough (see pertussis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound infections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td>C</td>
<td>DI</td>
<td>No dressing or dressing does not contain drainage adequately.</td>
</tr>
<tr>
<td>Minor or limited</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yersinia enterocolitica gastroenteritis (see gastroenteritis)</td>
<td>S</td>
<td>DI</td>
<td>No dressing or dressing does not contain drainage adequately.</td>
</tr>
<tr>
<td>Zoster (varicella-zoster) (see herpes zoster)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zygomycosis (phycomycosis, mucormycosis)</td>
<td>S</td>
<td></td>
<td>Not transmitted person to person.</td>
</tr>
</tbody>
</table>

*Type of precautions: A, airborne precautions; 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.
Management of multidrug-resistant organisms in health care settings, 2006

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Dallas, Texas; San Diego, California; and Atlanta, Georgia

Multidrug-resistant organisms (MDROs), including methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), and certain gram-negative bacilli (GNB) have important infection control implications that either have not been addressed or received only limited consideration in previous isolation guidelines. Increasing experience with these organisms is improving understanding of the routes of transmission and effective preventive measures. Although transmission of MDROs is most frequently documented in acute care facilities, all health care settings are affected by the emergence and transmission of antimicrobial-resistant microbes. The severity and extent of disease caused by these pathogens varies by the population(s) affected and by the institution(s) in which they are found. Institutions, in turn, vary widely in physical and functional characteristics, ranging from long-term care facilities (LTCF) to specialty units (e.g., intensive care units [ICU], burn units, neonatal ICUs [NICUs]) in tertiary care facilities. Because of this, the approaches to prevention and control of these pathogens need to be tailored to the specific needs of each population and individual institution. The prevention and control of MDROs is a national priority—one that requires that all health care facilities and agencies assume responsibility.1,2 The following discussion and recommendations are provided to guide the implementation of strategies and
practices to prevent the transmission of MRSA, VRE, and other MDROs. The administration of health care organizations and institutions should ensure that appropriate strategies are fully implemented, regularly evaluated for effectiveness, and adjusted such that there is a consistent decrease in the incidence of targeted MDROs. Successful prevention and control of MDROs require administrative and scientific leadership and a financial and human resource commitment. Resources must be made available for infection prevention and control, including expert consultation, laboratory support, adherence monitoring, and data analysis. Infection prevention and control professionals have found that health care personnel (HCP) are more receptive and adherent to the recommended control measures when organizational leaders participate in efforts to reduce MDRO transmission.

BACKGROUND

MDRO definition

For epidemiologic purposes, MDROs are defined as microorganisms, predominantly bacteria, that are resistant to 1 or more classes of antimicrobial agents. Although the names of certain MDROs describe resistance to only 1 agent (eg, MRSA, VRE), these pathogens are frequently resistant to most available antimicrobial agents. These highly resistant organisms deserve special attention in health care facilities. In addition to MRSA and VRE, certain GNB, including those producing extended spectrum β-lactamases (ESBLs) and others that are resistant to multiple classes of antimicrobial agents, are of particular concern. Multidrug-resistant strains of Mycobacterium tuberculosis are not addressed in this document because of the markedly different patterns of transmission and spread of the pathogen and the very different control interventions that are needed for prevention of M tuberculosis infection. Current recommendations for prevention and control of tuberculosis can be found at: http://www.cdc.gov/mmwr/pdf/rrrr5417.pdf. In addition to Escherichia coli and Klebsiella pneumoniae, these include strains of Acinetobacter baumannii resistant to all antimicrobial agents, or all except imipenem, and organisms such as Stenotrophomonas maltophilia, Burkholderia cepacia, and Ralstonia pickettii that are intrinsically resistant to the broadest spectrum antimicrobial agents. In some residential settings (eg, LTCFs), it is important to control multidrug-resistant Streptococcus pneumoniae (MDRSP) that are resistant to penicillin and other broad-spectrum agents such as macrolides and fluoroquinolones. Strains of S aureus that have intermediate susceptibility or are resistant to vancomycin (ie, vancomycin-intermediate S aureus [VISA], vancomycin-resistant S aureus [VRSA]) have affected specific populations, such as hemodialysis patients.

Clinical importance of MDROs

In most instances, MDRO infections have clinical manifestations that are similar to infections caused by susceptible pathogens. However, options for treating patients with these infections are often extremely limited. For example, until recently, only vancomycin provided effective therapy for potentially life-threatening MRSA infections, and, during the 1990s, there were virtually no antimicrobial agents to treat infections caused by VRE. Although antimicrobials are now available for treatment of MRSA and VRE infections, resistance to each new agent has already emerged in clinical isolates. Similarly, therapeutic options are limited for ESBL-producing isolates of gram-negative bacilli, strains of A baumannii resistant to all antimicrobial agents except imipenem, and intrinsically resistant Stenotrophomonas species. These limitations may influence antibiotic usage patterns in ways that suppress normal flora and create a favorable environment for development of colonization when exposed to potential MDR pathogens (ie, selective advantage).

Increased lengths of stay, costs, and mortality also have been associated with MDROs. Two studies documented increased mortality, hospital lengths of stay, and hospital charges associated with multidrug-resistant gram-negative bacilli (MDR-GNBs), including a NICU outbreak of ESBL-producing Klebsiella pneumoniae and the emergence of third-generation cephalosporin resistance in Enterobacter species in hospitalized adults. Vancomycin resistance has been reported to be an independent predictor of death from enterococcal bacteremia. 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. However, MRSA may behave differently from other MDROs. When patients with MRSA have been compared with patients with methicillin-susceptible S aureus (MSSA), MRSA-colonized patients more frequently develop symptomatic infections. Furthermore, higher case fatality rates have been observed for certain MRSA infections, including bacteremia, poststernotomy mediastinitis, and surgical site infections. These outcomes may be a result of delays in the administration of vancomycin, the relative decrease in the bactericidal activity of vancomycin, or persistent bacteremia associated with intrinsic characteristics of certain MRSA strains. Mortality may be increased further by S aureus with reduced vancomycin...
susceptibility (VISA). Also, some studies have reported an association between MRSA infections and increased length of stay, and health care costs, whereas others have not. Finally, some hospitals have observed an increase in the overall occurrence of staphylococcal infections following the introduction of MRSA into a hospital or special care unit.

EPIDEMIOLOGY OF MDRO

Trends

Prevalence of MDROs varies temporally, geographically, and by health care 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, and MDRSP varies in prevalence by state. The type and level of care also influence the prevalence of MDROs. ICUs, especially those at tertiary care facilities, may have a higher prevalence of MDRO infections than do non-ICU settings. Antimicrobial resistance rates are also strongly correlated with hospital size, tertiary-level care, and facility type (e.g., LTCF). The frequency of clinical infection caused by these pathogens is low in LTCFs. Nonetheless, MDRO infections in LTCFs can cause serious disease and mortality, and colonized or infected LTCF residents may serve as reservoirs and vehicles for MDRO introduction into acute care facilities. Another example of population differences in prevalence of target MDROs is in the pediatric population. Point prevalence surveys conducted by the Pediatric Prevention Network (PPN) in 8 US pediatric ICUs and 7 US NICUs in 2000 found that ≤4% of patients were colonized with MRSA or VRE compared with 10% to 24% who were colonized with ceftazidime- or aminoglycoside-resistant gram-negative bacilli; <3% were colonized with ESBL-producing gram-negative bacilli. Despite some evidence that MDRO burden is greatest in adult hospital patients, MDRO require similar control efforts in pediatric populations as well.

During the last several decades, the prevalence of MDROs in US hospitals and medical centers has increased steadily. MRSA was first isolated in the United States in 1968. By the early 1990s, MRSA accounted for 20% to 25% of S aureus isolates from hospitalized patients. In 1999, MRSA accounted for >50% of S aureus isolates from patients in ICUs in the National Nosocomial Infection Surveillance (NNIS) system; in 2003, 59.5% of S aureus isolates in NNIS ICUs were MRSA. A similar rise in prevalence has occurred with VRE. From 1990 to 1997, the prevalence of VRE in enterococcal isolates from hospitalized patients increased from <1% to approximately 15%. VRE accounted for almost 25% of enterococcus isolates in NNIS ICUs in 1999 and 28.5% in 2003. GNB resistant to ESBLs, fluoroquinolones, carbapenems, and aminoglycosides also have increased in prevalence. For example, in 1997, the SENTRY Antimicrobial Surveillance Program found that, among K pneumoniae strains isolated in the United States, resistance rates to ceftazidime and other third-generation cephalosporins were 6.6%, 9.7%, 5.4%, and 3.6% for bloodstream, pneumonia, wound, and urinary tract infections, respectively. In 2003, 20.6% of all K pneumoniae isolates from NNIS ICUs were resistant to these drugs. Similarly, between 1999 and 2003, Pseudomonas aeruginosa resistance to fluoroquinolone antibiotics increased from 23% to 29.5% in NNIS ICUs. Also, a 3-month survey of 15 Brooklyn hospitals in 1999 found that 53% of A baumannii strains exhibited resistance to carbapenems and that 24% of P aeruginosa strains were resistant to imipenem. During 1994-2000, a national review of ICU patients in 43 states found that the overall susceptibility to ciprofloxacin decreased from 86% to 76% and was temporally associated with increased use of fluoroquinolones in the United States.

Last, an analysis of temporal trends of antimicrobial resistance in non-ICU patients in 23 US hospitals during 1996-1997 and 1998-1999 found significant increases in the prevalence of resistant isolates including MRSA, ciprofloxacin-resistant P aeruginosa, and ciprofloxacin- or ofloxacin-resistant E coli. Several factors may have contributed to these increases including the following: selective pressure exerted by exposure to antimicrobial agents, particularly fluoroquinolones, outside of the ICU and/or in the community; increasing rates of community-associated MRSA colonization and infection; inadequate adherence to infection control practices; or a combination of these factors.

Important concepts in transmission

Once MDROs are introduced into a health care setting, transmission and persistence of the resistant strain is determined by the availability of vulnerable patients, selective pressure exerted by antimicrobial use, increased potential for transmission from larger numbers of colonized or infected patients (“colonization pressure”), and the impact of implementation and adherence to prevention efforts. 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). Hospitalized patients, especially ICU patients, tend to have more risk factors than nonhospitalized patients and have the highest infection rates. For example, the risk
that an ICU patient will acquire VRE increases significantly once the proportion of ICU patients colonized with VRE exceeds 50%\textsuperscript{101} or the number of days of exposure to a VRE patient exceeds 15 days.\textsuperscript{105} A similar effect of colonization pressure has been demonstrated for MRSA in a medical ICU.\textsuperscript{102} Increasing numbers of infections with MDROs also have been reported in non-ICU areas of hospitals.\textsuperscript{97}

There is ample epidemiologic evidence to suggest that MDROs are carried from one person to another via the hands of HCP.\textsuperscript{106-109} Hands are easily contaminated during the process of caregiving or from contact with environmental surfaces in close proximity to the patient.\textsuperscript{110-113} The latter is especially important when patients have diarrhea and the reservoir of the MDRO is the gastrointestinal tract.\textsuperscript{114-117} Without adherence to published recommendations for hand hygiene and glove use,\textsuperscript{111} HCP are more likely to transmit MDROs to patients. Thus, strategies to increase and monitor adherence are important components of MDRO control programs.\textsuperscript{106,118}

Opportunities for transmission of MDROs beyond the acute care hospital result from patients receiving care at multiple health care facilities and moving between acute care, ambulatory, and/or chronic care and LTC environments. System-wide surveillance at LDS Hospital in Salt Lake City, UT, monitored patients identified as being infected or colonized with MRSA or VRE and found that those patients subsequently received inpatient or outpatient care at as many as 62 different health care facilities in that system during a 5-year span.\textsuperscript{119}

**Role of colonized HCP in MDRO transmission**

Rarely, HCP may introduce an MDRO into a patient care unit.\textsuperscript{120-123} Occasionally, HCP can become persistently colonized with an MDRO, but these HCP have a limited role in transmission, unless other factors are present. Additional factors that can facilitate transmission include chronic sinusitis,\textsuperscript{120} upper respiratory infection,\textsuperscript{123} and dermatitis.\textsuperscript{124}

**Implications of community-associated MRSA**

The emergence of new epidemic strains of MRSA in the community, among patients without established MRSA risk factors, may present new challenges to MRSA control in health care settings.\textsuperscript{125-128} Historically, genetic analyses of MRSA isolated from patients in hospitals worldwide revealed that a relatively small number of MRSA strains have unique qualities that facilitate their transmission from patient to patient within health care facilities over wide geographic areas, explaining the dramatic increases in HAIIs caused by MRSA in the 1980s and early 1990s.\textsuperscript{129} To date, most MRSA strains isolated from patients with community-associated (CA)-MRSA infections have been microbiologically distinct from those endemic in health care settings, suggesting that some of these strains may have arisen de novo in the community via acquisition of methicillin resistance genes by established MSSA strains.\textsuperscript{130-132} Two pulsed-field types, termed USA300 and USA400 according to a typing scheme established at the Centers for Disease Control and Prevention (CDC), have accounted for the majority of CA-MRSA infections characterized in the United States, whereas pulsed-field types USA100 and USA200 are the predominant genotypes endemic in health care settings.\textsuperscript{133}

USA300 and USA400 genotypes almost always carry type IV of the staphylococcal chromosomal cassette \textit{mec}, the mobile genetic element that carries the \textit{mecA} methicillin-resistance gene.\textsuperscript{133,134} This genetic cassette is smaller than types I through III, the types typically found in health care-associated MRSA strains, and is hypothesized to be more easily transferable among \textit{S aureus} strains.

CA-MRSA infection presents most commonly as relatively minor skin and soft tissue infections, but severe invasive disease, including necrotizing pneumonia, necrotizing fasciitis, severe osteomyelitis, and a sepsis syndrome with increased mortality have also been described in children and adults.\textsuperscript{134-136}

Transmission within hospitals of MRSA strains first described in the community (eg, USA300 and USA400) are being reported with increasing frequency.\textsuperscript{137-140} Changing resistance patterns of MRSA in ICUs in the NNIS system from 1992 to 2003 provide additional evidence that the new epidemic MRSA strains are becoming established health care-associated as well as community pathogens.\textsuperscript{90} Infections with these strains have most commonly presented as skin disease in community settings. However, intrinsic virulence characteristics of the organisms can result in clinical manifestations similar to or potentially more severe than traditional health care-associated MRSA infections among hospitalized patients. The prevalence of MRSA colonization and infection in the surrounding community may therefore affect the selection of strategies for MRSA control in health care settings.

**MDRO PREVENTION AND CONTROL**

**Prevention of infections**

Preventing infections will reduce the burden of MDROs in health care settings. Prevention of antimicrobial resistance depends on appropriate clinical practices that should be incorporated into all routine patient care. These include optimal management of vascular and urinary catheters, prevention of lower
Reduced rates of VRE transmission in The Netherlands, Belgium, Denmark, and other Scandinavian countries after the implementation of aggressive and sustained infection control interventions (ie, ASC; preemptive use of contact precautions upon admission until proven culture negative; and, in some instances, closure of units to new admissions). MRSA generally accounts for a very small proportion of *S aureus* clinical isolates in these countries.146-150

- Reduced rates of VRE transmission in health care facilities in the 3-state Siouxland region (Iowa, Nebraska, and South Dakota) following formation of a coalition and development of an effective region-wide infection control intervention that included ASC and isolation of infected patients. The overall prevalence rate of VRE in the 50 participating facilities decreased from 2.2% in 1997 to 0.5% in 1999.151
- Eradication of endemic MRSA infections from 2 NICUs. The first NICU included implementation of ASC, contact precautions, use of triple dye on the umbilical cord, and systems changes to improve surveillance and adherence to recommended practices and to reduce overcrowding.152 The second NICU used ASC and contact precautions; surgical masks were included in the barriers used for contact precautions.153
- Control of an outbreak and eventual eradication of VRE from a burn unit over a 13-month period with implementation of aggressive culturing, environmental cleaning, and barrier isolation.154
- Control of an outbreak of VRE in a NICU over a 3-year period with implementation of ASC, other infection control measures such as use of a waterless hand disinfectant, and mandatory in-service education.155
- Eradication of MDR strains of *A baumannii* from a burn unit over a 16-month period with implementation of strategies to improve adherence to hand hygiene, isolation, environmental cleaning, and temporary unit closure.38
- In addition, more than 100 reports published during 1982-2005 support the efficacy of combinations of various control interventions to reduce the burden of MRSA, VRE, and MDR-GNBs (Tables 1 and 2). Case-rate reduction or pathogen eradication was reported in a majority of studies.

VRE was eradicated in 7 special care units,154,156-160 2 hospitals,161,162 and 1 LTCF.163

- MRSA was eradicated from 9 special care units,89,152,153,164-169 2 hospitals,170 1 LTCF,167 and 1 Finnish district.171 Furthermore, 4 MRSA reports described continuing success in sustaining low endemic MRSA rates for over 5 years.68,166,172,173

- A MDR-GNB was eradicated from 13 special care units38,174-180 and 2 hospitals.11,181

These success stories testify to the importance of having dedicated and knowledgeable teams of health care professionals who are willing to persist for years, if necessary, to control MDROs. Eradication and control of MDROs, such as those reported, frequently required periodic reassessment and the addition of new and more stringent interventions over time (tiered strategy). For example, interventions were added in a stepwise fashion during a 3-year effort that eventually eradicated MRSA from a NICU.152 A series of interventions was adopted throughout the course of a year to eradicate VRE from a burn unit.154 Similarly, eradication of carbapenem-resistant strains of *A baumannii* from a hospital required multiple and progressively more intense interventions over several years.11
Nearly all studies reporting successful MDRO control employed a median of 7 to 8 different interventions concurrently or sequentially (Table 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 did not include them as interventions, and some “single measures” are, in fact, a complex combination of several interventions. The use of multiple concurrent control measures in these reports underscores the need for a comprehensive approach for controlling MDROs.

Several factors affect the ability to generalize the results of the various studies reviewed, including differences in definition, study design, end points and variables measured, and period of follow-up. Two thirds of the reports cited in Tables 1 and 2 involved perceived outbreaks, and one third described efforts to reduce endemic transmission. Few reports described preemptive efforts or prospective studies to control MDROs before they had reached high levels within a unit or facility.

With these and other factors, it has not been possible to determine the effectiveness of individual interventions, or a specific combination of interventions, that would be appropriate for all health care facilities to implement to control their target MDROs.

Randomized controlled trials are necessary to acquire this level of evidence. A National Institutes of Health (NIH)-sponsored, randomized controlled trial on the prevention of MRSA and VRE transmission in adult ICUs is ongoing and may provide further insight into optimal control measures (http://clinicaltrials.gov/ct/show/NCT00100386?order=1). This trial compares the use of education (to improve adherence to hand hygiene) and standard precautions to the use of ASC and contact precautions.

### Table 1. Categorization of reports about control of MDROs in health care settings, 1982-2005

<table>
<thead>
<tr>
<th>MDRO</th>
<th>MDR-GNB</th>
<th>MRSA</th>
<th>VRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of studies reviewed/category</td>
<td>30</td>
<td>35</td>
<td>39</td>
</tr>
<tr>
<td>Types of health care facilities from which study or report arose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. (%) from academic facilities</td>
<td>30 (100)</td>
<td>28 (80)</td>
<td>33 (85)</td>
</tr>
<tr>
<td>No. (%) from other hospitals</td>
<td>0</td>
<td>4 (11)</td>
<td>3 (8)</td>
</tr>
<tr>
<td>No. (%) from LTCFs</td>
<td>0</td>
<td>1 (3)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>No. (%) from multiple facilities in a region</td>
<td>0</td>
<td>2 (6)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Unit of study for MDRO control efforts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special unit</td>
<td>20</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Hospital</td>
<td>10</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>LTCF</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Region</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Nature of study or report on MDRO control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outbreak</td>
<td>22</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Nonoutbreak</td>
<td>8</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Total period of observation after interventions introduced</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 yr</td>
<td>17</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>1-2 yr</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2-5 yr</td>
<td>5</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Greater than 5 yr</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Numbers of control measures employed in outbreaks/studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>2-12</td>
<td>0-11</td>
<td>1-12</td>
</tr>
<tr>
<td>Median</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Mode</td>
<td>8</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>


*Variably described as university hospitals, medical school affiliated hospitals, VA teaching hospitals, and, to a much lesser extent, community teaching hospitals.

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.

Based on authors’ description: whether they called their experience an outbreak or not; authors vary in use of term, so there is probable overlap between 2 categories.

Control interventions

The various types of interventions used to control or eradicate MDROs may be grouped into 7 categories. These include administrative support, judicious use of antimicrobials, surveillance (routine and enhanced), standard and contact precautions, environmental measures, education, and decolonization. These interventions provide the basis for the recommendations for control of MDROs in health care settings that follow this review and as summarized in Table 3. In the studies reviewed, these interventions were applied in various combinations and degrees of intensity, with differences in outcome.

Administrative support. In several reports, administrative support and involvement were important for the...
successful control of the target MDRO and authorities in infection control have strongly recommended such support. There are several examples of MDRO control interventions that require administrative commitment of fiscal and human resources. One is the use of ASC. Other interventions that require administrative support include the following: (1) implementing system changes to ensure prompt and effective communications, eg, computer alerts to identify patients previously known to be colonized/infected with MDROs; (2), providing the necessary number and appropriate placement of handwashing sinks and alcohol-containing handrub dispensers in the facility; (3) maintaining staffing levels appropriate to the intensity of care required; and (4) enforcing adherence to recommended infection control practices (eg, hand hygiene, standard and contact precautions) for MDRO control. Other measures that have been associated with a positive impact on prevention efforts, which require administrative support, are direct observation with feedback to HCP on adherence to recommended precautions and keeping HCP informed about changes in transmission rates. A “How-to guide” for implementing change in ICUs, including analysis of structure, process, and outcomes when designing interventions, can assist in identification of needed administrative interventions. Last, participation in existing or the creation of new, city-wide, state-wide, regional or national coalitions to combat emerging or growing MDRO problems is an effective strategy that requires administrative support.

**Education.** Facility-wide, unit-targeted, and informal, educational interventions were included in several successful studies. The focus of the interventions was to encourage a behavior change through improved understanding of the problem MDRO that the facility was trying to control. Whether the desired change involved hand hygiene, antimicrobial prescribing patterns, or other outcomes, enhancing understanding and creating a culture that supported and promoted the desired behavior were viewed as essential to the success of the intervention. Educational campaigns to enhance adherence to hand hygiene practices in conjunction with other control measures have been associated temporally with decreases in MDRO transmission in various health care settings.

**Judicious use of antimicrobial agents.** Although a comprehensive review of antimicrobial stewardship is beyond the scope of this guideline, recommendations for control of MDROs must include attention to judicious antimicrobial use. 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.

### Table 2. Control measures for MDROs employed in studies performed in health care settings, 1982-2005

<table>
<thead>
<tr>
<th>Focus of MDRO (No. of studies)</th>
<th>MDR-GNB (n = 30)</th>
<th>MRSA (n = 35)</th>
<th>VRE (n = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%) of studies using control measure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education of staff, patients, or visitors</td>
<td>19 (63)</td>
<td>11 (31)</td>
<td>20 (53)</td>
</tr>
<tr>
<td>Emphasis on handwashing</td>
<td>16 (53)</td>
<td>21 (60)</td>
<td>9 (23)</td>
</tr>
<tr>
<td>Use of antiseptics for handwashing</td>
<td>8 (30)</td>
<td>12 (36)</td>
<td>16 (41)</td>
</tr>
<tr>
<td>Contact precautions or glove use</td>
<td>20 (67)</td>
<td>27 (77)</td>
<td>34 (87)</td>
</tr>
<tr>
<td>Private rooms</td>
<td>4 (15)</td>
<td>10 (28)</td>
<td>10 (27)</td>
</tr>
<tr>
<td>Segregation of cases</td>
<td>4 (15)</td>
<td>3 (9)</td>
<td>5 (14)</td>
</tr>
<tr>
<td>Cohorting of patients</td>
<td>11 (37)</td>
<td>12 (34)</td>
<td>14 (36)</td>
</tr>
<tr>
<td>Cohorting of staff</td>
<td>2 (7)</td>
<td>6 (17)</td>
<td>9 (23)</td>
</tr>
<tr>
<td>Change in antimicrobial use</td>
<td>12 (41)</td>
<td>1 (3)</td>
<td>17 (44)</td>
</tr>
<tr>
<td>Surveillance cultures of patients</td>
<td>19 (63)</td>
<td>34 (97)</td>
<td>36 (92)</td>
</tr>
<tr>
<td>Surveillance cultures of staff</td>
<td>9 (31)</td>
<td>8 (23)</td>
<td>7 (19)</td>
</tr>
<tr>
<td>Environmental cultures</td>
<td>15 (50)</td>
<td>14 (42)</td>
<td>15 (38)</td>
</tr>
<tr>
<td>Extra cleaning and disinfection</td>
<td>11 (37)</td>
<td>7 (21)</td>
<td>20 (51)</td>
</tr>
<tr>
<td>Dedicated equipment</td>
<td>5 (17)</td>
<td>0</td>
<td>12 (32)</td>
</tr>
<tr>
<td>Decolonization</td>
<td>3 (10)</td>
<td>25 (71)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Ward closure to new admission or to all patients</td>
<td>6 (21)</td>
<td>4 (12)</td>
<td>5 (14)</td>
</tr>
<tr>
<td>Other miscellaneous measures</td>
<td>6 (22)</td>
<td>9 (27)</td>
<td>17 (44)</td>
</tr>
</tbody>
</table>


*Contact precautions mentioned specifically, use of gloves with gowns or aprons mentioned, barrier precautions, strict isolation, all included under this heading.

1Includes signage, record flagging, unannounced inspections, selective decontamination, and peer compliance monitoring (1 to 4 studies employing any of these measures).

2Includes requirements for masks, signage, record tracking, alerts, early discharge, and preventive isolation of new admissions pending results of screening cultures (1 to 4 studies employing any of these measures).

3Includes computer flags, signage, requirement for mask, one-to-one nursing, changing type of thermometer used, and change in rounding sequence (1 to 7 studies employing any of these measures).
Follow recommended cleaning, disinfection and sterilization guidelines for maintaining patient care areas and equipment. Dedicate noncritical medical items to use on individual patients known to be infected or colonized with an MDRO. Prioritize room cleaning of patients on CP.

Focus on cleaning and disinfecting frequently touched surfaces (eg, bed rails, bedside commodes, bathroom fixtures in patient room, doorknobs) and equipment in immediate vicinity of patient.

Not recommended routinely.
Consult with experts on a case-by-case basis regarding the appropriate use of decolonization therapy for patients or staff during limited period of time as a component of an intensified MRSA control program (II). When decolonization for MRSA testing for the decolonizing agent against the target organism or the MDRO strain epidemiologically implicated in transmission. Monitor susceptibility to detect emergence of resistance to the decolonizing agent. Consult with microbiologists for appropriate testing for mupirocin resistance because standards have not been established. Do not use topical mupirocin routinely for MRSA decolonization of patients as a source of ongoing transmission. Use of CP: Implement CP routinely before or upon entry to patient's room or cubicle (IB). In LTCFs, modify CP to allow MRSA-colonized/infected patients whose site of colonization or infection can be appropriately contained and who can observe good hand hygiene practices to enter common areas and participate in group activities. When active surveillance cultures are obtained as part of an intensified MRSA control program, implement CP until the surveillance culture is reported negative for the target MDRO (IB). No recommendation is made for universal use of gloves and/or masks (Unresolved issue). Implement policies for patient admission and placement as needed to prevent transmission of the problem MDRO (IB). When single-patient rooms are available, assign priority for these rooms to patients with known or suspected MDRO colonization or infection. Give highest priority to those patients who have conditions that may facilitate transmission, eg, uncontained secretions or excretions. When single-patient rooms are not available, cohort patients with the same MDRO in the same room or patient care area (IB). 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 from infection and are likely to have short lengths of stay (II). Stop new admissions to the unit or facility if transmission continues despite the implementation of the intensified control measures (IB).

Review the role of antimicrobial use in perpetuating the MDRO problem targeted for intensified intervention. Control and improve antimicrobial use as indicated. Antimicrobial agents that may be targeted include vancomycin, third-generation cephalosporins, antianaerobic agents for VRE; third-generation cephalosporins for ESBLs; and quinolones and carbapenems (IB).

Calculate and analyze incidence rates of target MDROs (single isolates/patient; location and service specific) (IB). Increase frequency of compiling, monitoring antimicrobial susceptibility summary reports (II). Implement laboratory protocols for storing isolates of selected MDROs for molecular typing; perform typing if needed (IB). Develop and implement protocols to obtain active surveillance cultures from patients in populations at risk (IB). (See recommendations for appropriate body sites and culturing methods.) Conduct culture surveys to assess efficacy of intensified MDRO control interventions. Conduct serial (eg, weekly) unit-specific point prevalence culture surveys of the target MDRO to determine whether transmission has decreased or ceased (IB). Repeat point-prevalence culture surveys at routine intervals and at time of patient discharge or transfer until transmission has ceased (IB). If indicated by assessment of the MDRO problem, collect cultures to assess the colonization status of roommates and other patients with substantial exposure to patients with known MDRO infection or colonization (IB). Obtain cultures from HCP for target MDROs when there is epidemiologic evidence implicating the staff member as a source of ongoing transmission (IB).

NOTE. Institute 1 or more of the interventions described in Tier 2 when (1) incidence or prevalence of MDROs are not decreasing despite the use of routine control measures or (2) the first case or outbreak of an epidemiologically important MDRO (eg, VRE, MRSA, VISA, VRSA, MDR-GNB) is identified within a health care facility or unit (IB). Continue to monitor the incidence of target MDRO infection and colonization; if rates do not decrease, implement additional interventions as needed to reduce MDRO transmission. CP, contact precautions; CPOE, computerized physician order entry.
been associated with changes in antimicrobial use.\textsuperscript{219} 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.\textsuperscript{193,220} Limiting antimicrobial use alone may fail to control resistance because of a combination of factors, including (1) the relative effect of antimicrobials on providing initial selective pressure, compared with perpetuating resistance once it has emerged; (2) inadequate limits on usage; or (3) insufficient time to observe the impact of this intervention. With the intent of addressing numbers 2 and 3 above in the study design, one study demonstrated a decrease in the prevalence of VRE associated with a formulary switch from ticarcillin-clavulanate to piperacillin-tazobactam.\textsuperscript{221}

The CDC Campaign to Prevent Antimicrobial Resistance that was launched in 2002 provides evidence-based principles for judicious use of antimicrobials and tools for implementation\textsuperscript{222} (www.cdc.gov/drugresistance/healthcare). This effort targets all health care settings and focuses on effective antimicrobial treatment of infections, use of narrow-spectrum agents, treatment of infections and not contaminants, avoiding excessive duration of therapy, and restricting use of broad-spectrum or more potent antimicrobials to treatment of serious infections when the pathogen is not known or when other effective agents are unavailable. Achieving these objectives would likely diminish the selective pressure that favors proliferation of MDROs. Strategies for influencing antimicrobial prescribing patterns within health care facilities include education; formulary restriction; prior approval programs, including preapproved indications; automatic stop orders; academic interventions to counteract pharmaceutical influences on prescribing patterns; antimicrobial cycling\textsuperscript{223-226}, computer-assisted management programs\textsuperscript{227-229}, and active efforts to remove redundant antimicrobial combinations.\textsuperscript{230} A systematic review of controlled studies identified several successful practices. These include social marketing (ie, consumer education), practice guidelines, authorization systems, formulary restriction, mandatory consultation, and peer review and feedback. It further suggested that online systems that provide clinical information, structured order entry, and decision support are promising strategies.\textsuperscript{231} These changes are best accomplished through an organizational, multidisciplinary, antimicrobial management program.\textsuperscript{232}

**MDRO surveillance.** Surveillance is a critically important component of any MDRO control program, allowing detection of newly emerging pathogens, monitoring epidemiologic trends, and measuring the effectiveness of interventions. Multiple MDRO surveillance strategies have been employed, ranging from surveillance of clinical microbiology laboratory results obtained as part of routine clinical care to use of ASC to detect asymptomatic colonization.

**Surveillance for MDROs isolated from routine clinical cultures: antibiograms**

The simplest form of MDRO surveillance is monitoring of clinical microbiology isolates resulting from tests ordered as part of routine clinical care. This method is particularly useful to detect emergence of new MDROs not previously detected, either within an individual health care facility or community wide. In addition, this information can be used to prepare facility- or unit-specific summary antimicrobial susceptibility reports that describe pathogen-specific prevalence of resistance among clinical isolates. Such reports may be useful to monitor for changes in known resistance patterns that might signal emergence or transmission of MDROs and also to provide clinicians with information to guide antimicrobial prescribing practices.\textsuperscript{233-235}

**MDRO incidence based on clinical culture results**

Some investigators have used clinical microbiology results to calculate measures of incidence of MDRO isolates in specific populations or patient care locations (eg, new MDRO isolates/1000 patient-days, new MDRO isolates per month).\textsuperscript{205,236,237} Such measures may be useful for monitoring MDRO trends and assessing the impact of prevention programs, although they have limitations. Because they are based solely on positive culture results without accompanying clinical information, they do not distinguish colonization from infection and may not fully demonstrate the burden of MDRO-associated disease. Furthermore, these measures do not precisely measure acquisition of MDRO colonization in a given population or location. Isolating a MDRO from a clinical culture obtained from a patient several days after admission to a given unit or facility does not establish that the patient acquired colonization in that unit. On the other hand, patients who acquire MDRO colonization may remain undetected by clinical cultures.\textsuperscript{107} Despite these limitations, incidence measures based on clinical culture results may be highly correlated with actual MDRO transmission rates derived from information using ASC, as demonstrated in a recent multicenter study.\textsuperscript{237} These results suggest that incidence measures based on clinical cultures alone might be useful surrogates for monitoring changes in MDRO transmission rates.

**MDRO infection rates**

Clinical cultures can also be used to identify targeted MDRO infections in certain patient populations or...
units. This strategy requires investigation of clinical circumstances surrounding a positive culture to distinguish colonization from infection, but it can be particularly helpful in defining the clinical impact of MDROs within a facility.

**Molecular typing of MDRO isolates**

Many investigators have used molecular typing of selected isolates to confirm clonal transmission to enhance understanding of MDRO transmission and the effect of interventions within their facility.

**Surveillance for MDROs by detecting asymptomatic colonization**

Another form of MDRO surveillance is the use of ASC to identify patients who are colonized with a targeted MDRO. This approach is based on the observation that, for some MDROs, detection of colonization may be delayed or missed completely if culture results obtained in the course of routine clinical care are the primary means of identifying colonized patients. Several authors report having used ASC when new pathogens emerge to define the epidemiology of the particular agent. In addition, the authors of several reports have concluded that ASC, in combination with use of contact precautions for colonized patients, contributed directly to the decline or eradication of the target MDRO. However, not all studies have reached the same conclusion. Poor control of MRSA despite use of ASC has been described. A recent study failed to identify cross transmission of MRSA or MSSA in a MICU during a 10-week period when ASC were obtained, despite the fact that culture results were not reported to the staff. The investigators suggest that the degree of cohorting and adherence to standard precautions might have been the important determinants of transmission prevention, rather than the use of ASC and contact precautions for MRSA-colonized patients. The authors of a systematic review of the literature on the use of isolation measures to control health care-associated MRSA concluded that there is evidence that concerted efforts that include ASC and isolation can reduce MRSA even in endemic settings. However, the authors also noted that methodologic weaknesses and inadequate reporting in published research make it difficult to rule out plausible alternative explanations for reductions in MRSA acquisition associated with these interventions and therefore concluded that the precise contribution of active surveillance and isolation alone is difficult to assess.

Mathematical modeling studies have been used to estimate the impact of ASC use in control of MDROs. One such study evaluating interventions to decrease VRE transmission indicated that use of ASC (vs no cultures) could potentially decrease transmission 39% and that, with preemptive isolation plus ASC, transmission could be decreased 65%. Another mathematical model examining the use of ASC and isolation for control of MRSA predicted that isolating colonized or infected patients on the basis of clinical culture results is unlikely to be successful at controlling MRSA, whereas use of active surveillance and isolation can lead to successful control, even in settings in which MRSA is highly endemic. There is less literature on the use of ASC in controlling MDR-GNBs. Active surveillance cultures have been used as part of efforts to successful control of MDR-GNBs in outbreak settings. The experience with ASC as part of successful control efforts in endemic settings is mixed. One study reported successful reduction of extended-spectrum β-lactamase-producing Enterobacteriaceae over a 6-year period using a multifaceted control program that included use of ASC. Other reports suggest that use of ASC is not necessary to control endemic MDR-GNBs.

More research is needed to determine the circumstances under which ASC are most beneficial but their use should be considered in some settings, especially if other control measures have been ineffective. When use of ASC is incorporated into MDRO prevention programs, the following should be considered:

- The decision to use ASC as part of an infection prevention and control program requires additional support for successful implementation, including the following: (1) personnel to obtain the appropriate cultures, (2) microbiology laboratory personnel to process the cultures, (3) mechanism for communicating results to caregivers, (4) concurrent decisions about use of additional isolation measures triggered by a positive culture (eg, contact precautions), and (5) mechanism for assuring adherence to the additional isolation measures.

- The populations targeted for ASC are not well-defined and vary among published reports. Some investigators have chosen to target specific patient populations considered at high risk for MDRO colonization based on factors such as location (eg, ICU with high MDRO rates), antibiotic exposure history, presence of underlying diseases, prolonged duration of stay, exposure to other MDRO-colonized patients, patients transferred from other facilities known to have a high prevalence of MDRO carriage, or having a history of recent hospital or nursing home stays.

A more commonly employed strategy involves obtaining surveillance cultures from all patients admitted to units experiencing high rates of
colonization/infection with the MDROs of interest, unless they are already known to be MDRO carriers.\textsuperscript{153,184,242,254} In an effort to better define target populations for active surveillance, investigators have attempted to create prediction rules to identify subpopulations of patients at high risk for colonization on hospital admission.\textsuperscript{255,256} Decisions about which populations should be targeted for active surveillance should be made in the context of local determinations of the incidence and prevalence of MDRO colonization within the intervention facility as well as other facilities with which patients are frequently exchanged.\textsuperscript{257}

- Optimal timing and interval of ASC are not well-defined. In many reports, cultures were obtained at the time of admission to the hospital or intervention unit or at the time of transfer to or from designated units (eg, ICU).\textsuperscript{107} In addition, some hospitals have chosen to obtain cultures on a periodic basis (eg, weekly\textsuperscript{8,153,159},) to detect silent transmission. Others have based follow-up cultures on the presence of certain risk factors for MDRO colonization, such as antibiotic exposure, exposure to other MDRO colonized patients, or prolonged duration of stay in a high-risk unit.\textsuperscript{253}

- Methods for obtaining ASC must be carefully considered and may vary depending on the MDRO of interest:
  - MRSA: Studies suggest that cultures of the nares identify most patients with MRSA and that perirectal and wound cultures can identify additional carriers.\textsuperscript{152,258-261}
  - VRE: Stool, rectal, or perirectal swabs are generally considered a sensitive method for detection of VRE. Although one study suggested that rectal swabs may identify only 60% of individuals harboring VRE, and may be affected by VRE stool density,\textsuperscript{262} this observation has not been reported elsewhere in the literature.
  - MDR-GNBs: Several methods for detection of MDR-GNBs have been employed, including use of perirectal or rectal swabs alone or in combination with oropharyngeal, endotracheal, inguinal, or wound cultures. The absence of standardized screening media for many gram-negative bacilli can make the process of isolating a specific MDR-GNB a relatively labor-intensive process.\textsuperscript{38,190,241,250}
  - Rapid detection methods: Using conventional culture methods for active surveillance can result in a delay of 2 to 3 days before results are available. If the infection control precautions (eg, contact precautions) are withheld until the results are available, the desired infection control measures could be delayed. If empiric precautions are used pending negative surveillance culture results, precautions may be unnecessarily implemented for many, if not most, patients. For this reason, investigators have sought methods for decreasing the time necessary to obtain a result from ASC. Commercially available media containing chromogenic enzyme substrates (CHROMagar MRSA\textsuperscript{265,266}) has been shown to have high sensitivity and specificity for identification of MRSA and facilitate detection of MRSA colonies in screening cultures as early as 16 hours after inoculation. In addition, real-time polymerase chain reaction-based tests for rapid detection of MRSA directly from culture swabs (< 1-2 hours) are now commercially available,\textsuperscript{265-267} as well as polymerase chain reaction-based tests for detection of vanA and vanB genes from rectal swabs.\textsuperscript{268} The impact of rapid testing on the effectiveness of active surveillance as a prevention strategy, however, has not been fully determined. Rapid identification of MRSA in one study was associated with a significant reduction in MRSA infections acquired in the medical ICU but not the surgical ICU.\textsuperscript{265} A mathematical model characterizing MRSA transmission dynamics predicted that, in comparison with conventional culture methods, the use of rapid detection tests may decrease isolation needs in settings of low endemicity and result in more rapid reduction in prevalence in highly endemic settings.\textsuperscript{249}

- Some MDRO control reports described surveillance cultures of HCP during outbreaks, but colonized or infected HCP are rarely the source of ongoing transmission, and this strategy should be reserved for settings in which specific HCP have been epidemiologically implicated in the transmission of MDROs.\textsuperscript{38,92,152-154,188}

Infection control precautions. Since 1996, the CDC has recommended the use of standard and contact precautions for MDROs “judged by an infection control program...to be of special clinical and epidemiologic significance.” This recommendation was based on general consensus and was not necessarily evidence based. No studies have directly compared the efficacy of standard precautions alone versus standard precautions and contact precautions, with or without ASC, 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 study intervention.\textsuperscript{164,190,205,269-271} The NIH-sponsored study mentioned earlier (section: Overview of the MDRO control literature) may provide some answers, http://clinicaltrials.gov/ct/show/NCT00100386?order=1).
Standard precautions have 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; even surveillance cultures may fail to identify colonized persons because of lack of sensitivity, laboratory deficiencies, or intermittent colonization because of antimicrobial therapy. Therefore, standard precautions must be used to prevent transmission from potentially colonized patients. Hand hygiene is an important component of standard precautions. The authors of the Guideline for Hand Hygiene in Healthcare Settings cited 9 studies that demonstrated a temporal relationship between improved adherence to recommended hand hygiene practices and control of MDROs. It is noteworthy that, in one report, the frequency of hand hygiene did not improve with use of contact precautions but did improve when gloves were used (per standard precautions) for contact with MDRO patients.

MDRO control efforts frequently involved changes in isolation practices, especially during outbreaks. In the majority of reports, contact precautions were implemented for all patients found to be colonized or infected with the target MDRO (see Table 2).

Some facilities also preemptively used contact precautions, in conjunction with ASC, for all new admissions or for all patients admitted to a specific unit, until a negative screening culture for the target MDRO was reported. Contact precautions are intended to prevent transmission of infectious agents, including epidemiologically important microorganisms, which are transmitted by direct or indirect contact with the patient or the patient’s environment. A single-patient room is preferred for patients who require contact precautions. When a single-patient room is not available, consultation with infection control is necessary to assess the various risks associated with other patient placement options (eg, cohorting, keeping the patient with an existing roommate). HCP caring for patients on contact precautions should wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient’s environment. Donning gown and gloves upon room entry and discarding before exiting the patient room is done to contain pathogens, especially those that have been implicated in transmission through environmental contamination (eg, VRE, C difficile, noroviruses and other intestinal tract agents; respiratory syncytial virus).

Cohorting and other MDRO control strategies

In several reports, cohorting of patients, use of designated beds or units, and even unit closure were necessary to control transmission. Some authors indicated that implementation of the latter 2 strategies were the turning points in their control efforts; however, these measures usually followed many other actions to prevent transmission. In one, 2-center study, moving MRSA-positive patients into single rooms or cohorting these patients in designated bays failed to reduce transmission in ICUs. However, in this study, adherence to recommendations for hand hygiene between patient contacts was only 21%. Other published studies, including one commissioned by the American Institute of Architects and the Facility Guidelines Institute (www.aia.org/aaah_gd_hospcons), have documented a beneficial relationship between private rooms and reduction in risk of acquiring MDROs. Additional studies are needed to define the specific contribution of using single-patient rooms and/or cohorting on preventing transmission of MDROs.

Duration of contact precautions

The necessary duration of contact precautions for patients treated for infection with an MDRO, but who may continue to be colonized with the organism at one or more body sites, remains an unresolved issue. Patients may remain colonized with MDROs for prolonged periods; shedding of these organisms may be intermittent, and surveillance cultures may fail to detect their presence. The 1995 HICPAC guideline for preventing the transmission of VRE suggested 3 negative stool/perianal cultures obtained at weekly intervals as a criterion for discontinuation of contact precautions. One study found these criteria generally reliable. However, this and other studies have noted a recurrence of VRE-positive cultures in persons who subsequently received antimicrobial therapy, and persistent or intermittent carriage of VRE for more than 1 year has been reported. Similarly, colonization with MRSA can be prolonged. Studies demonstrating initial clearance of MRSA following decolonization therapy have reported a high frequency of subsequent carriage. There is a paucity of information in the literature on when to discontinue contact precautions for patients colonized with a MDR-GNB, possibly because infection and colonization with these MDROs are often associated with outbreaks. Despite the uncertainty about when to discontinue contact precautions, the studies offer some guidance. In the context of an outbreak, prudence would dictate that contact precautions be used indefinitely for all previously infected and known colonized patients. Likewise, if ASC are used to detect and isolate patients colonized with MRSA or VRE, and there is no decolonization of...
these patients, it is logical to assume that contact precautions would be used for the duration of stay in the setting in which they were first implemented. In general, it seems reasonable to discontinue contact precautions when 3 or more surveillance cultures for the target MDRO are repeatedly negative over the course of a week or 2 in a patient who has not received antimicrobial therapy for several weeks, especially in the absence of a draining wound, profuse respiratory secretions, or evidence implicating the specific patient in ongoing transmission of the MDRO within the facility.

**Impact of contact precautions on patient care and well-being**

There are limited data regarding the impact of contact precautions on patients. Two studies found that HCP, including attending physicians, were half as likely to enter the rooms or examine patients on contact precautions. Other investigators have reported similar observations on surgical wards. Two studies reported that patients in private rooms and on barrier precautions for an MDRO had increased anxiety and depression scores. Another study found that patients placed on contact precautions for MRSA 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. Therefore, when patients are placed on contact precautions, efforts must be made by the health care team to counteract these potential adverse effects.

**Barriers used for contact with patients infected or colonized with MDROs**

Three studies evaluated the use of gloves with or without gowns for all patient contacts to prevent VRE acquisition in ICU settings. Two of the studies showed that use of both gloves and gowns reduced VRE transmission, whereas the third showed no difference in transmission based on the barriers used. One study in a LTCF compared the use of gloves only with gloves plus contact isolation for patients with 4 MDROs, including VRE and MRSA, and found no difference. However, patients on contact isolation were more likely to acquire MDR-K pneumoniae strains that were prevalent in the facility; reasons for this were not specifically known. In addition to differences in outcome, differing methodologies make comparisons difficult. Specifically, HCP adherence to the recommended protocol, influence of added precautions on the number of HCP-patient interactions, and colonization pressure were not consistently assessed.

**Environmental measures.** The potential role of environmental reservoirs, such as surfaces and medical equipment, in the transmission of VRE and other MDROs has been the subject of several reports. Although environmental cultures are not routinely recommended, environmental cultures were used in several studies to document contamination and led to interventions that included the use of dedicated noncritical medical equipment. Assignment of dedicated cleaning personnel to the affected patient care unit, and increased cleaning and disinfection of frequently touched surfaces (eg, bed rails, charts, bedside commodes, doorknobs). A common reason given for finding environmental contamination with a MDRO was the lack of adherence to facility procedures for cleaning and disinfection. In an educational and observational intervention, which targeted a defined group of housekeeping personnel, there was a persistent decrease in the acquisition of VRE in a medical ICU. Therefore, monitoring for adherence to recommended environmental cleaning practices is an important determinant for success in controlling transmission of MDROs and other pathogens in the environment.

In the MDRO reports reviewed, enhanced environmental cleaning was frequently undertaken when there was evidence of environmental contamination and ongoing transmission. Rarely, control of the target MDRO required vacating a patient care unit for complete environmental cleaning and assessment.

**Decolonization.** Decolonization entails treatment of persons colonized with a specific MDRO, usually MRSA, to eradicate carriage of that organism. Although some investigators have attempted to decolonize patients harboring VRE, few have achieved success. However, decolonization of persons carrying MRSA in their nares has proved possible with several regimens that include topical mupirocin alone or in combination with orally administered antibiotics (eg, rifampin in combination with trimethoprim-sulfamethoxazole or ciprofloxacin) plus the use of an antimicrobial soap for bathing. In one report, a 3-day regimen of baths with povidone-iodine and nasal therapy with mupirocin resulted in eradication of nasal MRSA colonization. These and other methods of MRSA decolonization have been thoroughly reviewed.

Decolonization regimens are not sufficiently effective to warrant routine use. Therefore, most health care facilities have limited the use of decolonization to MRSA outbreaks, or other high-prevalence situations, especially those affecting special care units. Several factors limit the utility of this control measure on a widespread basis: (1) identification of candidates for decolonization requires surveillance cultures; (2) candidates receiving decolonization treatment must...
receive follow-up cultures to ensure eradication; and (3) recolonization with the same strain, initial colonization with a mupirocin-resistant strain, and emergence of resistance to mupirocin during treatment can occur. HCP implicated in transmission of MRSA are candidates for decolonization and should be treated and culture negative before returning to direct patient care. In contrast, HCP who are colonized with MRSA, but are asymptomatic, and have not been linked epidemiologically to transmission, do not require decolonization.

DISCUSSION

This review demonstrates the depth of published science on the prevention and control of MDROs. Using a combination of interventions, MDROs in endemic, outbreak, and nonendemic settings have been brought under control. However, despite the volume of literature, an appropriate set of evidence-based control measures that can be universally applied in all health care settings has not been definitively established. This is due in part to differences in study methodology and outcome measures, including an absence of randomized controlled trials comparing one MDRO control measure or strategy with another. Additionally, the data are largely descriptive and quasiexperimental in design. Few reports described preemptive efforts or prospective studies to control MDROs before they had reached high levels within a unit or facility. Furthermore, small hospitals and LTCFs are infrequently represented in the literature. A number of questions remain and are discussed below.

Impact on other MDROs from interventions targeted to 1 MDRO

Only 1 report described control efforts directed at more than 1 MDRO, ie, MDR-GNB and MRSA. Several reports have shown either decreases or increases in other pathogens with efforts to control 1 MDRO. For example, 2 reports on VRE control efforts demonstrated an increase in MRSA following the prioritization of VRE patients to private rooms and cohort beds. Similarly, an outbreak of *Serratia marcescens* was temporally associated with a concurrent, but unrelated, outbreak of MRSA in a NICU. In contrast, Wright et al reported a decrease in MRSA and VRE acquisition in an ICU during and after their successful effort to eradicate an MDR strain of *A baumannii* from the unit.

Colonization with multiple MDROs appears to be common. One study found that nearly 50% of residents in a skilled care unit in a LTCF were colonized with a target MDRO and that 26% were coccolonized with >1 MDRO; a detailed analysis showed that risk factors for colonization varied by pathogen. One review of the literature reported that patient risk factors associated with colonization with MRSA, VRE, MDR-GNB, *C difficile*, and *Candida* species were the same. This review concluded that control programs that focus on only 1 organism or 1 antimicrobial drug are unlikely to succeed because vulnerable patients will continue to serve as a magnet for other MDROs.

Costs

Several authors have provided evidence for the cost-effectiveness of approaches that use ASC. However, the supportive evidence often relied on assumptions, projections, and estimated attributable costs of MDRO infections. Similar limitations apply to a study suggesting that gown use yields a cost benefit in controlling transmission of VRE in ICUs. To date, no studies have directly compared the benefits and costs associated with different MDRO control strategies.

Feasibility

The subject of feasibility, as it applies to the extrapolation of results to other health care settings, has not been addressed. For example, smaller hospitals and LTCFs may lack the on-site laboratory services needed to obtain ASC in a timely manner. This factor could limit the applicability of an aggressive program based on obtaining ASC and preemptive placement of patients on contact precautions in these settings. However, with the growing problem of antimicrobial resistance, and the recognized role of all health care settings for control of this problem, it is imperative that appropriate human and fiscal resources be invested to increase the feasibility of recommended control strategies in every setting.

Factors that influence selection of MDRO control measures

Although some common principles apply, the preceding literature review indicates that no single approach to the control of MDROs is appropriate for all health care facilities. Many factors influence the choice of interventions to be applied within an institution, including the following:

- Type and significance of problem MDROs within the institution. Many facilities have a MRSA problem, whereas others have ESBL-producing *K 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. The magnitude of the problem also varies. Health care facilities may have very low numbers of cases,
eg, with a newly introduced strain, or may have prolonged, extensive outbreaks or colonization in the population. Between these extremes, facilities may have low or high levels of endemic colonization and variable levels of infection.

- Population and health care settings. The presence of high-risk patients (eg, transplant, hematopoietic stem-cell transplant) and special care units (eg, adult, pediatric, and neonatal ICUs; burn; hemodialysis) will influence surveillance needs and could limit the areas of a facility targeted for MDRO control interventions. Although it appears that MDRO transmission seldom occurs in ambulatory and outpatient settings, some patient populations (eg, hemodialysis, cystic fibrosis) and patients receiving chemotherapy agents are at risk for colonization and infection with MDROs. Furthermore, the emergence of VRSA within the outpatient setting demonstrates that even these settings need to make MDRO prevention a priority.

Differences of opinion on the optimal strategy to control MDROs

Published guidance on the control of MDROs reflects areas of ongoing debate on optimal control strategies. A key issue is the use of ASC in control efforts and preemptive use of contact precautions pending negative surveillance culture results. The various guidelines currently available exhibit a spectrum of approaches, which their authors deem to be evidence based. One guideline for control of MRSA and VRE, the Society for Healthcare Epidemiology of America (SHEA) guideline from 2003, emphasizes routine use of ASC and contact precautions. That position paper does not address control of MDR-GNBs. The salient features of SHEA recommendations for MRSA and VRE control and the recommendations in this guideline for control of MDROs, including MRSA and VRE, have been compared; recommended interventions are similar. Other guidelines for VRE and MRSA, eg, those proffered by the Michigan Society for Infection Control (www.msiconline.org/resource_sections/aro_guidelines), emphasize consistent practice of standard precautions and tailoring the use of ASC and contact precautions to local conditions, the specific MDROs that are prevalent and being transmitted, and the presence of risk factors for transmission. A variety of approaches have reduced MDRO rates. Therefore, selection of interventions for controlling MDRO transmission should be based on assessments of the local problem, prevalence of various MDRO, and feasibility. Individual facilities should seek appropriate guidance and adopt effective measures that fit their circumstances and needs. Most studies have been in acute care settings; for nonacute care settings (eg, LCTF; small rural hospitals), the optimal approach is not well-defined.

Two-tiered approach for control of MDROs

Reports describing successful control of MDRO transmission in health care facilities have included 7 categories of interventions (Table 3). As a rule, these reports indicate that facilities confronted with a MDRO problem selected a combination of control measures, implemented them, and reassessed their impact. In some cases, new measures were added serially to enhance further the control efforts. This evidence indicates that the control of MDROs is a dynamic process that requires a systematic approach tailored to the problem and health care setting. The nature of this evidence gave rise to the 2-tiered approach to MDRO control recommended in this guideline. This approach provides the flexibility needed to prevent and control MDRO transmission in every kind of facility addressed by this guideline. Detailed recommendations for MDRO control in all health care settings follow and are summarized in Table 3. Table 3, which applies to all health care settings, contains 2 tiers of activities. In the first tier is the baseline level of MDRO control activities designed to ensure recognition of MDROs as a problem, of involvement of health care administrators, and of provision of safeguards for managing unidentified carriers of MDROs.

With the emergence of a MDRO problem that cannot be controlled with the basic set of infection control measures, additional control measures should be selected from the second tier of interventions presented in Table 3. Decisions to intensify MDRO control activity arise from surveillance observations and assessments of the risk to patients in various settings. Circumstances that may trigger these decisions include the following:

- Identification of a MDRO from even 1 patient in a facility or special unit with a highly vulnerable patient population (eg, an ICU, NICU, burn unit) that had previously not encountered that MDRO.
- Failure to decrease the prevalence or incidence of a specific MDRO (eg, incidence of resistant clinical isolates) despite infection control efforts to stop its transmission. (Statistical process control charts or other validated methods that account for normal variation can be used to track rates of targeted MDROs).

The combination of new or increased frequency of MDRO isolates and patients at risk necessitates escalation of efforts to achieve or reestablish control, ie, to reduce rates of transmission to the lowest possible level.
Intensification of MDRO control activities should begin with an assessment of the problem and evaluation of the effectiveness of measures in current use. Once the problem is defined, appropriate additional control measures should be selected from the second tier of Table 3. A knowledgeable infection prevention and control professional or health care epidemiologist should make this determination. This approach requires support from the governing body and medical staff of the facility. Once interventions are implemented, ongoing surveillance should be used to determine whether selected control measures are effective and whether additional measures or consultation are indicated. The result of this process should be to decrease MDRO rates to minimum levels. Health care facilities must not accept ongoing MDRO outbreaks or high endemic rates as the status quo. With selection of infection control measures appropriate to their situation, all facilities can achieve the desired goal and reduce the MDRO burden substantially.

PREVENTION OF TRANSMISSION OF MDROS

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.

V.A. General recommendations for all health care settings independent of the prevalence of MDRO infections or the population served.

V.A.1. Administrative measures.

V.A.1.a. Make MDRO prevention and control an organizational patient safety priority. Category IB.

V.A.1.b. Provide administrative support, and both fiscal and human resources, to prevent and control MDRO transmission within the health care organization. Category IB.

V.A.1.c. In health care facilities without expertise for analyzing epidemiologic data, recognizing MDRO problems, or devising effective control strategies (eg, small or rural hospitals, rehabilitation centers, LTCFs, freestanding ambulatory centers), identify experts who can provide consultation as needed. Category II.

V.A.1.d. Implement systems to communicate information about reportable MDROs (eg, VRSA, VISA, MRSA, penicillin-resistant S pneumoniae) to administrative personnel and as required by state and local health authorities (www.cdc.gov/epo/dphsi/nndsshis.htm). Refer to Web sites for updated requirements of local and state health departments. Category II/IC.

V.A.1.e. Implement a multidisciplinary process to monitor and improve HCP adherence to recommended practices for standard and contact precautions. Category IB.

V.A.1.f. Implement systems to designate patients known to be colonized or infected with a targeted MDRO and to notify receiving health care facilities and personnel prior to transfer of such patients within or between facilities. Category IB.

V.A.1.g. Support participation of the facility or health care system in local, regional, and national coalitions to combat emerging or growing MDRO problems. Category IB.

V.A.1.h. Provide updated feedback at least annually to health care providers and administrators on facility and patient care unit trends in MDRO infections. Include information on changes in prevalence or incidence of infection, results of assessments for system failures, and action plans to improve adherence to and effectiveness of recommended infection control practices to prevent MDRO transmission. Category IB.

V.A.2. Education and training of HCP

V.A.2.a. Provide education and training on risks and prevention of MDRO transmission during orientation and periodic educational updates for HCP; include information on organizational experience with MDROs and prevention strategies. Category IB.

V.A.3. Judicious use of antimicrobial agents. The goal of the following recommendations is to ensure that systems are in place to promote optimal treatment of infections and appropriate antimicrobial use.

V.A.3.a. In hospitals and LTCFs, ensure that a multidisciplinary process is in place to review antimicrobial utilization, local susceptibility patterns (antibiograms), and antimicrobial agents included in the formulary to foster appropriate antimicrobial use. Category IB.

V.A.3.b. Implement systems (eg, computerized physician order entry, comment in microbiology susceptibility report, notification from a clinical pharmacist or unit director) to prompt clinicians to use the appropriate antimicrobial agent and regimen for the given
clinical situation.\textsuperscript{156,157,161,166,174,175,212,214,218,254,334,355,337,340-346} Category IB.

V.A.3.b.i. Provide clinicians with antimicrobial susceptibility reports and analysis of current trends, updated at least annually, to guide antimicrobial prescribing practices.\textsuperscript{342,347} Category IB.

V.A.3.b.ii. In settings that administer antimicrobial agents but have limited electronic communication systems to implement physician prompts (eg, LTCFs, home care, and infusion companies), implement a process for appropriate review of prescribed antimicrobials. Prepare and distribute reports to prescribers that summarize findings and provide suggestions for improving antimicrobial use.\textsuperscript{342,348,349} Category II.


V.A.4.a. In microbiology laboratories, use standardized laboratory methods and follow published guidance for determining antimicrobial susceptibility of targeted (eg, MRSA, VRE, MDR-ESBLs) and emerging (eg, VRS, MDR-Acinetobacter baumannii) MDROs.\textsuperscript{8,154,177,190,209,254,347,350-353} Category IB.

V.A.4.b. In all health care organizations, establish systems to ensure that clinical microbiology laboratories (in-house and outsourced) promptly notify infection control staff or a medical director/designee when a novel resistance pattern for that facility is detected.\textsuperscript{9,22,154,162,169} Category IB.

V.A.4.c. In hospitals and LTCFs, develop and implement laboratory protocols for storing isolates of selected MDROs for molecular typing when needed to confirm transmission or delineate the epidemiology of the MDRO within the health care setting.\textsuperscript{7,8,38,140,153,154,187,190,208,217,354,355} Category IB.

V.A.4.d. Prepare facility-specific antimicrobial susceptibility reports as recommended by the Clinical and Laboratory Standards Institute (CLSI) (www.phppo.cdc.gov/dls/master/default.aspx); monitor these reports for evidence of changing resistance patterns that may indicate the emergence or transmission of MDROs.\textsuperscript{347,351,356,357} Category IB/C.

V.A.4.d.i. In hospitals and LTCFs with special care units (eg, ventilator dependent, ICU, or oncology units), develop and monitor unit-specific antimicrobial susceptibility reports.\textsuperscript{358-361} Category IB.

V.A.4.d.ii. Establish a frequency for preparing summary reports based on volume of clinical isolates, with updates at least annually.\textsuperscript{347,362} Category III/C.

V.A.4.d.iii. In health care organizations that outsource microbiology laboratory services (eg, ambulatory care, home care, LTCFs, smaller acute care hospitals), specify by contract that the laboratory provides either facility-specific susceptibility data or local or regional aggregate susceptibility data to identify prevalent MDROs and trends in the geographic area served.\textsuperscript{363} Category II.

V.A.4.e. Monitor trends in the incidence of target MDROs in the facility over time using appropriate statistical methods to determine whether MDRO rates are decreasing and whether additional interventions are needed.\textsuperscript{152,154,183,195,205,209,217,242,300,325,326,364,365} Category IA.

V.A.4.e.i. Specify isolate origin (ie, location and clinical service) in MDRO monitoring protocols in hospitals and other large multunit facilities with high-risk patients.\textsuperscript{8,38,152,154,217,358,361} Category IB.

V.A.4.e.ii. Establish a baseline (eg, incidence) for targeted MDRO isolates by reviewing results of clinical cultures; if more timely or localized information is needed, perform baseline point prevalence studies of colonization in high-risk units. When possible, distinguish colonization from infection in analysis of these data.\textsuperscript{152,153,183,184,189,190,193,205,242,365} Category IB.

V.A.5. Infection control precautions to prevent transmission of MDROs.

V.A.5.a. Follow standard precautions during all patient encounters in all settings in which health care is delivered.\textsuperscript{119,164,255,315,316} Category IB.

V.A.5.b. Use masks according to standard precautions when performing splash-generating procedures (eg, wound irrigation, oral suctioning, intubation); when caring for patients with open tracheostomies and the potential for projectile secretions; and in circumstances in which there is evidence of transmission from heavily colonized sources (eg, burn wounds). Masks are not otherwise recommended for prevention of MDRO transmission from patients to HCP during routine care (eg, upon room entry).\textsuperscript{8,22,151,152,154,189,190,193,208,240,366} Category IB.

V.A.5.c. Use of contact precautions.

V.A.5.c.i. In acute care hospitals, implement contact precautions routinely for all patients infected with target MDROs and for patients who have been previously identified as being colonized with target MDROs (eg, patients transferred from other units or facilities who are known to be colonized).\textsuperscript{11,38,66,144,151,183,188,204,217,242,304} Category IB.

V.A.5.c.ii. In LTCFs, consider the individual patient’s clinical situation and prevalence or incidence of MDRO in the facility when deciding whether to implement or modify contact precautions in addition to standard precautions for a patient infected or colonized with a target MDRO. Category II.

V.A.5.c.ii.1. For relatively healthy residents (eg, mainly independent) follow standard precautions, making sure that gloves and gowns are used for contact with uncontrolled secretions, pressure ulcers, draining wounds, stool incontinence, and ostomy tubes/bags.\textsuperscript{78,80,85,151,367,368} Category II.

V.A.5.c.ii.2. For ill residents (eg, those totally dependent on HCP for health care and activities of daily
living, ventilator dependent) and for those residents whose infected secretions or drainage cannot be contained, use contact precautions in addition to standard precautions.\textsuperscript{316,369,370} Category II.

V.A.5.c.iii. For MDRO colonized or infected patients without draining wounds, diarrhea, or uncontrolled secretions, establish ranges of permitted ambulation, socialization, and use of common areas based on their risk to other patients and on the ability of the colonized or infected patients to observe proper hand hygiene and other recommended precautions to contain secretions and excretions.\textsuperscript{151,165,371} Category II.

V.A.5.d. In ambulatory settings, use standard precautions for patients known to be infected or colonized with target MDROs, making sure that gloves and gowns are used for contact with uncontrolled secretions, pressure ulcers, draining wounds, stool incontinence, and ostomy tubes and bags. Category II.

V.A.5.e. In home care settings, the following apply:

- Follow standard precautions making sure to use gowns and gloves for contact with uncontrolled secretions, pressure ulcers, draining wounds, stool incontinence, and ostomy tubes and bags. Category II.
- Limit the amount of reusable patient care equipment that is brought into the home of patients infected or colonized with MDROs. When possible, leave patient care equipment in the home until the patient is discharged from home care services. Category II.
- If noncritical patient care equipment (eg, 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 to another site for subsequent cleaning and disinfection. Category II.

V.A.5.e.i. No recommendation is made for routine use of gloves, gowns, or both to prevent MDRO transmission in ambulatory or home care settings. Unresolved issue.

V.A.5.e.ii. In hemodialysis units, follow the “Recommendations to Prevent Transmission of Infections in Chronic Hemodialysis patients”\textsuperscript{372} (www.cms.hhs.gov/home/regsguidance.asp). Category IC.

V.A.5.f. Discontinuation of contact precautions. No recommendation can be made regarding when to discontinue contact precautions. Unresolved issue (See Background section for discussion of options).

V.A.5.g. Patient placement in hospitals and LTCFs.

V.A.5.g.i. When single-patient rooms are available, assign priority for these rooms to patients with known or suspected MDRO colonization or infection. Give highest priority to those patients who have conditions that may facilitate transmission, eg, uncontained secretions or excretions.\textsuperscript{8,38,110,151,188,208,240,304} Category IB.

V.A.5.g.ii. When single-patient rooms are not available, cohort patients with the same MDRO in the same room or patient care area.\textsuperscript{8,38,92,151,153,162,183,184,188,217,242,304} Category IB.

V.A.5.g.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 from infection and are likely to have short lengths of stay. Category II.


V.A.6.a. Clean and disinfect surfaces and equipment that may be contaminated with pathogens, including those that are in close proximity to the patient (eg, bed rails, over bed tables) and frequently touched surfaces in the patient care environment (eg, doorknobs, surfaces in and surrounding toilets in patients’ rooms) on a more frequent schedule compared with that for minimal touch surfaces (eg, horizontal surfaces in waiting rooms).\textsuperscript{111,297,373} Category IB.

V.A.6.b. Dedicate noncritical medical items to use on individual patients known to be infected or colonized with MDROs.\textsuperscript{38,217,324,374,375} Category IB.

V.A.6.c. Prioritize room cleaning of patients on contact precautions. Focus on cleaning anddisinfecting frequently touched surfaces (eg, bed rails, bedside commodes, bathroom fixtures in the patient’s room, doorknobs) and equipment in the immediate vicinity of the patient.\textsuperscript{109,110,114-117,297,301,373,376,377} Category IB.

V.B. Intensified interventions to prevent MDRO transmission The interventions presented below have been utilized in various combinations to reduce transmission of MDROs in health care facilities. Neither the effectiveness of individual components nor that of specific combinations of control measures has been assessed in controlled trials. Nevertheless, various combinations of control elements selected under the guidance of knowledgeable content experts have repeatedly reduced MDRO transmission rates in a variety of health care settings.

V.B.1. Indications and approach.

V.B.1.a. Indications for intensified MDRO control efforts (VII.B.1.a.i and VII.B.1.a.ii) should result in selection and implementation of 1 or more of the interventions described in VII.B.2 to VII.B.8 below. Individualize the selection of control measures according to local considerations.\textsuperscript{8,11,38,68,114,152-154,185-185,189,190,193,194,209,217,242,312,364,365} Category IB.

V.B.1.ii. When incidence or prevalence of MDROs are not decreasing despite implementation of and correct adherence to the routine control measures described above, intensify MDRO control efforts by adopting 1 or more of the interventions described below.\textsuperscript{92,152,183,184,193,365} Category IB.
V.B.1.a.ii. When the first case or outbreak of an epidemiologically important MDRO (eg, VRE, MRSA, VISA, VRSA, MDR-GNB) is identified.

V.B.1.b. Continue to monitor the incidence of target MDRO infection and colonization after additional interventions are implemented. If rates do not decrease, implement more interventions as needed to reduce MDRO transmission.8,38,68,114,151-154,184,365 Category IB.

V.B.2. Administrative measures.

V.B.2.a. Identify persons with experience in infection control and the epidemiology of MDRO, 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.3,68,146,151-154,167,184,190,193,242,328,377 Category IB.

V.B.2.b. Provide necessary leadership, funding, and day-to-day oversight to implement interventions selected. Involve the governing body and leadership of the health care facility or system that have organizational responsibility for this and other infection control efforts.8,38,152,154,184,189,190,208 Category IB.

V.B.2.c. Evaluate health care system factors for their role in creating or perpetuating transmission of MDROs, including staffing levels, education and training, availability of consumable and durable resources, communication processes, policies and procedures, and adherence to recommended infection control measures (eg, hand hygiene and standard or contact precautions). Develop, implement, and monitor action plans to correct system failures.3,68,152,154,172,173,175,188,190,199,199,208,217,280,324,379,380 Category IB.

V.B.2.d. During the process, update health care providers and administrators on the progress and effectiveness of the intensified interventions. Include information on changes in prevalence, rates of infection, and colonization; results of assessments and corrective actions for system failures; degrees of adherence to recommended practices; and action plans to improve adherence to recommended infection control practices to prevent MDRO transmission.152,154,159,184,204,205,312,332,381 Category IB.

V.B.3. Educational interventions.

Intensify the frequency of MDRO educational programs for HCP, especially those who work in areas in which MDRO rates are not decreasing. Provide individual or unit-specific feedback when available.3,38,152,154,159,170,182,183,189,190,193,194,204,205,209,215,218,312 Category IB.


Review the role of antimicrobial use in perpetuating the MDRO problem targeted for intensified intervention. Control and improve antimicrobial use as indicated. Antimicrobial agents that may be targeted include vancomycin, third-generation cephalosporins, and antianaerobic agents for VRE; third-generation cephalosporins for ESBLs; and quinolones and carbapenems.80,156,166,174,175,209,218,242,254,529,354,355,357,341 Category IB.

V.B.5. Surveillance.

V.B.5.a. Calculate and analyze prevalence and incidence rates of targeted MDRO infection and colonization in populations at risk; when possible, distinguish colonization from infection.152,153,183,184,190,193,205,215,242,365 Category IB.

V.B.5.a.i. Include only 1 isolate per patient, not multiple isolates from the same patient, when calculating rates.347,382 Category II.

V.B.5.a.ii. Increase the frequency of compiling and monitoring antimicrobial susceptibility summary reports for a targeted MDRO as indicated by an increase in incidence of infection or colonization with that MDRO. Category II.

V.B.5.b. Develop and implement protocols to obtain ASC for targeted MDROs from patients in populations at risk (eg, patients in intensive care, burn, bone marrow/stem cell transplant, and oncology units; patients transferred from facilities known to have high MDRO prevalence rates; roommates of colonized or infected persons; and patients known to have been previously infected or colonized with an MDRO).8,38,68,114,151-154,167,168,183,184,187-190,192,193,217,242 Category IB.

V.B.5.b.i. Obtain ASC from areas of skin breakdown and draining wounds. In addition, include the following sites according to target MDROs:

V.B.5.b.i.1. For MRSA: Sampling the anterior nares is usually sufficient; throat, endotracheal tube aspirate, percutaneous gastrostomy sites, and perirectal or perineal cultures may be added to increase the yield. Swabs from several sites may be placed in the same selective broth tube prior to transport.117,385,384 Category IB.

V.B.5.b.i.2. For VRE: Stool, rectal, or perirectal samples should be collected.154,193,217,242 Category IB.

V.B.5.b.i.3. For MDR-GNB: Endotracheal tube aspirates or sputum should be cultured if a respiratory tract reservoir is suspected, eg, Acinetobacter species, Burkholderia species.385,386 Category IB.

V.B.5.b.ii. Obtain surveillance cultures for the target MDRO from patients at the time of admission to high-risk areas, eg, ICUs and at periodic intervals as needed to assess MDRO transmission.8,151,154,159,184,208,215,242,387 Category IB.

V.B.5.c. Conduct culture surveys to assess the efficacy of the enhanced MDRO control interventions.

V.B.5.c.i. Conduct serial (eg, weekly, until transmission has ceased and then decreasing frequency) unit-specific point prevalence culture surveys of the target MDRO to determine whether transmission has decreased or ceased.107,167,175,184,188,218,339 Category IB.
V.B.5.c.ii. Repeat point-prevalence culture surveys at routine intervals or at time of patient discharge or transfer until transmission has ceased. Category IB.

V.B.5.c.iii. If indicated by assessment of the MDRO problem, collect cultures to assess the colonization status of roommates and other patients with substantial exposure to patients with known MDRO infection or colonization. Category IB.

V.B.5.d. Obtain cultures of HCP for target MDRO when there is epidemiologic evidence implicating the health care staff member as a source of ongoing transmission. Category IB.


V.B.6.a. Use of contact precautions.

V.B.6.a.i. Implement contact precautions routinely for all patients colonized or infected with a target MDRO. Category IA.

V.B.6.a.ii. Because environmental surfaces and medical equipment, especially those in close proximity to the patient, may be contaminated, don gowns and gloves before or upon entry to the patient’s room or cubicle. Category IB.

V.B.6.a.iii. In LTCFs, modify contact precautions to allow MDRO-colonized/infected patients whose site of colonization or infection can be appropriately contained and who can observe good hand hygiene practices to enter common areas and participate in group activities. Category IB.

V.B.6.b. When ASC are obtained as part of an intensified MDRO control program, implement contact precautions until the surveillance culture is reported negative for the target MDRO. Category IB.

V.B.6.c. No recommendation is made regarding universal use of gloves, gowns, or both in high-risk units in acute care hospitals. Unresolved issue.

V.B.7. Implement policies for patient admission and placement as needed to prevent transmission of a problem MDRO. Category IB.

V.B.7.a.i. Place MDRO patients in single-patient rooms. Category IB.

V.B.7.a.ii. Cohort patients with the same MDRO in designated areas (eg, rooms, bays, patient care areas). Category IB.

V.B.7.a.iii. When transmission continues despite adherence to standard and contact precautions and cohorting patients, assign dedicated nursing and ancillary service staff to the care of MDRO patients only. Some facilities may consider this option when intensified measures are first implemented. Category IB.

V.B.7.a.iv. Stop new admissions to the unit of facility if transmission continues despite the implementation of the enhanced control measures described above. (Refer to state or local regulations that may apply upon closure of hospital units or services.) Category IB.

V.B.8. Enhanced environmental measures.

V.B.8.a. Implement patient-dedicated or single-use disposable noncritical equipment (eg, blood pressure cuff, stethoscope) and instruments and devices. Category IB.

V.B.8.b. Intensify and reinforce training of environmental staff who work in areas targeted for intensified MDRO control and monitor adherence to environmental cleaning policies. Some facilities may choose to assign dedicated staff to targeted patient care areas to enhance consistency of proper environmental cleaning and disinfection services. Category IB.

V.B.8.c. Monitor (ie, supervise and inspect) cleaning performance to ensure consistent cleaning and disinfection of surfaces in close proximity to the patient and those likely to be touched by the patient and HCP (eg, bed rails, carts, bedside commodes, doorknobs, faucet handles). Category IB.

V.B.8.d. Obtain environmental cultures (eg, surfaces, shared medical equipment) when there is epidemiologic evidence that an environmental source is associated with ongoing transmission of the targeted MDRO. Category IB.

V.B.8.e. Vacate units for environmental assessment and intensive cleaning when previous efforts to eliminate environmental reservoirs have failed. Category II.


V.B.9.a. Consult with physicians with expertise in infectious diseases and/or health care epidemiology on a case-by-case basis regarding the appropriate use of decolonization therapy for patients or staff during limited periods of time, as a component of an intensified MRSA control program. Category II.

V.B.9.b. When decolonization for MRSA is used, perform susceptibility testing for the decolonizing agent against the target organism in the individual being treated or the MDRO strain that is epidemiologically implicated in transmission. Monitor susceptibility to detect emergence of resistance to the decolonizing agent. Consult with a microbiologist for appropriate testing for mupirocin resistance because standards have not been established. Category IB.
V.B.9.b.i. Because mupirocin-resistant strains may emerge and because it is unusual to eradicate MRSA when multiple body sites are colonized, do not use topical mupirocin routinely for MRSA decolonization of patients as a component of MRSA control programs in any health care setting. Category IB.

V.B.9.b.ii. Limit decolonization of HCP found to be colonized with MRSA to persons who have been epidemiologically linked as a likely source of ongoing transmission to patients. Consider reassignment of HCP.

V.B.9.c. No recommendation can be made for decolonizing patients with VRE or MDR-GNB. Regimens and efficacy of decolonization protocols for VRE and MDR-GNB have not been established. Unresolved issue.

Glossary: MDROs

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

Cohorting: In the context of this guideline, this term applies to the practice of grouping patients infected or colonized with the same infectious agent together to confine their care to 1 area and prevent contact with susceptible patients (cohorting patients). During outbreaks, HCP may be assigned to a cohort of patients to limit further the opportunities for transmission (cohorting staff).

Contact precautions: Contact precautions are a set of practices used to prevent transmission of infectious agents that are spread by direct or indirect contact with the patient or the patient’s environment. Contact precautions also apply where the presence of excessive wound drainage, fecal incontinence, or other discharges from the body suggest an increased transmission risk. A single-patient room is preferred for patients who require contact precautions. When a single-patient room is not available, consultation with infection control is helpful to assess the various risks associated with other patient placement options (eg, cohorting, keeping the patient with an existing roommate). In multipatient rooms, ≥5 feet spatial separation of between beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients. HCP caring for patients on contact precautions wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient’s environment. Donning of gown and gloves upon room entry, removal before exiting the patient room, and performance of hand hygiene immediately upon exiting are done to contain pathogens.

Epidemiologically important pathogens: Infectious agents that have 1 or more of the following characteristics: (1) a propensity for transmission within health care facilities based on published reports and the occurrence of temporal or geographic clusters of ≥2 patients, (eg, VRE, MRSA, MSSA, Clostridium difficile, norovirus, RSV, influenza, rotavirus, Enterobacter species, Serratia species, group A streptococcus). However, for group A streptococcus, most experts consider a single case of health care-associated disease a trigger for investigation and enhanced control measures because of the devastating outcomes associated with HAI group A streptococcus infections. For susceptible bacteria that are known to be associated with asymptomatic colonization, isolation from normally sterile body fluids in patients with significant clinical disease would be the trigger to consider the organism as epidemiologically important. (2) antimicrobial resistance implications:

- Resistance to first-line therapies (eg, MRSA, VRE, VISA, VRSA, ESBL-producing organisms).
- Unusual or usual agents with unusual patterns of resistance within a facility (eg, the first isolate of Burkholderia cepacia complex or Ralstonia species in non-cystic fibrosis patients or a quinolone-resistant strain of Pseudomonas in a facility.
- Difficult to treat because of innate or acquired resistance to multiple classes of antimicrobial agents (eg, Stenotrophomonas maltophilia, Acinetobacter species).

(3) associated with serious clinical disease and increased morbidity and mortality (eg, MRSA and MSSA, group A streptococcus); or (4) a newly discovered or reemerging pathogen. The strategies described for MDROs may be applied for control of epidemiologically important organisms other than MDROs.

Hand hygiene: A general term that applies to any 1 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 hand flora and reduce resident hand flora).

HAI: An infection that develops in a patient who is cared for in any setting in which health care is delivered (eg, acute care hospital, chronic care facility, ambulatory clinic, dialysis center, surgicenter, home) and
is related to receiving health care (ie, was not incubating or present at the time health care was provided). In ambulatory and home settings, HAI would apply to any infection that is associated with a medical or surgical intervention performed in those settings.

Health care epidemiologist: A person whose primary training is medical (MD, DO) and/or masters- or doctorate-level epidemiology who has received advanced training in health care epidemiology. Typically, these professionals direct or provide consultation to an infection prevention and control program in a hospital, LTCF, or health care delivery system (also see infection prevention and control professional).

HCP: All paid and unpaid persons who work in a health care setting (also known as health care workers) (eg, any person who has professional or technical training in a health care-related field and provides patient care in a health care setting or any person who provides services that support the delivery of health care such as dietary, housekeeping, engineering, maintenance personnel).

Home care: A wide range of medical, nursing, rehabilitation, hospice, and social services delivered to patients in their place of residence (eg, private residence, senior living center, assisted living facility). Home health care services include care provided by home health aides and skilled nurses, respiratory therapists, dieticians, physicians, chaplains, and volunteers; provision of durable medical equipment; home infusion therapy; and physical, speech, and occupational therapy.

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, analysis, and feedback of infection data and trends to health care providers; consultation on infection risk assessment, on prevention and on 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 (eg, to ensure appropriate containment of construction dust); evaluation of new products or procedures on patient outcomes; oversight of employee health services related to infection prevention; implementation of preparedness plans; communication within the health care setting, with local and state health departments, and with the community at large concerning infection control issues; and participation in research.

Infection prevention and control program: A multidisciplinary program that includes a group of activities to ensure that recommended practices for the prevention of health care-associated infections are implemented and followed by HCP, making the health care setting safe from infection for patients and HCP. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires the following 5 components of an infection prevention and control program for accreditation: (1) surveillance: monitoring patients and HCP 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). The infection prevention and control program staff has the ultimate authority to determine infection control policies for a health care organization with the approval of the organization’s governing body.

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, assisted living facilities, retirement homes, adult day health care facilities, rehabilitation centers, and long-term psychiatric hospitals.

Mask: A term that applies collectively to items used to cover the nose and mouth and includes both procedure masks and surgical masks (www.fda.gov/cdrh/odoeguidance/094.html#4).

MDROs: In general, bacteria (excluding M tuberculosis) that are resistant to 1 or more classes of antimicrobial agents and usually are resistant to all but 1 or 2 commercially available antimicrobial agents (eg, MRSA, VRE, ESBL-producing or intrinsically resistant gram-negative bacilli).

Nosocomial infection: Derived from 2 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.

Standard precautions: A group of infection prevention practices that apply to all patients, regardless of suspected or confirmed diagnosis or presumed infection status. Standard precautions are a combination and expansion of universal precautions and body substance isolation. Standard precautions are based on the principle that all blood, body fluids, secretions, excretions except sweat, intact skin, and mucous membranes may contain transmissible infectious agents. Standard precautions include 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).

The authors and HICPAC thank Dr. Larry Strausbaugh for his many contributions and valued guidance in the preparation of this guideline.

References
