2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings

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

Suggested citation: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings
http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf

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EXECUTIVE SUMMARY

The *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings 2007* updates and expands the *1996 Guideline for Isolation Precautions in Hospitals*. The following developments led to revision of the 1996 guideline:

1. The transition of healthcare delivery from primarily acute care hospitals to other healthcare settings (e.g., home care, ambulatory care, free-standing specialty care sites, long-term care) created a need for recommendations that can be applied in all healthcare 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 healthcare delivery settings. Furthermore, the term "nosocomial infections" is replaced by "healthcare• associated infections" (HAIs) to reflect the changing patterns in healthcare 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 (e.g., SARS-CoV associated with the severe acute respiratory syndrome [SARS], Avian influenza in humans), renewed concern for evolving known pathogens (e.g., *C. difficile,* noroviruses, community-associated MRSA [CA-MRSA]), development of new therapies (e.g., gene therapy), and increasing concern for the threat of bioweapons attacks, established a need to address a broader scope of issues than in previous isolation guidelines.
3. 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 healthcare 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 (e.g., myelography, epidural anesthesia). The need for a recommendation for Respiratory Hygiene/Cough Etiquette grew out of observations during the SARS outbreaks where failure to implement simple source control measures with patients, visitors, and healthcare personnel with respiratory symptoms may have contributed to SARS coronavirus (SARS-CoV) transmission. 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 re-iterate 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 (allogeneic hematopoietic stem-cell transplant patients) led to the update on the components of the Protective Environment (PE).
5. Evidence that organizational characteristics (e.g., nurse staffing levels and composition, establishment of a safety culture) influence healthcare personnel adherence to recommended infection control practices, and therefore 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 healthcare settings and the expanded body of knowledge concerning prevention of transmission of MDROs created a need for more specific recommendations for surveillance and control of these pathogens that would be practical and effective in various types of healthcare settings.

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

Parts I - III: Review of the Scientific Data Regarding Transmission of Infectious Agents in Healthcare Settings Part I reviews the relevant scientific literature that supports the recommended prevention and control practices. As with 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 (i.e. multidrug-resistant organisms, *C. difficile)*. Several other pathogens that hold special infection control interest (i.e., norovirus, SARS, Category A bioterrorist agents, prions, monkeypox, and the hemorrhagic fever viruses) also are 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 healthcare 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 healthcare system components that influence transmission risks, including those under the influence of healthcare 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 modern, complex healthcare system. Evidence presented also demonstrates another administrative concern, the importance of nurse staffing levels, including numbers of appropriately trained nurses in ICUs for preventing HAIs. The role of the clinical microbiology laboratory in supporting infection control is described to emphasize the need for this service in healthcare facilites. Other factors that influence transmission risks are discussed i.e., healthcare worker adherence to recommended infection control practices, organizational safety culture or climate, education and training
Discussed for the first time in an isolation guideline is surveillance of healthcare-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 Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Centers for Disease Control and Prevention (CDC) and provides guidance for their application in various healthcare 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 (gowns, gloves, mask) *upon entry into the patient's room* for patients who are on Contact and/or Droplet Precautions since 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 Protective Environment (PE) for allogeneic hematopoietic stem cell transplant patients, described in previous guidelines, has been updated.

Tables, Appendices, and other Information
There are several tables that summarize important information: 1) a summary of the evolution of this document; 2) guidance on using empiric isolation precautions according to a clinical syndrome; 3) a summary of infection control recommendations for category A agents of bioterrorism; 4) components of Standard Precautions and recommendations for their application; 5) components of the Protective Environment; and 6) a glossary of definitions used in this guideline. New in this guideline is a figure that shows a recommended sequence for donning and removing personal protective equipment 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 consists of 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 one 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 healthcare 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.

Pre- Publication 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 Healthcare Settings 2006 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 healthcare settings and is intended to provide a context for evaluation of MDRO at individual healthcare 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 healthcare settings, information concerning the judicious use of antimicrobial agents is presented since such practices are intricately related to the size of the reservoir of MDROs which in turn influences transmission (e.g. colonization pressure). There are two tables that summarize recommended prevention and control practices using the following seven categories of interventions to control MDROs: administrative measures, education of healthcare personnel, judicious antimicrobial use, surveillance, infection control precautions, environmental measures, and decolonization. Recommendations for each category apply to and are adapted for the various healthcare settings. With the increasing incidence and prevalence of MDROs, all healthcare facilities must 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 presented to be added 1) if the incidence of transmission of a target MDRO is NOT decreasing despite implementation of basic MDRO infection control measures, and 2) when the *first* case(s) of an epidemiologically important MDRO is identified within a healthcare facility.

Summary

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

Abbreviations Used in the Guideline

AIIR	Airborne infection isolation room
CDC	Centers for Disease Control and Prevention
CF	Cystic fibrosis
CJD	Creutzfeld-Jakob Disease
CLSI	Clinical Laboratory Standards Institute
ESBL	Extended spectrum beta-lactamases
FDA	Food and Drug Administration
HAI	Healthcare-associated infections
HBV	Hepatitis B virus
HCV	Hepatitis C virus
HEPA	High efficiency particulate air [filtration]
HICPAC	Healthcare Infection Control Practices Advisory Committee
HIV	Human immunodeficiency virus
HCW	Healthcare worker
HSCT	Hematopoetic stem-cell transplant
ICU	Intensive care unit LTCF
	Long-term care facility
MDRO	Multidrug-resistant organism
MDR-GNB	Multidrug-resistant gram-negative bacilli
MRSA	Methicillin-resistant *Staphylococcus aureus*
NCCLS	National Committee for Clinical Laboratory Standards
NICU	Neonatal intensive care unit
NIOSH	National Institute for Occupational Safety and Health, CDC
NNIS	National Nosocomial Infection Surveillance
NSSP	Nonsusceptible *Streptococcus pneumoniae*
OSHA	Occupational Safety and Health Administration
PICU	Pediatric intensive care unit
PPE	Personal protective equipment
RSV	Respiratory syncytial virus
SARS	Severe acquired respiratory syndrome
vCJD	variant Creutzfeld-Jakob Disease
VRE	Vancomycin-resistant enterococci
WHO	World Health Organization

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

I.A. Evolution of the 2007 Document

The *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings 2007* builds upon a series of isolation and infection prevention documents promulgated since 1970. These previous documents are summarized and referenced in Table 1 and in Part I of the *1996 Guideline for Isolation Precautions in Hospitals* [1].

Objectives and methods The objectives of this guideline are to 1) provide infection control recommendations for all components of the healthcare delivery system, including hospitals, long-term care facilities, ambulatory care, home care and hospice; 2) reaffirm Standard Precautions as the foundation for preventing transmission during patient care in all healthcare 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 healthcare settings. The information also will be useful for other healthcare personnel, healthcare administrators, and anyone needing information about infection control measures to prevent transmission of infectious agents. Commonly used abbreviations are provided on page 12 and terms used in the guideline are defined in the Glossary (page 137).

Med-line and Pub Med 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 healthcare settings is derived from studies that used “quasi-experimental designs”, also referred to as nonrandomized, pre- post-intervention 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, (e.g., 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 if the results should change practice or in designing new studies [2, 6, 7].

Changes or clarifications in terminology This guideline contains four changes in terminology from the 1996 guideline:

- The term *nosocomial infection* is retained to refer only to infections acquired in hospitals. The term *healthcare-associated infection* (HAI) is used to refer to infections associated with healthcare delivery in any setting (e.g., hospitals, long-term care facilities, ambulatory settings, home care). This term reflects the inability to determine with certainty where the pathogen is acquired since patients may be colonized with or exposed to potential pathogens outside of the healthcare setting, before receiving health care, or may develop infections caused by those pathogens when exposed to the conditions associated with delivery of healthcare. Additionally, patients frequently move among the various settings within a healthcare system [8].
- A new addition to the practice recommendations for Standard Precautions is *Respiratory Hygiene/Cough Etiquette*. While Standard Precautions generally apply to the recommended practices of healthcare personnel during patient care, Respiratory Hygiene/Cough Etiquette applies broadly to all persons who enter a healthcare setting, including healthcare personnel, patients and visitors. These recommendations evolved from observations during the SARS epidemic that failure to implement basic source control measures with patients, visitors, and healthcare personnel with signs and symptoms of respiratory tract infection may have contributed to SARS coronavirus (SARS-CoV) transmission. This concept has been incorporated into CDC planning documents for SARS and pandemic influenza [9, 10].
- The term *"Airborne Precautions"* has been supplemented with the term "*Airborne Infection Isolation Room (AIIR)*" for consistency with the *Guidelines for Environmental Infection Control in Healthcare Facilities* [11], the *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings 2005*[12] and the American Institute of Architects (AIA) guidelines for design and construction of hospitals, 2006 [13]
- A set of prevention measures termed *Protective Environment* has been added to the precautions used to prevent HAIs. These measures, which have been defined in other guidelines , consist of engineering and design interventions that decrease the risk of exposure to environmental fungi for severely immunocompromised allogeneic hematiopoietic stem cell transplant (HSCT) patients during their highest risk phase, usually the first 100 days post transplant, or longer in the presence of graft-versus-host disease [11, 13-15]. Recommendations for a Protective Environment apply only to acute care hospitals that provide care to HSCT patients.

Scope This guideline, like its predecessors, focuses primarily on interactions between patients and healthcare providers. The Guidelines for the Prevention of MDRO Infection were published separately in November 2006, and are available online at www.cdc.gov/ncidod/dhqp/index.html. Several other HICPAC

guidelines to prevent transmission of infectious agents associated with healthcare delivery are cited; e.g., *Guideline for Hand Hygiene*, *Guideline for Environmental Infection Control*, *Guideline for Prevention of Healthcare-Associated Pneumonia*, and *Guideline for Infection Control in Healthcare Personnel* [11, 14, 16, 17]. In combination, these provide comprehensive guidance on the primary infection control measures for ensuring a safe environment for patients and healthcare personnel.

This guideline does not discuss in detail specialized infection control issues in defined populations that are addressed elsewhere, (e.g., *Recommendations for Preventing Transmission of Infections among Chronic Hemodialysis Patients* , *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* [12, 18-20]. An exception has been made by including abbreviated guidance for a Protective Environment used for allogeneic HSCT recipients because components of the Protective Environment have been more completely defined since publication of the *Guidelines for Preventing Opportunistic Infections Among HSCT Recipients in 2000* and the *Guideline for Environmental Infection Control in Healthcare Facilities* [11, 15].

I.B. Rationale for Standard and Transmission-Based Precautions in healthcare settings

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

I.B.1. Sources of infectious agents Infectious agents transmitted during healthcare derive primarily from human sources but inanimate environmental sources also are implicated in transmission. Human reservoirs include patients [20-28], healthcare personnel [29-35 17, 36-39], and household members and other visitors [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. The endogenous flora of patients (e.g., bacteria residing in the respiratory or gastrointestinal tract) also are the source of HAIs [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 are also important, as are the infectious dose, mechanisms of disease production and route of exposure [55]. There is a spectrum of possible outcomes following exposure to an infectious agent. Some persons exposed to pathogenic microorganisms never develop symptomatic disease while others become severely ill and even die. Some individuals are prone to becoming transiently or permanently colonized but remain asymptomatic. Still others progress from colonization to symptomatic disease either immediately following exposure, or after a period of asymptomatic colonization. The immune state at the time of exposure to an infectious agent, interaction between pathogens, and virulence factors intrinsic to the agent are important predictors of an individuals' outcome. Host factors such as extremes of age and underlying disease (e.g. diabetes [56, 57]), human immunodeficiency virus/acquired immune deficiency syndrome [HIV/AIDS] [58, 59], malignancy, and transplants [18, 60, 61] can increase susceptibility to infection as do a variety of medications that alter the normal flora (e.g., antimicrobial agents, gastric acid suppressants, corticosteroids, antirejection drugs, antineoplastic agents, and immunosuppressive drugs). Surgical procedures and radiation therapy impair defenses of the skin and other involved organ systems. Indwelling devices such as urinary catheters, endotracheal tubes, central venous and arterial catheters [62-64] and synthetic implants facilitate development of HAIs by allowing potential pathogens to bypass local defenses that would ordinarily impede their invasion and by providing surfaces for development of bioflms that may facilitate adherence of microorganisms and protect from antimicrobial activity [65]. Some infections associated with invasive procedures result from transmission within the healthcare facility; others arise from the patient's endogenous flora [46-50]. High-risk patient populations with noteworthy risk factors for infection are discussed further in Sections I.D, I.E., and I.F.

I.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, *Staphylococcus aureus*), others by the droplet, (e.g., influenza virus, *B. pertussis*) or airborne routes (e.g., *M. tuberculosis)*. Other infectious agents, such as bloodborne viruses (e.g., hepatitis B and C viruses [HBV, HCV] and HIV are transmitted rarely in healthcare settings, via percutaneous or mucous membrane exposure. Importantly, not all infectious agents are transmitted from person to person. These are distinguished in Appendix A. The three principal routes of transmission are summarized below.

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

I.B.3.a.i. *Direct contact transmission* Direct transmission occurs when microorganisms are transferred from one infected person to another person without a contaminated intermediate object or person. Opportunities for direct contact transmission between patients and healthcare personnel have been summarized in the Guideline for Infection Control in Healthcare Personnel, 1998 [17] and include:

- blood or other blood-containing body fluids from a patient directly enters a caregiver's body through contact with a mucous membrane [66] or breaks (i.e., cuts, abrasions) in the skin [67].
- mites from a scabies-infested patient are transferred to the skin of a caregiver while he/she is having direct ungloved contact with the patient's skin [68, 69].
- a healthcare provider develops herpetic whitlow on a finger after contact with HSV when providing oral care to a patient without using gloves or HSV is transmitted to a patient from a herpetic whitlow on an ungloved hand of a healthcare worker (HCW) [70, 71].

I.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 healthcare personnel are important contributors to indirect contact transmission [16]. Examples of opportunities for indirect contact transmission include:

- Hands of healthcare personnel may transmit pathogens after touching an infected or colonized body site on one patient or a contaminated inanimate object, if hand hygiene is not performed before touching another patient.[72, 73].
- 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[74 75-77].
- Shared toys may become a vehicle for transmitting respiratory viruses (e.g., respiratory syncytial virus [24, 78, 79] or pathogenic bacteria (e.g., *Pseudomonas aeruginosa* [80]) among pediatric patients.
- Instruments that are inadequately cleaned between patients before disinfection or sterilization (e.g., endoscopes or surgical instruments) [81-85] or that have manufacturing defects that interfere with the effectiveness of reprocessing [86, 87] may transmit bacterial and viral pathogens.

Clothing, uniforms, laboratory coats, or isolation gowns used as personal protective equipment (PPE), may become contaminated with potential pathogens after care of a patient colonized or infected with an infectious agent, (e.g., MRSA [88], VRE [89], and *C. difficile* [90]. Although contaminated clothing has not been

implicated directly in transmission, the potential exists for soiled garments to transfer infectious agents to successive patients.

I.B.3.b. *Droplet transmission* Droplet transmission is, technically, a form of contact transmission, and some infectious agents transmitted by the droplet route also may be transmitted by the direct and indirect contact routes. However, in contrast to contact transmission, respiratory droplets carrying infectious pathogens transmit infection when they travel directly from the respiratory tract of the infectious individual to susceptible mucosal surfaces of the recipient, generally over short distances, necessitating facial protection. Respiratory droplets are generated when an infected person coughs, sneezes, or talks [91, 92] or during procedures such as suctioning, endotracheal intubation, [93-96], cough induction by chest physiotherapy [97] and cardiopulmonary resuscitation [98, 99]. Evidence for droplet transmission comes from epidemiological studies of disease outbreaks [100-103], experimental studies [104] and from information on aerosol dynamics [91, 105]. Studies have shown that the nasal mucosa, conjunctivae and less frequently the mouth, are susceptible portals of entry for respiratory viruses [106]. The maximum distance for droplet transmission is currently unresolved, although pathogens transmitted by the droplet route have not been transmitted through the air over long distances, in contrast to the airborne pathogens discussed below. Historically, the area of defined risk has been a distance of ≤3 feet around the patient and is based on epidemiologic and simulated studies of selected infections [103, 104]. Using this distance for donning masks has been effective in preventing transmission of infectious agents via the droplet route. However, experimental studies with smallpox [107, 108] and investigations during the global SARS outbreaks of 2003 [101] suggest that droplets from patients with these two infections could reach persons located 6 feet or more from their source. It is likely that the distance droplets travel depends on the velocity and mechanism by which respiratory droplets are propelled from the source, the density of respiratory secretions, environmental factors such as temperature and humidity, and the ability of the pathogen to maintain infectivity over that distance [105]. Thus, a distance of ≤3 feet around the patient is best viewed as an *example* of what is meant by “a short distance from a patient” and should not be used as the sole *criterion* for deciding when a mask should be donned to protect from droplet exposure. Based on these considerations, it may be prudent to don a mask when within 6 to 10 feet of the patient or upon entry into the patient’s room, especially when exposure to emerging or highly virulent pathogens is likely. More studies are needed to improve understanding of droplet transmission under various circumstances.

Droplet size is another variable under discussion. Droplets traditionally have been defined as being >5 µm in size. Droplet nuclei, particles arising from desiccation of suspended droplets, have been associated with airborne transmission and defined as ≤5 µm in size [105] , a reflection of the pathogenesis of pulmonary tuberculosis which is not generalizeable to other organisms. Observations of particle dynamics have demonstrated that a range of droplet sizes, including those with diameters of 30µm or greater, can remain suspended

in the air [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 therefore do not require special air handling and ventilation. Examples of infectious agents that are transmitted via the droplet route include *Bordetella pertussis* [110], influenza virus [23], adenovirus [111] , rhinovirus [104], *Mycoplasma pneumoniae* [112], SARS-associated coronavirus (SARS-CoV) [21, 96, 113], group A streptococcus [114], and *Neisseria meningitidis* [95, 103, 115]. Although respiratory syncytial virus may be transmitted by the droplet route, direct contact with infected respiratory secretions is the most important determinant of transmission and consistent adherence to Standard plus Contact Precautions prevents transmission in healthcare settings [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 *S. aureus* is transmitted most frequently by the contact route, viral upper respiratory tract infection has been associated with increased dispersal of *S. aureus* from the nose into the air for a distance of 4 feet under both outbreak and experimental conditions and is known as the “cloud baby” and “cloud adult” phenomenon[118-120].

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 (e.g., spores of *Aspergillus* spp, and *Mycobacterium tuberculosis*). Microorganisms carried in this manner may be dispersed over long distances by air currents and may be inhaled by susceptible individuals who have not had face-to-face contact with (or been in the same room with) the infectious individual [121-124]. Preventing the spread of pathogens that are transmitted by the airborne route requires the use of special air handling and ventilation systems (e.g., AIIRs) to contain and then safely remove the infectious agent [11, 12]. Infectious agents to which this applies include *Mycobacterium tuberculosis* [124-127], rubeola virus (measles) [122], and varicella-zoster virus (chickenpox) [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 [108, 128, 129]. In addition to AIIRs, respiratory protection with NIOSH certified N95 or higher level respirator is recommended for healthcare personnel entering the AIIR to prevent acquisition of airborne infectious agents such as *M. tuberculosis* [12].

For certain other respiratory infectious agents, such as influenza [130, 131] and rhinovirus [104], and even some gastrointestinal viruses (e.g., norovirus [132] and rotavirus [133]) there is some evidence that the pathogen may be transmitted via small-particle aerosols, under natural and experimental conditions. Such transmission has occurred over distances longer than 3 feet but within a defined

airspace (e.g., patient room), suggesting that it is unlikely that these agents remain viable on air currents that travel long distances. AIIRs are not required routinely to prevent transmission of these agents. Additional issues concerning examples of small particle aerosol transmission of agents that are most frequently transmitted by the droplet route are discussed below.

I.B.3.d. Emerging issues concerning airborne transmission of infectious agents.

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 because of conflicting information and uncertainty about possible routes of transmission. Although SARS-CoV is transmitted primarily by contact and/or droplet routes, airborne transmission over a limited distance (e.g. within a room), has been suggested, though not proven [134-141]. This is true of other infectious agents such as influenza virus [130] and noroviruses [132, 142, 143]. Influenza viruses are transmitted primarily by close contact with respiratory droplets [23, 102] and acquisition by healthcare personnel 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 a single aircraft [130]. Observations of a protective effect of UV lights in preventing influenza among patients with tuberculosis during the influenza pandemic of 1957-'58 have been used to suggest airborne transmission [145, 146].
In contrast to the strict interpretation of an airborne route for transmission (i.e., long distances beyond the patient room environment), short distance transmission by small particle aerosols generated under specific circumstances (e.g., during endotracheal intubation) to persons in the immediate area near the patient has been demonstrated. Also, aerosolized particles <100 μm can remain suspended in air when room air current velocities exceed the terminal settling velocities of the particles [109]. SARS-CoV transmission has been associated with endotracheal intubation, noninvasive positive pressure ventilation, and cardio• pulmonary resuscitation [93, 94, 96, 98, 141]. Although the most frequent routes of transmission of noroviruses are contact and food and waterborne routes, several reports suggest that noroviruses may be transmitted through aerosolization of infectious particles from vomitus or fecal material [142, 143, 147, 148]. It is hypothesized that the aerosolized particles are inhaled and subsequently swallowed.

Roy and Milton proposed a new classification for aerosol transmission when evaluating routes of SARS transmission: 1) *obligate*: under natural conditions, disease occurs following transmission of the agent only through inhalation of small particle aerosols (e.g., tuberculosis); 2) *preferential*: natural infection results from transmission through multiple routes, but small particle aerosols are the predominant route (e.g. measles, varicella); and 3) *opportunistic*: agents that naturally cause disease through other routes, but under special circumstances

may be transmitted via fine particle aerosols [149]. This conceptual framework can explain rare occurrences of airborne transmission of agents that are transmitted most frequently by other routes (e.g., 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 more extreme prevention strategies than may be necessary; therefore, recommended precautions could change as the epidemiology of an emerging infection is defined and controversial issues are resolved.

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 (e.g., *Aspergillus spp*.) are ubiquitous in the environment and may cause disease in immunocompromised patients who inhale aerosolized (e.g., via construction dust) spores [152, 153]. As a rule, neither of these organisms is subsequently transmitted from infected patients. However, there is one well-documented report of person-to-person transmission of *Aspergillus* sp. in the ICU setting that was most likey due to the aerosolization of spores during wound debridement [154]. A Protective Environment refers to 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 Transmission of infection from sources other than infectious individuals include those associated with *common environmental sources or vehicles* (e.g. contaminated food, water, or medications (e.g. intravenous fluids). Although *Aspergillus* spp. have been recovered from hospital water systems [159], the role of water as a reservoir for immunosuppressed patients remains uncertain. *Vectorborne transmission* of infectious agents from mosquitoes, flies, rats, and other vermin also can occur in healthcare settings. Prevention of vector borne transmission is not addressed in this document.

I.C. Infectious agents of special infection control interest for healthcare settings

Several infectious agents with important infection control implications that either were not discussed extensively in previous isolation guidelines or have emerged recently are discussed below. These are epidemiologically important organisms (e.g., *C. difficile*), agents of bioterrorism, prions, SARS-CoV, monkeypox, noroviruses, and the hemorrhagic fever viruses. Experience with these agents has broadened the understanding of modes of transmission and effective

preventive measures. These agents are included for purposes of information and, for some (i.e., SARS-CoV, monkeypox), because of the lessons that have been learned about preparedness planning and responding effectively to new infectious agents**.**

I.C.1. Epidemiologically important organisms Any infectious agents transmitted in healthcare settings may, under defined conditions, become targeted for control because they are epidemiologically important. *C. difficile* is specifically discussed below because of wide recognition of its current importance in U.S. healthcare facilities. In determining what constitutes an "epidemiologically important organism", the following characteristics apply:

- A propensity for transmission within healthcare facilities based on published reports and the occurrence of temporal or geographic clusters of > 2 patients, (e.g., *C..difficile*, norovirus, respiratory syncytial virus (RSV), influenza, rotavirus, *Enterobacter* spp; *Serratia* spp., group A streptococcus). A single case of healthcare-associated invasive disease caused by certain pathogens (e.g., group A streptococcus post-operatively [160], in burn units [161], or in a LTCF [162]; *Legionella* sp. [14, 163], *Aspergillus* sp. [164]) is generally considered a trigger for investigation and enhanced control measures because of the risk of additional cases and severity of illness associated with these infections. Antimicrobial resistance
- Resistance to first-line therapies (e.g., MRSA, VISA, VRSA, VRE, ESBL-producing organisms).
- Common and uncommon microorganisms with unusual patterns of resistance within a facility (e.g., the first isolate of *Burkholderia cepacia* complex or *Ralstonia* spp. in non-CF patients or a quinolone-resistant strain of *Pseudomonas aeruginosa* in a facility).
- Difficult to treat because of innate or acquired resistance to multiple classes of antimicrobial agents (e.g., *Stenotrophomonas maltophilia, Acinetobacter spp.*).
- Association with serious clinical disease, increased morbidity and mortality (e.g., MRSA and MSSA, group A streptococcus)
- A newly discovered or reemerging pathogen

I.C.1.a. *C.difficile* *C. difficile* is a spore-forming gram positive anaerobic bacillus that was first isolated from stools of neonates in 1935 [165] and identified as the most commonly identified causative agent of antibiotic-associated diarrhea and pseudomembranous colitis in 1977 [166]. This pathogen is a major cause of healthcare-associated diarrhea and has been responsible for many large outbreaks in healthcare settings that were extremely difficult to control. Important factors that contribute to healthcare-associated outbreaks include environmental contamination, persistence of spores for prolonged periods of time, resistance of spores to routinely used disinfectants and antiseptics, hand carriage by healthcare personnel to other patients, and exposure of patients to frequent courses of antimicrobial agents [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 been observed in several U.S. states, Canada, England and the Netherlands [168-172]. The same strain of *C. difficile* has been implicated in these outbreaks [173]. This strain, toxinotype III, North American PFGE type 1, and PCR-ribotype 027 (NAP1/027). has been found to hyperproduce toxin A (16 fold increase) and toxin B (23 fold increase) compared with isolates from 12 different pulsed-field gel electrophoresisPFGE types. A recent survey of U.S. infectious disease physicians found that 40% 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 resulting in more environmental contamination. Considering the greater morbidity, mortality, length of stay, and costs associated with *C. difficile* disease in both acute care and long term care facilities, control of this pathogen is now even more important than previously. Prevention of transmission focuses on syndromic application of Contact Precautions for patients with diarrhea, accurate identification of patients, environmental measures (e.g., rigorous cleaning of patient rooms) and consistent hand hygiene. Use of soap and water, rather than alcohol based handrubs, for mechanical removal of spores from hands, and a bleach-containing disinfectant (5000 ppm) for environmental disinfection, may be valuable when there is transmission in a healthcare facility. See Appendix A for specific recommendations.

I.C.1. b. Multidrug-Resistant Organisms (MDROs) In general, MDROs are defined as microorganisms – predominantly bacteria – that are resistant to one or more classes of antimicrobial agents[176]. Although the names of certain MDROs suggest resistance to only one agent (e.g., methicillin-resistant *Staphylococcus aureus* [MRSA], vancomycin resistant enterococcus [VRE]), these pathogens are usually resistant to all but a few commercially available antimicrobial agents. This latter feature defines MDROs that are considered to be epidemiologically important and deserve special attention in healthcare facilities[177]. Other MDROs of current concern include multidrug-resistant *Streptococcus pneumoniae* (MDRSP) which is resistant to penicillin and other broad-spectrum agents such as macrolides and fluroquinolones, multidrug-resistant gram-negative bacilli (MDR- GNB), especially those producing extended spectrum beta-lactamases (ESBLs); and strains of *S. aureus* that are intermediate or resistant to vancomycin (i.e., VISA and VRSA)[178-197 198].

MDROs are transmitted by the same routes as antimicrobial susceptible infectious agents. Patient-to-patient transmission in healthcare settings, usually via hands of HCWs, has been a major factor accounting for the increase in MDRO incidence and prevalence, especially for MRSA and VRE in acute care

facilities[199-201]. Preventing the emergence and transmission of these pathogens requires a comprehensive approach that includes administrative involvement and measures (e.g., nurse staffing, communication systems, performance improvement processes to ensure adherence to recommended infection control measures), education and training of medical and other healthcare personnel, judicious antibiotic use, comprehensive surveillance for targeted MDROs, application of infection control precautions during patient care, environmental measures (e.g., cleaning and disinfection of the patient care environment and equipment, dedicated single-patient-use of non-critical equipment), and decolonization therapy when appropriate.

The prevention and control of MDROs is a national priority - one that requires that all healthcare facilities and agencies assume responsibility and participate in community-wide control programs[176, 177]. A detailed discussion of this topic and recommendations for prevention was published in 2006 may be found at http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf

I.C.2. Agents of bioterrorism 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 require special action for public health preparedness[202]. General information relevant to infection control in healthcare settings for Category A agents of bioterrorism is summarized in Table 3. Consult 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.

Healthcare facilities confront a different set of issues when dealing with a suspected bioterrorism event as compared with other communicable diseases. An understanding of the epidemiology, modes of transmission, and clinical course of each disease, as well as carefully drafted plans that provide an approach and relevant websites and other resources for disease-specific guidance to healthcare, 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, healthcare personnel, 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 there are an insufficient number of AIIRs available;5) providing adequate quantities of appropriate personal protective equipment; and 6) identifying appropriate staff to care for potentially infectious patients (e.g., vaccinated healthcare personnel for

care of patients with smallpox). The response is likely to differ for exposures resulting from an intentional release compared with naturally occurring disease because of the large number persons that can be exposed at the same time and possible differences in pathogenicity.

A variety of sources offer guidance for the management of persons exposed to the most likely agents of bioterrorism. Federal agency websites (e.g., www.usamriid.army.mil/publications/index.html , www.bt.cdc.gov) and state and county health department web sites should be consulted for the most up-to-date information. Sources of information on specific agents include: anthrax [203]; 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 healthcare personnel Vaccination of personnel in preparation for a possible smallpox exposure has important infection control implications [213-215]. These include the need for meticulous screening for vaccine contraindications in persons who are at increased risk for adverse vaccinia events; containment and monitoring of the vaccination site to prevent transmission in the healthcare setting and at home; and the management of patients with vaccinia-related adverse events [216, 217]. The pre-event U.S. 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. Approximately 760,000 individuals were vaccinated in the Department of Defense and 40,000 in the civilian or public health populations from December 2002 to February 2005, including approximately 70,000 who worked in healthcare settings. There were no cases of eczema vaccinatum, progressive vaccinia, fetal vaccinia, or contact transfer of vaccinia in healthcare settings or in military workplaces [218, 219]. Outside the healthcare setting, there were 53 cases of contact transfer from military vaccinees to close personal contacts (e.g., bed partners or contacts during participation in sports such as wrestling [220]). 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 30 cases, and two of the confirmed cases resulted from tertiary transfer. All recipients, including one breast-fed infant, recovered without complication. Subsequent studies using viral culture and PCR techniques have confirmed the effectiveness of semipermeable dressings to contain vaccinia [221-224]. This experience emphasizes the importance of ensuring that newly vaccinated healthcare personnel adhere to recommended vaccination-site care, especially if they are to care for high-risk patients. Recommendations for pre-event smallpox vaccination of healthcare personnel and vaccinia-related infection control recommendations are published in the MMWR [216, 225] with updates posted on the CDC bioterrorism web site [205].

I.C.3. Prions Creutzfeldt-Jakob disease (CJD) is a rapidly progressive, degenerative, neurologic disorder of humans with an incidence in the United States of approximately 1 person/million population/year [226, 227]

(www.cdc.gov/ncidod/diseases/cjd/cjd.htm). CJD is believed to be caused by a transmissible proteinaceous infectious agent termed a prion. Infectious prions are isoforms of a host-encoded glycoprotein known as the prion protein. The incubation period (i.e., time between exposure and and onset of symptoms) varies from two 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% are familial. Iatrogenic transmission has occurred with most resulting from treatment with human cadaveric pituitary-derived growth hormone or gonadotropin [228, 229], from implantation of contaminated human dura mater grafts [230] or from corneal transplants [231]). Transmission has been linked to the use of contaminated neurosurgical instruments or stereotactic electroencephalogram electrodes [232, 233, 234, 235].

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 [236]. BSE, first recognized in the United Kingdom (UK) 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 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 [237]. Although most cases of vCJD have been reported from the UK, a few cases also have been reported from Europe, Japan, Canada, and the United States. Most vCJD cases worldwide lived in or visited the UK during the years of a large outbreak of BSE (1980-96) and may have consumed contaminated cattle products during that time (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 on the following website: www.cdc.gov/ncidod/diseases/cjd/cjd.htm. The public health impact of prion diseases has been reviewed [238].

vCJD in humans has different clinical and pathologic characteristics from sporadic or classic CJD [239], including the following: 1) younger median age at death: 28 (range 16-48) vs. 68 years; 2) longer duration of illness: median 14 months vs. 4-6 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 from vCJD patients but not from sporadic CJD patients [240]. 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 U.S. has not detected sporadic CJD transmission through

blood transfusion [241-243]. However, bloodborne transmission of vCJD is believed to have occurred in two UK patients [244, 245]. The following FDA websites provide information on steps that are being taken in the US to protect the blood supply from CJD and vCJD: http://www.fda.gov/cber/gdlns/cjdvcjd.htm;

http://www.fda.gov/cber/gdlns/cjdvcjdq&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 for contact with a body that has undergone autopsy [246]. Recommendations for reprocessing surgical instruments to prevent transmission of CJD in healthcare settings have been published by the World Health Organization (WHO) and are currently under review at CDC.

Questions 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 may arise. 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 US may find useful (http://www.hpa.org.uk/infections/topics_az/cjd/information_documents.htm).

I.C.4. Severe Acute Respiratory Syndrome (SARS) SARS is a newly discovered respiratory disease that emerged in China late in 2002 and spread to several countries [135, 140]; Mainland China, Hong Kong, Hanoi, Singapore, and Toronto were affected significantly. SARS is caused by SARS CoV, a previously unrecognized member of the coronavirus family [247, 248]. The incubation period from exposure to the onset of symptoms is 2 to 7 days but can be as long as 10 days and uncommonly even longer [249]. The illness is initially difficult to distinguish from other common respiratory infections. Signs and symptoms usually include fever >38.0^{o}C and chills and rigors, sometimes accompanied by headache, myalgia, and mild to severe respiratory symptoms. Radiographic finding of atypical pneumonia is an important clinical indicator of possible SARS. Compared with adults, children have been affected less frequently, have milder disease, and are less likely to transmit SARS-CoV [135, 249-251]. The overall case fatality rate is approximately 6.0%; underlying disease and advanced age increase the risk of mortality (www.who.int/csr/sarsarchive/2003_05_07a/en/).

Outbreaks in healthcare settings, with transmission to large numbers of healthcare personnel and patients have been a striking feature of SARS; undiagnosed, infectious patients and visitors were important initiators of these outbreaks [21, 252-254]. The relative contribution of potential modes of transmission is not precisely known. There is ample evidence for droplet and contact transmission [96, 101, 113]; however, opportunistic airborne transmission cannot be excluded [101, 135-139, 149, 255]. For example, exposure to aerosol-generating

procedures (e.g., endotracheal intubation, suctioning) was associated with transmission of infection to large numbers of healthcare personnel outside of the United States [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 multi-bed room or shared airspace. A review of the infection control literature generated from the SARS outbreaks of 2003 concluded that the greatest risk of transmission is to those who have close contact, are not properly trained in use of protective infection control procedures, do not consistently use PPE; and that N95 or higher respirators may offer additional protection to those exposed to aerosol- generating procedures and high risk activities [256, 257]. Organizational and individual factors that affected adherence to infection control practices for SARS also were identified [257].

Control of SARS requires a coordinated, dynamic response by multiple disciplines in a healthcare setting [9]. Early detection of cases is accomplished by screening persons with symptoms of a respiratory infection for history of travel to areas experiencing community transmission or contact with SARS patients, followed by implementation of Respiratory Hygiene/Cough Etiquette (i.e., placing a mask over the patient's nose and mouth) and physical separation from other patients in common waiting areas.The precise combination of precautions to protect healthcare personnel has not been determined. At the time of this publication, 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 [138, 254, 258], Airborne Precautions, including use of fit-tested NIOSH-approved N95 or higher level respirators, and eye protection [259]. In Hong Kong, the use of Droplet and Contact Precautions, which included use of a mask but not a respirator, was effective in protecting healthcare personnel[113]. However, in Toronto, consistent use of an N95 respirator was slightly more protective than a mask [93]. It is noteworthy that there was no transmission of SARS-CoV to public hospital workers in Vietnam despite inconsistent use of infection control measures, including use of PPE, which suggests other factors (e.g., severity of disease, frequency of high risk procedures or events, environmental features) may influence opportunities for transmission [260].

SARS-CoV also has been transmitted in the laboratory setting through breaches in recommended laboratory practices. Research laboratories where 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 [261, 262]. Studies of the SARS outbreaks of 2003 and transmissions that occurred in the laboratory re-affirm the effectiveness of recommended infection control precautions and highlight the importance of consistent adherence to these measures.

Lessons from the SARS outbreaks are useful for planning to respond to future public health crises, such as pandemic influenza and bioterrorism events. Surveillance for cases among patients and healthcare personnel, ensuring availability of adequate supplies and staffing, and limiting access to healthcare

facilities were important factors in the response to SARS that have been summarized [9]. Guidance for infection control precautions in various settings is available at www.cdc.gov/ncidod/sars.

I.C.5. Monkeypox Monkeypox is a rare viral disease found mostly in the rain forest countries of Central and West Africa. The disease 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 following 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 [263]. This outbreak demonstrates the importance of recognition and prompt reporting of unusual disease presentations by clinicians to enable prompt identification of the etiology; and the potential of epizootic diseases to spread from animal reservoirs to humans through personal and occupational exposure [264].

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 (e.g., during administration of nebulized medications to ill prairie dogs [265]). Among humans, four instances of monkeypox transmission within hospitals have been reported in Africa among children, usually related to sharing the same ward or bed [266, 267]. Additional recent literature documents transmission of Congo Basin monkeypox in a hospital compound for an extended number of generations [268].

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 [269]. 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 [270]; this awaits further study. Smallpox vaccine is 85% protective against Congo Basin monkeypox [271]. Since there is an associated case fatality rate of $\leq$10%, administration of smallpox vaccine within 4 days to individuals who have had direct exposure to patients or animals with monkeypox is a reasonable consideration [272]. For the most current information on monkeypox, see www.cdc.gov/ncidod/monkeypox/clinicians.htm.

I.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 [273]. Environmental contamination also has been documented as a contributing factor in ongoing transmission during outbreaks [274, 275]. Although noroviruses cannot be propagated in cell culture,

DNA detection by molecular diagnostic techniques has facilitated a greater appreciation of their role in outbreaks of gastrointestinal disease [276]. Reported outbreaks in hospitals [132, 142, 277], nursing homes [275, 278-283], cruise ships [284, 285], hotels [143, 147], schools [148], and large crowded shelters established for hurricane evacuees [286], demonstrate their highly contagious nature, the disruptive impact they have in healthcare facilities and the community, and the difficulty of controlling outbreaks in settings where people share common facilites and space. Of note, there is nearly a 5 fold increase in the risk to patients in outbreaks where a patient is the index case compared with exposure of patients during outbreaks where a staff member is the index case [287].

The average incubation period for gastroenteritis caused by noroviruses is 12-48 hours and the clinical course lasts 12-60 hours [273]. Illness is characterized by acute onset of nausea, vomiting, abdominal cramps, and/or diarrhea. The disease is largely self-limited; rarely, death caused by severe dehydration can occur, particularly among the elderly with debilitating health conditions.

The epidemiology of norovirus outbreaks shows that even though primary cases may result from exposure to a fecally-contaminated food or water, secondary and tertiary cases often result from person-to-person transmission that is facilitated by contamination of fomites [273, 288] and dissemination of infectious particles, especially during the process of vomiting [132, 142, 143, 147, 148, 273, 279, 280]. Widespread, persistent and inapparent contamination of the environment and fomites can make outbreaks extremely difficult to control [147, 275, 284].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 (i.e., <100 viral particles) [289] and the resistance of these viruses to the usual cleaning and disinfection agents (i.e., may survive $\leq$ 10 ppm chlorine) [290-292]. An alternate phenolic agent that was shown to be effective against feline calicivirus was used for environmental cleaning in one outbreak [275, 293]. There are insufficient data to determine the efficacy of alcohol-based hand rubs against noroviruses when the hands are not visibly soiled [294]. Absence of disease in certain individuals during an outbreak may be explained by protection from infection conferred by the B histo-blood group antigen [295]. Consultation on outbreaks of gastroenteritis is available through CDC's Division of Viral and Rickettsial Diseases [296].

I.C.7. Hemorrhagic fever viruses (HFV) The hemorrhagic fever viruses are a mixed group of viruses that cause serious disease with high fever, skin rash, bleeding diathesis, and in some cases, high mortality; the disease caused is referred to as viral hemorrhagic fever (VHF). Among the more commonly known HFVs are Ebola and Marburg viruses (Filoviridae), Lassa virus (Arenaviridae), Crimean-Congo hemorrhagic fever and Rift Valley Fever virus (Bunyaviridae),

and Dengue and Yellow fever viruses (Flaviviridae) [212, 297]. These viruses are transmitted to humans via contact with infected animals or via arthropod vectors. While none of these viruses is endemic in the United States, outbreaks in affected countries provide potential opportunities for importation by infected humans and animals. Furthermore, there are concerns that some of these agents could be used as bioweapons [212]. Person-to-person transmission is documented for Ebola, Marburg, Lassa and Crimean-Congo hemorrhagic fever viruses. In resource-limited healthcare settings, transmission of these agents to healthcare personnel, patients and visitors has been described and in some outbreaks has accounted for a large proportion of cases [298-300]. Transmissions within households also have occurred among individuals who had direct contact with ill persons or their body fluids, but not to those who did not have such contact [301].

Evidence concerning the transmission of HFVs has been summarized [212, 302]. Person-to-person transmission is associated primarily with direct blood and body fluid contact. Percutaneous exposure to contaminated blood carries a particularly high risk for transmission and increased mortality [303, 304]. The finding of large numbers of Ebola viral particles in the skin and the lumina of sweat glands has raised concern that transmission could occur from direct contact with intact skin though epidemiologic evidence to support this is lacking [305]. Postmortem handling of infected bodies is an important risk for transmission [301, 306, 307]. In rare situations, cases in which the mode of transmission was unexplained among individuals with no known direct contact , have led to speculation that airborne transmission could have occurred [298]. However, airborne transmission of naturally occurring HFVs in humans has not been seen. In one study of airplane passengers exposed to an in-flight index case of Lassa fever, there was no transmission to any passengers[308].

In the laboratory setting, animals have been infected experimentally with Marburg or Ebola viruses via direct inoculation of the nose, mouth and/or conjunctiva [309, 310] and by using mechanically generated virus-containing aerosols [311, 312]. Transmission of Ebola virus among laboratory primates in an animal facility has been described [313]. Secondarily infected animals were in individual cages and separated by approximately 3 meters. Although the possibility of airborne transmission was suggested, the authors were not able to exclude droplet or indirect contact transmission in this incidental observation.

Guidance on infection control precautions for HVFs that are transmitted person-to-person have been published by CDC [1, 211] and by the Johns Hopkins Center for Civilian Biodefense Strategies [212]. The most recent recommendations at the time of publication of this document were posted on the CDC website on 5/19/05 [314]. Inconsistencies among the various recommendations have raised questions about the appropriate precautions to use in U.S. hospitals. In less developed countries, outbreaks of HFVs have been controlled with basic hygiene, barrier precautions, safe injection practices, and safe burial practices [299, 306]. The preponderance of evidence on HFV transmission indicates that Standard, Contact and Droplet Precautions with eye protection are effective in protecting

healthcare personnel and visitors who may attend an infected patient. Single gloves are adequate for routine patient care; double-gloving is advised during invasive procedures (e.g., surgery) that pose an increased risk for blood exposure. Routine eye protection (i.e. goggles or face shield) is particularly important. Fluid-resistant gowns should be worn for all patient contact. Airborne Precautions are not required for routine patient care; however, use of AIIRs is prudent when procedures that could generate infectious aerosols are performed (e.g., endotracheal intubation, bronchoscopy, suctioning, autopsy procedures involving oscillating saws). N95 or higher level respirators may provide added protection for individuals in a room during aerosol-generating procedures (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 upon presentation and then modified as more information is obtained (Table 2). Patients with hemorrhagic fever syndrome in the setting of a suspected bioweapon attack should be managed using Airborne Precautions, including AIIRs, since the epidemiology of a potentially weaponized hemorrhagic fever virus is unpredictable.

I.D. Transmission risks associated with specific types of healthcare settings

Numerous factors influence differences in transmission risks among the various healthcare settings. These include the population characteristics (e.g., increased susceptibility to infections, type and prevalence of indwelling devices), intensity of care, exposure to environmental sources, length of stay, and frequency of interaction between patients/residents with each other and with HCWs. These factors, as well as organizational priorities, goals, and resources, influence how different healthcare settings adapt transmission prevention guidelines to meet their specific needs [315, 316]. 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, overdoses, strokes, gastrointestinal bleeding, renal failure, hepatic failure, multi-organ system failure, and the extremes of age). Although ICUs account for a relatively

small proportion of hospitalized patients, infections acquired in these units accounted for >20% of all HAIs [317]. In the National Nosocomial Infection Surveillance (NNIS) system, 26.6% of HAIs were reported from ICU and high risk nursery (NICU) patients in 2002 (NNIS, unpublished data). This patient population has increased susceptibility to colonization and infection, especially with MDROs and *Candida* sp. [318, 319], 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 (ECMO), hemodialysis/-filtration, pacemakers, implantable left ventricular assist devices), the frequency of contact with healthcare personnel, prolonged length of stay, and prolonged exposure to antimicrobial agents [320-331]. Furthermore, adverse patient outcomes in this setting are more severe and are associated with a higher mortality [332]. Outbreaks associated with a variety of bacterial, fungal and viral pathogens due to common-source and person-to-person transmissions are frequent in adult and pediatric ICUs [31, 333-336, 337 , 338] .

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 [320, 339, 340]. In patients with a burn injury involving ≥30% of the total body surface area (TBSA), the risk of invasive burn wound infection is particularly high [341, 342]. Infections that occur in patients with burn injury involving <30% TBSA are usually associated with the use of invasive devices. Methicillin-susceptible *Staphylococcus aureus*, MRSA, enterococci, including VRE, gram-negative bacteria, and candida are prevalent pathogens in burn infections [53, 340, 343-350] and outbreaks of these organisms have been reported [351-354]. Shifts over time in the predominance of pathogens causing infections among burn patients often lead to changes in burn care practices [343, 355-358]. Burn wound infections caused by *Aspergillus* sp. or other environmental molds may result from exposure to supplies contaminated during construction [359] or to dust generated during construction or other environmental disruption [360].

Hydrotherapy equipment is an important environmental reservoir of gram-negative organisms. Its use for burn care is discouraged based on demonstrated associations between use of contaminated hydrotherapy equipment and infections. Burn wound infections and colonization, as well as bloodstream infections, caused by multidrug-resistant *P. aeruginosa* [361], *A. baumannii* [362], and MRSA [352] have been associated with hydrotherapy; excision of burn wounds in operating rooms is preferred.

Advances in burn care, specifically early excision and grafting of the burn wound, use of topical antimicrobial agents, and institution of early enteral feeding, have led to decreased infectious complications. Other advances have included prophylactic antimicrobial usage, selective digestive decontamination (SDD), and use of antimicrobial-coated catheters (ACC), but few epidemiologic studies and no efficacy studies have been performed to show the relative benefit of these measures [357].

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 [358], laminar flow [363] and high efficiency particulate air filtration [HEPA] [360] or maintaining burn patients in a separate unit without exposure to patients or equipment from other units [364]). There also is controversy regarding the need for and type of barrier precautions for routine care of burn patients. One retrospective study demonstrated efficacy and cost effectiveness of a simplified barrier isolation protocol for wound colonization, emphasizing handwashing and use of gloves, caps, masks and plastic impermeable aprons (rather than isolation gowns) for direct patient contact [365]. However, there have been no studies that define the most effective combination of infection control precautions for use in burn settings. Prospective studies in this area are needed.

I.D.1.c. Pediatrics Studies of the epidemiology of HAIs in children have identified unique infection control issues in this population [63, 64, 366-370]. Pediatric intensive care unit (PICU) patients and the lowest birthweight babies in the high-risk nursery (HRN) monitored in the NNIS system have had high rates of central venous catheter-associated bloodstream infections [64, 320, 369-372]. Additionally, there is a high prevalence of community-acquired infections among hospitalized infants and young children who have not yet become immune either by vaccination or by natural infection. The result is more patients and their sibling visitors with transmissible infections present in pediatric healthcare settings, especially during seasonal epidemics (e.g., pertussis [36, 40, 41], respiratory viral infections including those caused by RSV [24], influenza viruses [373], parainfluenza virus [374], human metapneumovirus [375], and adenoviruses [376]; rubeola [measles] [34], varicella [chickenpox] [377], and rotavirus [38, 378]).

Close physical contact between healthcare personnel and infants and young children (eg. cuddling, feeding, playing, changing soiled diapers, and cleaning copious uncontrolled respiratory secretions) provides abundant opportunities for transmission of infectious material. Practices and behaviors such as congregation of children in play areas where toys and bodily secretions are easily shared and family members rooming-in with pediatric patients can further increase the risk of transmission. Pathogenic bacteria have been recovered from toys used by hospitalized patients [379]; contaminated bath toys were implicated in an outbreak of multidrug-resistant *P. aeruginosa* on a pediatric oncology unit [80]. In addition, several patient factors increase the likelihood that infection will result from exposure to pathogens in healthcare settings (e.g., immaturity of the neonatal immune system, lack of previous natural infection and resulting immunity, prevalence of patients with congenital or acquired immune deficiencies, congenital anatomic anomalies, and use of life-saving invasive devices in neontal and pediatric intensive care units) [63]. 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 [380] and kangaroo care [381] that may increase opportunity for skin-to-skin exposure of multiple gestation infants to each other and to their mothers, respectively; although infection risk smay actually be

reduced among infants receiving kangaroo care [382]. Children who attend child care centers [383, 384] and pediatric rehabilitation units [385] may increase the overall burden of antimicrobial resistance (eg. by contributing to the reservoir of community-associated MRSA [CA-MRSA]) [386-391]. Patients in chronic care facilities may have increased rates of colonization with resistant GNBs and may be sources of introduction of resistant organisms to acute care settings [50].

I.D.2. Nonacute healthcare settings Healthcare is provided in various settings outside of hospitals including facilities, such as long-term care facilities (LTCF) (e.g. nursing homes), homes for the developmentally disabled, settings where behavioral health services are provided, rehabilitation centers and hospices[392]. In addition, healthcare may be provided in nonhealthcare settings such as workplaces with occupational health clinics, adult day care centers, assisted living facilities, homeless shelters, jails and prisons, school clinics and infirmaries. Each of these settings has unique circumstances and population risks to consider when designing and implementing an infection control program. Several of the most common settings and their particular challenges are discussed below. While this Guideline does not address each setting, the principles and strategies provided 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 [393-395]. 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 [396]. Estimates of HAI rates of 1.8 to 13.5 per 1000 resident-care days have been reported with a range of 3 to 7 per 1000 resident-care days in the more rigorous studies [397-401]. 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 [402].

LCTFs are different from other healthcare settings in that elderly patients at increased risk for infection are brought together in one setting and remain in the facility for extended periods of time; for most residents, it is their home. An atmosphere of community is fostered and residents share common eating and living areas, and participate in various facility-sponsored activities [403, 404]. Since able residents interact freely with each other, controlling transmission of infection in this setting is challenging [405]. Residents who are colonized or infected with certain microorganisms are, in some cases, restricted to their room. However, because of the psychosocial risks associated with such restriction, it has been recommended that psychosocial needs be balanced with infection control needs in the LTCF setting [406-409]. Documented LTCF outbreaks have been caused by various viruses (e.g., influenza virus [35, 410-412], rhinovirus [413], adenovirus (conjunctivitis) [414], norovirus [278, 279 275, 281]) and bacteria, including group A streptococcus [162], *B. pertussis* [415], non-susceptible *S. pneumoniae* [197, 198], other MDROs, and *Clostridium difficile* [416]) These pathogens can lead to substantial

morbidity and mortality, and increased medical costs; prompt detection and implementation of effective control measures are required.

Risk factors for infection are prevalent among LTCF residents [395, 417, 418]. Age-related declines in immunity may affect responses to immunizations for influenza and other infectious agents, and increase susceptibility to tuberculosis. Immobility, incontinence, dysphagia, underlying chronic diseases, poor functional status, and age-related skin changes increase susceptibility to urinary, respiratory and cutaneous and soft tissue infections, while malnutrition can impair wound healing [419-423]. Medications (e.g., drugs that affect level of consciousness, immune function, gastric acid secretions, and normal flora, including antimicrobial therapy) and invasive devices (e.g., urinary catheters and feeding tubes) heighten susceptibility to infection and colonization in LTCF residents [424-426]. Finally, limited functional status and total dependence on healthcare personnel for activities of daily living have been identified as independent risk factors for infection [401, 417, 427] and for colonization with MRSA [428, 429] and ESBL-producing *K. pneumoniae* [430]. Several position papers and review articles have been published that provide guidance on various aspects of infection control and antimicrobial resistance in LTCFs [406-408, 431-436]. The Centers for Medicare and Medicaid Services (CMS) have established regulations for the prevention of infection in LTCFs [437].

Because residents of LTCFs are hospitalized frequently, they can transfer pathogens between LTCFs and healthcare facilities in which they receive care [8, 438-441]. This is also true for pediatric long-term care populations. Pediatric chronic care facilities have been associated with importing extended-spectrum cephalosporin-resistant, gram-negative bacilli into one PICU [50]. Children from pediatric rehabilitation units may contribute to the reservoir of community-associated MRSA [385, 389-391].

I.D.2.b. Ambulatory Care In the past decade, healthcare delivery in the United States has shifted from the acute, inpatient hospital to a variety of ambulatory and community-based settings, including the home. Ambulatory care is provided in hospital-based outpatient clinics, nonhospital-based clinics and physician offices, public health clinics, free-standing dialysis centers, ambulatory surgical centers, urgent care centers, and many others. In 2000, there were 83 million visits to hospital outpatient clinics and more than 823 million visits to physician offices [442]; ambulatory care now accounts for most patient encounters with the health care system [443]. In these settings, adapting transmission prevention guidelines is challenging because patients remain in common areas for prolonged periods waiting to be seen by a healthcare provider or awaiting admission to the hospital, examination or treatment rooms are turned around quickly with limited cleaning, and infectious patients may not be recognized immediately. Furthermore, immunocompromised patients often receive chemotherapy in infusion rooms where they stay for extended periods of time along with other types of patients.

There are few data on the risk of HAIs in ambulatory care settings, with the exception of hemodialysis centers [18, 444, 445]. Transmission of infections in outpatient settings has been reviewed in three publications [446-448]. Goodman and Solomon summarized 53 clusters of infections associated with the outpatient setting from 1961-1990 [446]. Overall, 29 clusters were associated with common source transmission from contaminated solutions or equipment, 14 with person-to-person transmission from or involving healthcare personnel and ten associated with airborne or droplet transmission among patients and healthcare workers. Transmission of bloodborne pathogens (i.e., hepatitis B and C viruses and, rarely, HIV) in outbreaks, sometimes involving hundreds of patients, continues to occur in ambulatory settings. These outbreaks often are related to common source exposures, usually a contaminated medical device, multi-dose vial, or intravenous solution [82, 449-453]. 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 summarized [454].

Airborne transmission of *M.tuberculosis* and measles in ambulatory settings, most frequently emergency departments, has been reported [34, 127, 446, 448, 455-457]. Measles virus was transmitted in physician offices and other outpatient settings during an era when immunization rates were low and measles outbreaks in the community were occurring regularly [34, 122, 458]. Rubella has been transmitted in the outpatient obstetric setting [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 via incompletely disinfected ophthalmology equipment and/or from healthcare workers to patients, presumably by contaminated hands [17, 446, 448, 459-462].

If transmission in outpatient settings is to be prevented, screening for potentially infectious symptomatic and asymptomatic individuals, especially those who may be at risk for transmitting airborne infectious agents (e.g., *M. tuberculosis,* varicella-zoster virus, rubeola [measles]), is necessary at the start of the initial patient encounter. Upon identification of a potentially infectious patient, implementation of prevention measures, including prompt separation of potentially infectious patients and implementation of appropriate control measures (e.g., Respiratory Hygiene/Cough Etiquette and Transmission-Based Precautions) can decrease transmission risks [9, 12]. Transmission of MRSA and VRE in outpatient settings has not been reported, but the association of CA• MRSA in healthcare personnel working in an outpatient HIV clinic with environmental CA-MRSA contamination in that clinic, suggests the possibility of transmission in that setting [463]. Patient-to-patient transmission of *Burkholderia species* and *Pseudomonas aeruginosa* in outpatient clinics for adults and children with cystic fibrosis has been confirmed [464, 465].

I.D.2.c. Home Care Home care in the United States is delivered by over 20,000 provider agencies that include home health agencies, hospices, durable medical equipment providers, home infusion therapy services, and personal care and

support services providers. Home care is provided to patients of all ages with both acute and chronic conditions. The scope of services ranges from assistance with activities of daily living and physical and occupational therapy to the care of wounds, infusion therapy, and chronic ambulatory peritoneal dialysis (CAPD).

The incidence of infection in home care patients, other than those associated with infusion therapy is not well studied [466-471]. However, data collection and calculation of infection rates have been accomplished for central venous catheter-associated bloodstream infections in patients receiving home infusion therapy [470-474] and for the risk of blood contact through percutaneous or mucosal exposures, demonstrating that surveillance can be performed in this setting [475]. Draft definitions for home care associated infections have been developed [476].

Transmission risks during home care are presumed to be minimal. The main transmission risks to home care patients are from an infectious healthcare provider or contaminated equipment; providers also can be exposed to an infectious patient during home visits. Since home care involves patient care by a limited number of personnel in settings without multiple patients or shared equipment, the potential reservoir of pathogens is reduced. Infections of home care providers, that could pose a risk to home care patients include infections transmitted by the airborne or droplet routes (e.g., chickenpox, tuberculosis, influenza), and skin infestations (e.g., scabies [69] and lice) and infections (e.g.,impetigo) transmitted by direct or indirect contact. There are no published data on indirect transmission of MDROs from one home care patient to another, although this is theoretically possible if contaminated equipment is transported from an infected or colonized patient and used on another patient. Of note, investigation of the first case of VISA in homecare [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 39% of recipients did not receive the antibiotic according to recommended guidelines [477].

Although most home care agencies implement policies and procedures to prevent transmission of organisms, the current approach is based on the adaptation of the *1996 Guideline for Isolation Precautions in Hospitals* [1] as well as other professional guidance [478, 479]. This issue has been very challenging in the home care industry and practice has been inconsistent and frequently not evidence-based. For example, many home health agencies continue to observe “nursing bag technique,” a practice that prescribes the use of barriers between the nursing bag and environmental surfaces in the home [480]. While the home environment may not always appear clean, the use of barriers between two non• critical surfaces has been questioned [481, 482]. Opportunites exist to conduct research in home care related to infection transmission risks [483].

I.D.2.d. Other sites of healthcare delivery Facilities that are not primarily healthcare settings but in which healthcare is delivered include clinics in correctional facilities and shelters. Both settings can have suboptimal features,

such as crowded conditions and poor ventilation. Economically disadvantaged individuals who may have chronic illnesses and healthcare problems related to alcoholism, injection drug use, poor nutrition, and/or inadequate shelter often receive their primary healthcare at sites such as these [484]. Infectious diseases of special concern for transmission include tuberculosis, scabies, respiratory infections (e.g., *N. meningitides, S. pneumoniae*), sexually transmitted and bloodborne diseases (e.g.,HIV, HBV, HCV, syphilis, gonorrhea), hepatitis A virus (HAV), diarrheal agents such as norovirus, and foodborne diseases [286, 485-488]. A high index of suspicion for tuberculosis and CA-MRSA in these populations is needed as outbreaks in these settings or among the populations they serve have been reported [489-497].

Patient encounters in these types of facilities provide an opportunity to deliver recommended immunizations and screen for *M. tuberculosis* infection in addition to diagnosing and treating acute illnesses [498]. Recommended infection control measures in these non-traditional areas designated for healthcare delivery are the same as for other ambulatory care settings. Therefore, these settings must be equipped to observe Standard Precautions and, when indicated, Transmission-based Precautions.

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 need to be addressed.

I.E.1. Immunocompromised patients Patients who have congenital primary immune deficiencies or acquired disease (eg. treatment-induced immune deficiencies) are at increased risk for numerous types of infections while receiving healthcare and may be located throughout the healthcare facility. The specific defects of the immune system determine the types of infections that are most likely to be acquired (e.g., viral infections are associated with T-cell defects and fungal and bacterial infections occur in patients who are neutropenic). As a general group, immunocompromised patients can be cared for in the same environment as other patients; however, it is always advisable to minimize exposure to other patients with transmissible infections such as influenza and other respiratory viruses [499, 500]. 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 [501, 502]. With the application of newer and more intense immunosuppressive therapies for a variety of medical conditions (e.g., rheumatologic disease [503, 504], inflammatory bowel disease [505]), immunosuppressed patients are likely to be more widely distributed throughout a healthcare 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 [15, 506, 507].

Published data provide evidence to support placing allogeneic HSCT patients in a Protective Environment [15, 157, 158]. Also, three guidelines have been developed that address the special requirements of these immunocompromised patients, including use of antimicrobial prophylaxis and engineering controls to create a Protective Environment for the prevention of infections caused by *Aspergillus* spp. and other environmental fungi [11, 14, 15]. 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 [508].

I.E.2. Cystic fibrosis patients Patients with cystic fibrosis (CF) require special consideration when developing infection control guidelines. Compared to other patients, CF patients require additional protection to prevent transmission from contaminated respiratory therapy equipment [509-513]. Infectious agents such as *Burkholderia cepacia* complex and *P. aeruginosa* [464, 465, 514, 515] have unique clinical and prognostic significance. In CF patients, *B. cepacia* infection has been associated with increased morbidity and mortality [516-518], while delayed acquisition of chronic *P.aeruginosa* infection may be associated with an improved long-term clinical outcome [519, 520].

Person-to-person transmission of *B. cepacia* complex has been demonstrated among children [517] and adults [521] with CF in healthcare settings [464, 522], during various social contacts [523], most notably attendance at camps for patients with CF [524], and among siblings with CF [525]. 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 [97, 526]. The Cystic Fibrosis Foundation published a consensus document with evidence-based recommendations for infection control practices for CF patients [20].

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

I.F.1. Gene therapy Gene therapy has has been attempted using a number of different 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. Greatest concern attends the use of replication-competent viruses, especially vaccinia. As of the time of publication, 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 [527-529].

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 [530] cytomegalovirus infection [531], Creutzfeldt-Jacob disease [230], hepatitis C [532], infections with *Clostridium* spp. [533] and group A streptococcus [534], malaria [535], babesiosis [536], Chagas disease [537], lymphocytic choriomeningitis [538], and rabies [539, 540]. Therefore, it is important to consider receipt of biologic products when evaluating patients for potential sources of infection.

I.F.3. Xenotransplantation The transplantation of nonhuman cells, tissues, and organs into humans potentially exposes patients to zoonotic pathogens. Transmission of known zoonotic infections (e.g., trichinosis from porcine tissue), constitutes one concern, but also of concern is the possibility that transplantation of nonhuman cells, tissues, or organs may transmit previously unknown zoonotic infections (xenozoonoses) to immunosuppressed human recipients. Potential infections that might accompany transplantation of porcine organs have been described [541]. Guidelines from the U.S. Public Health Service address many infectious diseases and infection control issues that surround the developing field of xenotransplantation [542]); work in this area is ongoing.

Part II:

Fundamental elements needed to prevent transmission of infectious agents in healthcare settings

II.A. Healthcare system components that influence the effectiveness of precautions to prevent transmission

II.A.1. Administrative measures Healthcare organizations can demonstrate a commitment to preventing transmission of infectious agents by incorporating infection control into the objectives of the organization's patient and occupational safety programs [543-547]. An infrastructure to guide, support, and monitor adherence to Standard and Transmission-Based Precautions [434, 548, 549] will facilitate fulfillment of the organization's mission and achievement of the Joint Commission on Accreditation of Healthcare Organization's patient safety goal to decrease HAIs [550]. Policies and procedures that explain how Standard and Transmission-Based Precautions are applied, including systems used to identify and communicate information about patients with potentially transmissible infectious agents, are essential to ensure the success of these measures and may vary according to the characteristics of the organization.

A key administrative measure is provision of fiscal and human resources for maintaining infection control and occupational health programs that are responsive to emerging needs. Specific components include bedside nurse [551] and infection prevention and control professional (ICP) staffing levels [552], inclusion of ICPs in facility construction and design decisions [11], clinical microbiology laboratory support [553, 554], adequate supplies and equipment including facility ventilation systems [11], adherence monitoring [555], assessment and correction of system failures that contribute to transmission [556, 557], and provision of feedback to healthcare personnel and senior administrators [434, 548, 549, 558]. The positive influence of institutional leadership has been demonstrated repeatedly in studies of HCW adherence to recommended hand hygiene practices [176, 177, 434, 548, 549, 559-564]. Healthcare administrator involvement in infection control processes can improve administrators' awareness of the rationale and resource requirements for following recommended infection control practices.

Several administrative factors may affect the transmission of infectious agents in healthcare settings: institutional culture, individual worker behavior, and the work environment. Each of these areas is suitable for performance improvement monitoring and incorporation into the organization's patient safety goals [543, 544, 546, 565].

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 United States hospitals was assessed by the CDC through the Study on the Efficacy of Nosocomial Infection Control (SENIC Project) conducted 1970-76 [566]. In a representative sample of US general hospitals, those with a trained infection control physician or microbiologist involved in an infection control program, and at least one infection control nurse per 250 beds, were associated with a 32% lower rate of four infections studied (CVC-associated bloodstream infections, ventilator-associated pneumonias, catheter-related urinary tract infections, and surgical site infections).

Since that landmark study was published, responsibilities of ICPs have expanded commensurate with the growing complexity of the healthcare system, the patient populations served, and the increasing numbers of medical procedures and devices used in all types of healthcare settings. The scope of work of ICPs was first assessed in 1982 [567-569] by the Certification Board of Infection Control (CBIC), and has been re-assessed every five years since that time [558, 570-572]. The findings of these task analyses have been used to develop and update the Infection Control Certification Examination, offered for the first time in 1983. With each survey, it is apparent that the role of the ICP is growing in complexity and scope, beyond traditional infection control activities in acute care hospitals. Activities currently assigned to ICPs in response to emerging challenges include: 1) surveillance and infection prevention at facilities other than acute care hospitals e.g., ambulatory clinics, day surgery centers, long term care facilities, rehabilitation centers, home care; 2) oversight of employee health services related to infection prevention, e.g. assessment of risk and administration of recommended treatment following exposure to infectious agents, tuberculosis screening, influenza vaccination, respiratory protection fit testing, and administration of other vaccines as indicated, such as smallpox vaccine in 2003; 3) preparedness planning for annual influenza outbreaks, pandemic influenza, SARS, bioweapons attacks; 4) adherence monitoring for selected infection control practices; 5) oversight of risk assessment and implementation of prevention measures associated with construction and renovation; 6) prevention of transmission of MDROs; 7) evaluation of new medical products that could be associated with increased infection risk. e.g.,intravenous infusion materials; 9) communication with the public, facility staff, and state and local health departments concerning infection control-related issues; and 10) participation in local and multi-center research projects [434, 549, 552, 558, 573, 574].

None of the CBIC 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 [558]. There is agreement in the literature that 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 level of staffing [552]. A survey of participants in the National

Nosocomial Infections Surveillance (NNIS) system found the average daily census per ICP was 115 [316]. Results of other studies have been similar: 3 per 500 beds for large acute care hospitals, 1 per 150-250 beds in long term care facilities, and 1.56 per 250 in small rural hospitals [573, 575]. The foregoing demonstrates that infection control staffing can no longer 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 healthcare system, tools available to assist personnel to perform essential tasks (e.g., electronic tracking and laboratory support for surveillance), and unique or urgent needs of the institution and community [552]. Furthermore, appropriate training is required to optimize the quality of work performed [558, 572, 576].

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 [577-582]. Such individuals receive training in basic infection control and have frequent communication with the 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 implementation of 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, <u>not</u> 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 [583, 584]. If there are adequate nursing staff, it is more likely that infection control practices, including hand hygiene and Standard and Transmission-Based Precautions, will be given appropriate attention and applied correctly and consistently [552]. A national multicenter study reported strong and consistent inverse relationships between nurse staffing and five adverse outcomes in medical patients, two of which were HAIs: urinary tract infections and pneumonia [583]. The association of nursing staff shortages with increased rates of HAIs has been demonstrated in several outbreaks in hospitals and long term care settings, and with increased transmission of hepatitis C virus in dialysis units [22, 418, 551, 585-597]. In most cases, when staffing improved as part of a comprehensive control intervention, the outbreak ended or the HAI rate declined. In two studies [590, 596], 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 pool nurses increased.

II.A.1.c. Clinical microbiology laboratory support The critical role of the clinical microbiology laboratory in infection control and healthcare epidemiology is described well [553, 554, 598-600] and is supported by the Infectious Disease Society

of America policy statement on consolidation of clinical microbiology laboratories published in 2001 [553]. The clinical microbiology laboratory contributes to preventing transmission of infectious diseases in healthcare settings by promptly detecting and reporting epidemiologically important organisms, identifying emerging patterns of antimicrobial resistance, and assisting in assessment of the effectiveness of recommended precautions to limit transmission during outbreaks [598]. Outbreaks of infections may be recognized first by laboratorians [162]. Healthcare 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 (e.g., providers of clinical care, infection control staff, healthcare epidemiologists, and infectious disease consultants) [601]. As concerns about emerging pathogens and bioterrorism grow, the role of the clinical microbiology laboratory takes on even greater importance. For healthcare organizations that outsource microbiology laboratory services (e.g., ambulatory care, home care, LTCFs, smaller acute care hospitals), it is important to specify by contract the types of services (e.g., periodic institution-specific aggregate susceptibility reports) 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 (NCCLS), known as the Clinical and Laboratory Standards Institute (CLSI) since 2005 [602], for the detection of emerging resistance patterns [603, 604], and for the preparation, analysis, and distribution of periodic cumulative antimicrobial susceptibility summary reports [605-607]. While not required, clinical laboratories ideally should have access to rapid genotypic identification of bacteria and their antibiotic resistance genes [608].
- 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 decisions concerning the indications for initiating and discontinuing active surveillance programs and optimize the use of laboratory resources.
- Molecular typing, on-site or outsourced, in order to investigate and control healthcare-associated outbreaks [609].
- 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 (e.g., influenza [610-612], B. pertussis [613], RSV [614, 615], and enteroviruses [616]). The microbiologist provides guidance to limit rapid testing to clinical situations in which rapid results influence patient

management decisions, as well as providing oversight of point-of-care testing performed by non-laboratory healthcare workers [617].

- Detection and rapid reporting of epidemiologically important organisms, including those that are reportable to public health agencies.
- Implementation of a quality control program that ensures testing services are appropriate for the population served, and 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 [618, 619].

II.A.2. Institutional safety culture and organizational characteristics Safety culture (or safety climate) refers to a work environment where a shared commitment to safety on the part of management and the workforce is understood and followed [557, 620, 621]. The authors of the Institute of Medicine Report, To Err is Human [543], acknowledge that causes of medical error are multifaceted but emphasize repeatedly the pivotal role of system failures and the benefits of a safety culture. A safety culture is created through 1) the actions management takes to improve patient and worker safety; 2) worker participation in safety planning; 3) the availability of appropriate protective equipment; 4) influence of group norms regarding acceptable safety practices; and 5) the organization's socialization process for new personnel. Safety and patient outcomes can be enhanced by improving or creating organizational characteristics within patient care units as demonstrated by studies of surgical ICUs [622, 623]. Each of these factors has a direct bearing on adherence to transmission prevention recommendations [257]. Measurement of an institutional culture of safety is useful for designing improvements in healthcare [624, 625]. 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 [626-632]. One study of hand hygiene practices concluded that improved adherence requires integration of infection control into the organization's safety culture [561]. Several hospitals that are part of the Veterans Administration Healthcare System have taken specific steps toward improving the safety culture, including error reporting mechanisms, performing root cause analysis on problems identified, providing safety incentives, and employee education. [633-635].

II.A.3. Adherence of healthcare personnel to recommended guidelines Adherence to recommended infection control practices decreases transmission of infectious agents in healthcare settings [116, 562, 636-640]. However, several observational studies have shown limited adherence to recommended practices by healthcare personnel [559, 640-657]. Observed adherence to universal precautions ranged from 43% to 89% [641, 642, 649, 651, 652]. However, the degree of adherence depended frequently on the practice that was assessed and, for glove use, the circumstance in which they were used. Appropriate glove use has ranged from a low of 15% [645] to a high of 82% [650]. However, 92% and 98% adherence with glove use have been reported during arterial blood gas collection and

resuscitation, respectively, procedures where there may be considerable blood contact [643, 656]. Differences in observed adherence have been reported among occupational groups in the same healthcare facility [641] and between experienced and nonexperienced professionals [645]. In surveys of healthcare personnel, self-reported adherence was generally higher than that reported in observational studies. Furthermore, where an observational component was included with a self-reported survey, self-perceived adherence was often greater than observed adherence [657]. Among nurses and physicians, increasing years of experience is a negative predictor of adherence [645, 651]. Education to improve adherence is the primary intervention that has been studied. While positive changes in knowledge and attitude have been demonstrated, [640, 658], there often has been limited or no accompanying change in behavior [642, 644]. Self-reported adherence is higher in groups that have received an educational intervention [630, 659]. Educational interventions that incorporated videotaping and performance feedback were successful in improving adherence during the period of study; the long-term effect of these interventions is not known [654].The use of videotape also served to identify system problems (e.g., communication and access to personal protective equipment) that otherwise may not have been recognized.

Use of engineering controls and facility design concepts for improving adherence is gaining interest. While introduction of automated sinks had a negative impact on consistent adherence to hand washing [660], use of electronic monitoring and voice prompts to remind healthcare workers to perform hand hygiene, and improving accessibility to hand hygiene products, increased adherence and contributed to a decrease in HAIs in one study [661]. More information is needed regarding how technology might improve adherence.

Improving adherence to infection control practices requires a multifaceted approach that incorporates continuous assessment of both the individual and the work environment [559, 561]. Using several behavioral theories, Kretzer and Larson concluded that a single intervention (e.g., a handwashing campaign or putting up new posters about transmission precautions) would likely be ineffective in improving healthcare personnel adherence [662]. Improvement requires that the organizational leadership make prevention an institutional priority and integrate infection control practices into the organization's safety culture [561]. A recent review of the literature concluded that variations in organizational factors (e.g., safety climate, policies and procedures, education and training) and individual factors (e.g., knowledge, perceptions of risk, past experience) were determinants of adherence to infection control guidelines for protection against SARS and other respiratory pathogens [257].

II.B. Surveillance for healthcare-associated infections (HAIs)

Surveillance is an essential tool for case-finding of single patients or clusters of patients who are infected or colonized with epidemiologically important organisms (e.g., susceptible bacteria such as *S. aureus, S. pyogenes* [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 [663]. The work of Ignaz Semmelweis that described 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 [664]. Surveillance of both process measures and the infection rates to which they are linked are important for evaluating the effectiveness of infection prevention efforts and identifying indications for change [555, 665-668].

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 [566]; however, surveillance was the only component essential for reducing all four types of HAIs. Although a similar study has not been conducted in other healthcare settings, a role for surveillance and the need for novel strategies have been described in LTCFs [398, 434, 669, 670] and in home care [470-473]. The essential elements of a surveillance system are: 1) standardized definitions; 2) identification of patient populations at risk for infection; 3) statistical analysis (e.g. risk-adjustment, calculation of rates using appropriate denominators, trend analysis using methods such as statistical process control charts); and 4) feedback of results to the primary caregivers [671•676]. Data gathered through surveillance of high-risk populations, device use, procedures, and/or facility locations (e.g., ICUs) are useful for detecting transmission trends [671-673]. Identification of clusters of infections should be followed by a systematic epidemiologic investigation to determine commonalities in persons, places, and time; and guide implementation of interventions and evaluation of the effectiveness of those interventions.

Targeted surveillance based on the highest risk areas or patients has been preferred over facility-wide surveillance for the most effective use of resources [673, 676]. However, surveillance for certain epidemiologically important organisms may need to be facility-wide. Surveillance methods will continue to evolve as healthcare delivery systems change [392, 677] and user-friendly electronic tools become more widely available for electronic tracking and trend analysis [674, 678, 679]. Individuals with experience in healthcare epidemiology and infection control should be involved in selecting software packages for data aggregation and analysis to assure 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 [680].

II.C. Education of HCWs, patients, and families

Education and training of healthcare personnel are a prerequisite for ensuring that policies and procedures for Standard and Transmission-Based Precautions are understood and practiced. Understanding the scientific rationale for the

precautions will allow HCWs to apply procedures correctly, as well as safely modify precautions based on changing requirements, resources, or healthcare settings [14, 655, 681-688]. In one study, the likelihood of HCWs developing SARS was strongly associated with less than 2 hours of infection control training and lack of understanding of infection control procedures [689]. Education about the important role of vaccines (e.g., influenza, measles, varicella, pertussis, pneumococcal) in protecting healthcare personnel, their patients, and family members can help improve vaccination rates [690-693].

Education on the principles and practices for preventing transmission of infectious agents should begin during training in the health professions and be provided to anyone who has an opportunity for contact with patients or medical equipment (e.g., nursing and medical staff; therapists and technicians, including respiratory, physical, occupational, radiology, and cardiology personnel; phlebotomists; housekeeping and maintenance staff; and students). In healthcare facilities, education and training on Standard and Transmission-Based Precautions are typically provided at the time of orientation and should be repeated as necessary to maintain competency; updated education and training are necessary when policies and procedures are revised or when there is a special circumstance, such as an outbreak that requires modification of current practice or adoption of new recommendations. Education and training materials and methods appropriate to the HCW's level of responsibility, individual learning habits, and language needs, can improve the learning experience [658, 694-702].

Education programs for healthcare personnel have been associated with sustained improvement in adherence to best practices and a related decrease in device-associated HAIs in teaching and non-teaching settings [639, 703] and in medical and surgical ICUs {Coopersmith, 2002 #2149; Babcock, 2004 #2126; Berenholtz, 2004 #2289; 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 HCWs knowledge,and adherence to recommended practices are necessary to achieve the desired changes and to identify continuing education needs [562, 704-708]. Effectiveness of this approach for isolation practices has been demonstrated for control of RSV [116, 684].

Patients, family members, and visitors can be partners in preventing transmission of infections in healthcare settings [9, 42, 709-711]. Information about Standard Precautions, especially hand hygiene, Respiratory Hygiene/Cough Etiquette, vaccination (especially against influenza) and other routine infection prevention strategies may be incorporated into patient information materials that are provided upon admission to the healthcare facility. Additional information about Transmission-Based Precautions is best provided at the time they are initiated. Fact sheets, pamphlets, and other printed material may include information on the rationale for the additional precautions, risks to household members, room assignment for Transmission-Based Precautions purposes, explanation about the use of personal protective equipment by HCWs, and directions for use of

such equipment by family members and visitors. Such information may be particularly helpful in the home environment where household members often have primary responsibility for adherence to recommended infection control practices. Healthcare personnel must be available and prepared to explain this material and answer questions as needed.

II.D. Hand hygiene

Hand hygiene has been cited frequently as the single most important practice to reduce the transmission of infectious agents in healthcare settings [559, 712, 713] and is an essential element of Standard Precautions. The term “hand hygiene” includes both handwashing with either plain or antiseptic-containing soap and water, and use of alcohol-based products (gels, rinses, foams) that do not require the use of water. In the absence of visible soiling of hands, approved alcohol-based products for hand disinfection are preferred over antimicrobial or plain soap and water because of their superior microbiocidal activity, reduced drying of the skin, and convenience [559]. Improved hand hygiene practices have been associated with a sustained decrease in the incidence of MRSA and VRE infections primarily in the ICU [561, 562, 714-717]. The scientific rationale, indications, methods, and products for hand hygiene are summarized in other publications [559, 717].

The effectiveness of hand hygiene can be reduced by the type and length of fingernails [559, 718, 719]. Individuals wearing artifical nails have been shown to harbor more pathogenic organisms, especially gram negative bacilli and yeasts, on the nails and in the subungual area than those with native nails [720, 721]. In 2002, CDC/HICPAC recommended (Category IA) that artificial fingernails and extenders not be worn by healthcare personnel who have contact with high-risk patients (e.g., those in ICUs, ORs) due to the association with outbreaks of gram-negative bacillus and candidal infections as confirmed by molecular typing of isolates [30, 31, 559, 722-725].The need to restrict the wearing of artificial fingernails by all healthcare personnel who provide direct patient care or by healthcare personnel who have contact with other high risk groups (e.g., oncology, cystic fibrosis patients), has not been studied, but has been recommended by some experts [20]. At this time such decisions are at the discretion of an individual facility’s infection control program. There is less evidence that jewelry affects the quality of hand hygiene. Although hand contamination with potential pathogens is increased with ring-wearing [559, 726], no studies have related this practice to HCW-to-patient transmission of pathogens.

II.E. Personal protective equipment (PPE) for healthcare personnel

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

interaction and/or the likely mode(s) of transmission. Guidance on the use of PPE is discussed in Part III. A suggested procedure for donning and removing PPE that will prevent skin or clothing contamination is presented in the Figure. Designated containers for used disposable or reusable PPE should be placed in a location that is 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 and methods for selecting this equipment.

II.E.1. Gloves Gloves are used to prevent contamination of healthcare personnel 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 e.g., VRE, MRSA, RSV [559, 727, 728]; or 3) handling or touching visibly or potentially contaminated patient care equipment and environmental surfaces [72, 73, 559]. Gloves can protect both patients and healthcare personnel from exposure to infectious material that may be carried on hands [73]. The extent to which gloves will protect healthcare personnel from transmission of bloodborne pathogens (e.g., HIV, HBV, HCV) following a needlestick or other pucture that penetrates the glove barrier has not been determined. Although gloves may reduce the volume of blood on the external surface of a sharp by 46•86% [729], the residual blood in the lumen of a hollowbore needle would not be affected; therefore, the effect on transmission risk is unknown.

Gloves manufactured for healthcare purposes are subject to FDA evaluation and clearance [730]. Nonsterile disposable medical gloves made of a variety of materials (e.g., latex, vinyl, nitrile) are available for routine patient care [731]. The selection of glove type for non-surgical use is based on a number of factors, including the task that is to be performed, anticipated contact with chemicals and chemotherapeutic agents, latex sensitivity, sizing, and facility policies for creating a latex-free environment [17, 732-734]. For contact with blood and body fluids during non-surgical patient care, a single pair of gloves generally provides adequate barrier protection [734]. However, there is considerable variability among gloves; both the quality of the manufacturing process and type of material influence their barrier effectiveness [735]. While there is little difference in the barrier properties of unused intact gloves [736], studies have shown repeatedly that vinyl gloves have higher failure rates than latex or nitrile gloves when tested under simulated and actual clinical conditions [731, 735-738]. For this reason either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity and/or will involve more than brief patient contact. It may be necessary to stock gloves in several sizes. Heavier, reusable utility gloves are indicated for non-patient care activities, such as handling or cleaning contaminated equipment or surfaces [11, 14, 739].

During patient care, transmission of infectious organisms can be reduced by adhering to the principles of working from “clean” to “dirty”, and confining or limiting contamination to surfaces that are directly needed for patient care. It may be necessary to change gloves during the care of a single patient to prevent

cross-contamination of body sites [559, 740]. It also may be necessary to change gloves if the patient interaction also involves touching portable computer keyboards or other mobile equipment that is transported from room to room. Discarding gloves between patients is necessary to prevent transmission of infectious material. Gloves must not be washed for subsequent reuse because microorganisms cannot be removed reliably from glove surfaces and continued glove integrity cannot be ensured. Furthermore, glove reuse has been associated with transmission of MRSA and gram-negative bacilli [741-743].
When gloves are worn in combination with other PPE, they are put on last. Gloves that fit snugly around the wrist are preferred for use with an isolation gown because they will cover the gown cuff and provide a more reliable continuous barrier for the arms, wrists, and hands. Gloves that are removed properly will prevent hand contamination (Figure). Hand hygiene following glove removal further ensures that the hands will not carry potentially infectious material that might have penetrated through unrecognized tears or that could contaminate the hands during glove removal [559, 728, 741].

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 [24, 88, 262, 744-746]. The need for and type of isolation gown selected is based on the nature of the patient interaction, including the anticipated degree of contact with infectious material and potential for blood and body fluid penetration of the barrier. The wearing of isolation gowns and other protective apparel is mandated by the OSHA Bloodborne Pathogens Standard [739]. Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered PPE.
When applying Standard Precautions, an isolation gown is worn only if contact with blood or body fluid is anticipated. However, when Contact Precautions are used (i.e., to prevent transmission of an infectious agent that is not interrupted by Standard Precautions alone and that is associated with environmental contamination), donning of both gown and gloves upon room entry is indicated to address unintentional contact with contaminated environmental surfaces [54, 72, 73, 88]. The routine donning of isolation gowns upon entry into an intensive care unit or other high-risk area does not prevent or influence potential colonization or infection of patients in those areas[365, 747-750].

Isolation gowns are always worn in combination with gloves, and with other PPE when indicated. Gowns are usually the first piece of PPE to be donned. Full coverage of the arms and body front, from neck to the mid-thigh or below will ensure that clothing and exposed upper body areas are protected. Several gown sizes should be available in a healthcare facility to ensure appropriate coverage for staff members. Isolation gowns should be removed before leaving the patient care area to prevent possible contamination of the environment outside the patient's room. Isolation gowns should be removed in a manner that prevents contamination of clothing or skin (Figure). 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, face shields

II.E.3.a. *Masks* Masks are used for three primary purposes in healthcare settings: 1) placed on healthcare personnel to protect them from contact with infectious material from patients e.g., respiratory secretions and sprays of blood or body fluids, consistent with Standard Precautions and Droplet Precautions; 2) placed on healthcare personnel when engaged in procedures requiring sterile technique to protect patients from exposure to infectious agents carried in a healthcare worker's mouth or nose, and 3) placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others (i.e., Respiratory Hygiene/Cough Etiquette). Masks may be used in combination with goggles to protect the mouth, nose and eyes, or a face shield may be used instead of a mask and goggles, to provide more complete protection for the face, as discussed below. **Masks should not be confused with particulate respirators that are used to prevent inhalation of small particles that may contain infectious agents transmitted via the airborne route as described below.**

The mucous membranes of the mouth, nose, and eyes are susceptible portals of entry for infectious agents, as can be other skin surfaces if skin integrity is compromised (e.g., by acne, dermatitis) [66, 751-754]. Therefore, use of PPE to protect these body sites is an important component of Standard Precautions. The protective effect of masks for exposed healthcare personnel has been demonstrated [93, 113, 755, 756]. Procedures that generate splashes or sprays of blood, body fluids, secretions, or excretions (e.g., endotracheal suctioning, bronchoscopy, invasive vascular procedures) require either a face shield (disposable or reusable) or mask and goggles [93-95, 96 , 113, 115, 262, 739, 757] .The wearing of masks, eye protection, and face shields in specified circumstances when blood or body fluid exposures are likely to occur is mandated by the OSHA Bloodborne Pathogens Standard [739]. Appropriate PPE should be selected based on the anticipated level of exposure.

Two mask types are available for use in healthcare settings: surgical masks that are cleared by the FDA and required to have fluid-resistant properties, and procedure or isolation masks [758 #2688]. No studies have been published that compare mask types to determine whether one mask type provides better protection than another. Since procedure/isolation masks are not regulated by the FDA, there may be more variability in quality and performance than with surgical masks. Masks come in various shapes (e.g., molded and non-molded), sizes, filtration efficiency, and method of attachment (e.g., ties, elastic, ear loops). Healthcare facilities may find that different types of masks are needed to meet individual healthcare personnel needs.

II.E.3.b. *Goggles, face shields* Guidance on eye protection for infection control has been published [759]. The eye protection chosen for specific work situations (e.g., goggles or face shield) depends upon the circumstances of exposure, other

PPE used, and personal vision needs. Personal eyeglasses and contact lenses are NOT considered adequate eye protection (www.cdc.gov/niosh/topics/eye/eye-infectious.html). NIOSH states that, eye protection must be comfortable, allow for sufficient peripheral vision, and must be adjustable to ensure a secure fit. It may be necessary to provide several different types, styles, and sizes of protective equipment. Indirectly-vented goggles with a manufacturer's anti-fog coating may provide the most reliable practical eye protection from splashes, sprays, and respiratory droplets from multiple angles. Newer styles of goggles may provide better indirect airflow properties to reduce fogging, as well as better peripheral vision and more size options for fitting goggles to different workers. Many styles of goggles fit adequately over prescription glasses with minimal gaps. While effective as eye protection, goggles do not provide splash or spray protection to other parts of the face.

The role of goggles, in addition to a mask, in preventing exposure to infectious agents transmitted via respiratory droplets has been studied only for RSV. Reports published in the mid-1980s demonstrated that eye protection reduced occupational transmission of RSV [760, 761]. Whether this was due to preventing hand-eye contact or respiratory droplet-eye contact has not been determined. However, subsequent studies demonstrated that RSV transmission is effectively prevented by adherence to Standard plus Contact Precations and that for this virus routine use of goggles is not necessary [24, 116, 117, 684, 762]. It is important to remind healthcare personnel that even if Droplet Precautions are not recommended for a specific respiratory tract pathogen, protection for the eyes, nose and mouth by using a mask and goggles, or face shield alone, is necessary when it is likely that there will be a splash or spray of any respiratory secretions or other body fluids as defined in Standard Precautions

Disposable or non-disposable face shields may be used as an alternative to goggles [759]. As compared with goggles, a face shield can provide protection to other facial areas in addition to the eyes. Face shields extending from chin to crown provide better face and eye protection from splashes and sprays; face shields that wrap around the sides may reduce splashes around the edge of the shield.

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

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 CDC workshop in 2004 [763]. Respiratory protection currently requires the use of a respirator with N95 or higher 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, 2005* (CDC.MMWR 2005; 54: RR-17 [12]).
Respiratory protection is broadly regulated by OSHA under the general industry standard for respiratory protection (29CFR1910.134)[764] which requires that U.S. employers in all employment settings implement a program to protect employees from inhalation of toxic materials. OSHA program components include medical clearance to wear a respirator; provision and use of appropriate respirators, including fit-tested NIOSH-certified N95 and higher particulate filtering respirators; education on respirator use and periodic re-evaluation of the respiratory protection program. When selecting particulate respirators, models with inherently good fit characteristics (i.e., those expected to provide protection factors of 10 or more to 95% of wearers) are preferred and could theoretically relieve the need for fit testing [765, 766]. Issues pertaining to respiratory protection remain the subject of ongoing debate. Information on various types of respirators may be found at www.cdc.gov/niosh/npptl/respirators/respsars.html and in published studies [765, 767, 768]. A user-seal check (formerly called a "fit check") should be performed by the wearer of a respirator each time a respirator is donned to minimize air leakage around the facepiece [769]. The optimal frequency of fit-testng has not been determined; re-testing may be indicated if there is a change in facial features of the wearer, onset of a medical condition that would affect respiratory function in the wearer, or a change in the model or size of the initially assigned respirator [12].
Respiratory protection was first recommended for protection of preventing U.S. healthcare personnel from exposure to *M. tuberculosis* in 1989. That recommendation has been maintained in two successive revisions of the Guidelines for Prevention of Transmission of Tuberculosis in Hospitals and other Healthcare Settings [12, 126]. The incremental benefit from respirator use, in addition to administrative and engineering controls (i.e., AIIRs, early recognition of patients likely to have tuberculosis and prompt placement in an AIIR, and maintenance of a patient with suspected tuberculosis in an AIIR until no longer infectious), for preventing transmission of airborne infectious agents (e.g., *M. tuberculosis)* is undetermined. Although some studies have demonstrated effective prevention of *M. tuberculosis* transmission in hospitals where surgical masks, instead of respirators, were used in conjunction with other administrative and engineering controls [637, 770, 771], CDC currently recommends N95 or higher level respirators for personnel exposed to patients with suspected or confirmed tuberculosis. Currently this is also true for other diseases that could be transmitted through the airborne route, including SARS [262] and smallpox [108, 129, 772], until inhalational transmission is better defined or healthcare-specific protective equipment more suitable for for preventing infection are developed. Respirators are also currently recommended to be worn during the performance of aerosol-generating procedures (e.g., intubation, bronchoscopy, suctioning) on patients withSARS Co-V infection, avian influenza and pandemic influenza (See Appendix A).
Although Airborne Precautions are recommended for preventing airborne transmission of measles and varicella-zoster viruses, there are no data upon

which to base a recommendation for respiratory protection to protect susceptible personnel against these two infections; transmission of varicella-zoster virus has been prevented among pediatric patients using negative pressure isolation alone [773]. Whether respiratory protection (i.e., wearing a particulate respirator) would enhance protection from these viruses has not been studied. Since the majority of healthcare personnel have natural or acquired immunity to these viruses, only immune personnel generally care for patients with these infections [774-777]. Although there is no evidence to suggest that masks are not adequate to protect healthcare personnel in these settings, for purposes of consistency and simplicity, or because of difficulties in ascertaining immunity, some facilities may require the use of respirators for entry into all AIIRs, regardless of the specific infectious agent.

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

II.F. Safe work practices to prevent HCW 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 healthcare personnel [778, 779]. The prevention of sharps injuries has always been an essential element of Universal and now Standard Precautions [1, 780]. 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 that are addressed elsewhere [781-785].

Since 1991, when OSHA first issued its Bloodborne Pathogens Standard to protect healthcare personnel from blood exposure, the focus of regulatory and legislative activity has been on implementing a hierarchy of control measures. This has included focusing attention on removing sharps hazards through the development and use of engineering controls. The federal Needlestick Safety and Prevention Act signed into law in November, 2000 authorized OSHA's revision of its Bloodborne Pathogens Standard to more explicitly require the use of safety-engineered sharp devices [786]. CDC has provided guidance on sharps injury prevention [787, 788], including for the design, implementation and evaluation of a comprehensive sharps injury prevention program [789].

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 healthcare personnel [66, 752, 754, 779]. The prevention of mucous membrane exposures has always been an element of Universal and now Standard Precautions for routine patient care [1, 753] and is subject to OSHA bloodborne pathogen regulations. Safe work practices, in addition to wearing PPE, are used to protect mucous membranes and non-intact skin from contact with potentially infectious material. These include keeping gloved and ungloved hands that are contaminated from touching the mouth, nose, eyes, or face; and positioning patients to direct sprays and splatter away from the face of the caregiver. Careful placement of PPE before patient contact will help avoid the need to make PPE adjustments and possible face or mucous membrane contamination during use.
In areas where the need for resuscitation is unpredictable, mouthpieces, pocket resuscitation masks with one-way valves, and other ventilation devices provide an alternative to mouth-to-mouth resuscitation, preventing exposure of the caregiver's nose and mouth to oral and respiratory fluids during the procedure.

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 healthcare personnel, including *M. tuberculosis* [790], SARS-CoV [93, 94, 98] and *N. meningitidis* [95]. Protection of the eyes, nose and mouth, in addition to gown and gloves, is recommended during performance of these procedures in accordance with Standard Precautions. Use of a particulate respirator is recommended during aerosol-generating procedures when the aerosol is likely to contain *M. tuberculosis*, SARS-CoV, or avian or pandemic influenza viruses.

II.G. Patient placement

II.G.1. Hospitals and long-term care settings Options for patient placement include single patient rooms, two patient rooms, and multi-bed wards. Of these, single patient rooms are prefered when there is a concern about transmission of an infectious agent. Although some studies have failed to demonstrate the efficacy of single patient rooms to prevent HAIs [791], other published studies, including one commissioned by the American Institute of Architects and the Facility Guidelines Institute, have documented a beneficial relationship between private rooms and reduction in infectious and noninfectious adverse patient outcomes [792, 793]. The AIA notes that private rooms are the trend in hospital planning and design. However, most hospitals and long-term care facilities have multi-bed rooms and must consider many competing priorities when determining the appropriate room placement for patients (e.g., reason for admission; patient characteristics, such as age, gender, mental status; staffing needs; family

requests; psychosocial factors; reimbursement concerns). In the absence of obvious infectious diseases that require specified airborne infection isolation rooms (e.g., tuberculosis, SARS, chickenpox), the risk of transmission of infectious agents is not always considered when making placement decisions**.** When there are only a limited number of single-patient rooms, it is prudent to prioritize them for those patients who have conditions that facilitate transmission of infectious material to other patients (e.g., draining wounds, stool incontinence, uncontained secretions) and for those who are at increased risk of acquisition and adverse outcomes resulting from HAI (e.g., immunosuppression, open wounds, indwelling catheters, anticipated prolonged length of stay, total dependence on HCWs for activities of daily living) [15, 24, 43, 430, 794, 795].

Single-patient rooms are always indicated for patients placed on Airborne Precautions and in a Protective Environment and are preferred for patients who require Contact or Droplet Precautions [23, 24, 410, 435, 796, 797]. During a suspected or proven outbreak caused by a pathogen whose reservoir is the gastrointestinal tract, use of single patient rooms with private bathrooms limits opportunities for transmission, especially when the colonized or infected patient has poor personal hygiene habits, fecal incontinence, or cannot be expected to assist in maintaining procedures that prevent transmission of microorganisms (e.g., infants, children, and patients with altered mental status or developmental delay). In the absence of continued transmission, it is not necessary to provide a private bathroom for patients colonized or infected with enteric pathogens as long as personal hygiene practices and Standard Precautions, especially hand hygiene and appropriate environmental cleaning, are maintained. Assignment of a dedicated commode to a patient,and cleaning and disinfecting fixtures and equipment that may have fecal contamination (e.g., bathrooms, commodes [798], scales used for weighing diapers) and the adjacent surfaces with appropriate agents may be especially important when a single-patient room can not be used since environmental contamination with intestinal tract pathogens is likely from both continent and incontinent patients [54, 799]. Results of several studies to determine the benefit of a single-patient room to prevent transmission of *Clostridium difficile* are inconclusive [167, 800-802]. Some studies have shown that being in the same room with a colonized or infected patient is not necessarily a risk factor for transmission [791, 803-805]. However, for children, the risk of healthcare-associated diarrhea is increased with the increased number of patients per room [806]. Thus, patient factors are important determinants of infection transmission risks, and the need for a single-patient room and/or private bathroom for any patient is best determined on a case-by-case basis.

Cohorting is the practice of grouping together patients who are colonized or infected with the same organism to confine their care to one area and prevent contact with other patients. Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology, and mode of transmission of the infectious agent. It is generally preferred not to place severely immunosuppressed patients in rooms with other patients. Cohorting has been used extensively for managing outbreaks of MDROs including MRSA [22, 807], VRE [638, 808, 809], MDR-ESBLs [810]; *Pseudomonas aeruginosa* [29]; methicillin-susceptible

Staphylococcus aureus [811]; RSV [812, 813]; adenovirus keratoconjunctivitis [814]; rotavirus [815]; and SARS [816]. Modeling studies provide additional support for cohorting patients to control outbreaks Talon [817-819]. However, cohorting often is implemented only after routine infection control measures have failed to control an outbreak.
Assigning or cohorting healthcare personnel to care only for patients infected or colonized with a single target pathogen limits further transmission of the target pathogen to uninfected patients [740, 819] but is difficult to achieve in the face of current staffing shortages in hospitals [583] and residential healthcare sites [820-822]. However, when continued transmission is occurring after implementing routine infection control measures and creating patient cohorts, cohorting of healthcare personnel may be beneficial.

During the seasons when RSV, human metapneumovirus [823], parainfluenza, influenza, other respiratory viruses [824], 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 [825]. For example, during the respiratory virus season, infants may be cohorted based soley on the clinical diagnosis of bronchiolitis due to the logistical difficulties and costs associated with requiring microbiologic confirmation prior to room placement, and the predominance of RSV during most of the season. However, when available, single patient rooms are always preferred since a common clinical presentation (e.g., bronchiolitis), can be caused by more than one infectious agent [823, 824, 826]. Furthermore, the inability of infants and children to contain body fluids, and the close physical contact that occurs during their care, increases infection transmission risks for patients and personnel in this setting [24, 795].

II.G.2. Ambulatory settings Patients actively infected with or incubating transmissible infectious diseases are seen frequently in ambulatory settings (e.g., outpatient clinics, physicians' offices, emergency departments) and potentially expose healthcare personnel and other patients, family members and visitors [21, 34, 127, 135, 142, 827]. In response to the global outbreak of SARS in 2003 and in preparation for pandemic influenza, healthcare providers working in outpatient settings are urged to implement source containment measures (e.g., asking couging patients to wear a surgical mask or cover their coughs with tissues) to prevent transmission of respiratory infections, beginning at the point of initial patient encounter [9, 262, 828] as described below in section III.A.1.a. Signs can be posted at the entrance to facilities or at the reception or registration desk requesting that the patient or individuals accompanying the patient promptly inform the receptionist if there are symptoms of a respiratory infection (e.g., cough, flu-like illness, increased production of respiratory secretions). The presence of diarrhea, skin rash, or known or suspected exposure to a transmissible disease (e.g., measles, pertussis, chickenpox, tuberculosis) also could be added. Placement of potentially infectious patients without delay in an examination room limits the number of exposed individuals, e.g., in the common waiting area.

In waiting areas, maintaining a distance between symptomatic and non-symptomatic patients (e.g., >3 feet), in addition to source control measures, may limit exposures. However, infections transmitted via the airborne route (e.g., *M tuberculosis*, measles, chickenpox) require additional precautions [12, 125, 829]. Patients suspected of having such an infection can wear a surgical mask for source containment, if tolerated, and should be placed in an examination room, preferably an AIIR, as soon as possible. If this is not possible, having the patient wear a mask and segregate him/herself from other patients in the waiting area will reduce opportunities to expose others. Since the person(s) accompanying the patient also may be infectious, application of the same infection control precautions may need to be extended to these persons if they are symptomatic [21, 252, 830]. For example, family members accompanying children admitted with suspected *M. tuberculosis* have been found to have unsuspected pulmonary tuberculosis with cavitary lesions, even when asymptomatic [42, 831].
Patients with underlying conditions that increase their susceptibility to infection (e.g., those who are immunocompromised [43, 44] or have cystic fibrosis [20]) require special efforts to protect them from exposures to infected patients in common waiting areas. By informing the receptionist of their infection risk upon arrival, appropriate steps may be taken to further protect them from infection. In some cystic fibrosis clinics, in order to avoid exposure to other patients who could be colonized with *B. cepacia*, patients have been given beepers upon registration so that they may leave the area and receive notification to return when an examination room becomes available [832].

II.G.3. Home care In home care, the patient placement concerns focus on protecting others in the home from exposure to an infectious household member. For individuals who are especially vulnerable to adverse outcomes associated with certain infections, it may be beneficial to either remove them from the home or segregate them within the home. Persons who are not part of the household may need to be prohibited from visiting during the period of infectivity. For example, if a patient with pulmonary tuberculosis is contagious and being cared for at home, very young children (<4 years of age) [833] 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 beneficial in preventing household transmission [249, 834].

II.H. Transport of patients

Several principles are used to guide transport of patients requiring Transmission-Based Precautions. In the inpatient and residential settings these include 1) limiting transport of such patients to essential purposes, such as diagnostic and therapeutic procedures that cannot be performed in the patient's room; 2) when transport is necessary, using appropriate barriers on the patient (e.g., mask, gown, wrapping in sheets or use of impervious dressings to cover the affected area(s) when infectious skin lesions or drainage are present, consistent with the route and risk of transmission; 3) notifying healthcare personnel in the receiving

area of the impending arrival of the patient and of the precautions necessary to prevent transmission; and 4) for patients being transported outside the facility, informing the receiving facility and the medi-van or emergency vehicle personnel in advance about the type of Transmission-Based Precautions being used. For tuberculosis, additional precautions may be needed in a small shared air space such as in an ambulance [12].

II.I. Environmental measures

Cleaning and disinfecting non-critical surfaces in patient-care areas are part of Standard Precautions. In general, these procedures do not need to be changed for patients on Transmission-Based Precautions. The cleaning and disinfection of all patient-care areas is important for frequently touched surfaces, especially those closest to the patient, that are most likely to be contaminated (e.g., bedrails, bedside tables, commodes, doorknobs, sinks, surfaces and equipment in close proximity to the patient) [11, 72, 73, 835]. The frequency or intensity of cleaning may need to change based on the patient's level of hygiene and the degree of environmental contamination and for certain for infectious agents whose reservoir is the intestinal tract [54]. This may be especially true in LTCFs and pediatric facilities where patients with stool and urine incontinence are encountered more frequently. Also, increased frequency of cleaning may be needed in a Protective Environment to minimize dust accumulation [11]. Special recommendations for cleaning and disinfecting environmental surfaces in dialysis centers have been published [18]. In all healthcare settings, administrative, staffing and scheduling activities should prioritize the proper cleaning and disinfection of surfaces that could be implicated in transmission. During a suspected or proven outbreak where an environmental reservoir is suspected, routine cleaning procedures should be reviewed, and the need for additional trained cleaning staff should be assessed. Adherence should be monitored and reinforced to promote consistent and correct cleaning is performed.

EPA-registered disinfectants or detergents/disinfectants that best meet the overall needs of the healthcare facility for routine cleaning and disinfection should be selected [11, 836]. In general, use of the existing facility detergent/disinfectant according to the manufacturer's recommendations for amount, dilution, and contact time is sufficient to remove pathogens from surfaces of rooms where colonized or infected individuals were housed. This includes those pathogens that are resistant to multiple classes of antimicrobial agents (e.g., *C. difficile*, VRE, MRSA, MDR-GNB [11, 24, 88, 435, 746, 796, 837]). Most often, environmental reservoirs of pathogens during outbreaks are related to a failure to follow recommended procedures for cleaning and disinfection rather than the specific cleaning and disinfectant agents used[838-841].
Certain pathogens (e.g., rotavirus, noroviruses, *C. difficile*) may be resistant to some routinely used hospital disinfectants [275, 292, 842-847].The role of specific disinfectants in limiting transmission of rotavirus has been demonstrated experimentally [842]. Also, since *C. difficile* may display increased levels of spore production when exposed to non-chlorine-based cleaning agents, and the spores are more resistant than vegetative cells to commonly used surface disinfectants,

some investigators have recommended the use of a 1:10 dilution of 5.25% sodium hypochlorite (household bleach) and water for routine environmental disinfection of rooms of patients with *C. difficile* when there is continued transmission [844, 848]. In one study, the use of a hypochlorite solution was associated with a decrease in rates of C. difficile infections [847]. The need to change disinfectants based on the presence of these organisms can be determined in consultation with the infection control committee [11, 847, 848]. 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 [11] and in the Guideline for Disinfection and Sterilization [848].

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 [86, 87, 325, 849]. Cleaning to remove organic material must always precede high level disinfection and sterilization of critical and semi-critical instruments and devices because residual proteinacous material reduces the effectiveness of the disinfection and sterilization processes [836, 848]. Noncritical equipment, such as commodes, intravenous pumps, and ventilators, must be thoroughly cleaned and disinfected before use on another patient. All such equipment and devices should be handled in a manner that will prevent HCW and environmental contact with potentially infectious material. It is important to include computers and personal digital assistants (PDAs) used in patient care in policies for cleaning and disinfection of non-critical items. The literature on contamination of computers with pathogens has been summarized [850] and two reports have linked computer contamination to colonization and infections in patients [851, 852]. Although keyboard covers and washable keyboards that can be easily disinfected are in use, the infection control benefit of those items and optimal management have not been determined.

In all healthcare settings, providing patients who are on Transmission-Based Precautions with dedicated noncritical medical equipment (e.g., stethoscope, blood pressure cuff, electronic thermometer) has been beneficial for preventing transmission [74, 89, 740, 853, 854]. When this is not possible, disinfection after use is recommended. Consult other guidelines for detailed guidance in developing specific protocols for cleaning and reprocessing medical equipment and patient care items in both routine and special circumstances [11, 14, 18, 20, 740, 836, 848].
In home care, it is preferable to remove visible blood or body fluids from durable medical equipment before it leaves the home. Equipment can be cleaned on-site using a detergent/disinfectant and, when possible, should be placed in a single plastic bag for transport to the reprocessing location [20, 739].

II.K. Textiles and laundry

Soiled textiles, including bedding, towels, and patient or resident clothing may be contaminated with pathogenic microorganisms. However, the risk of disease

transmission is negligible if they are handled, transported, and laundered in a safe manner [11, 855, 856]. Key principles for handling soiled laundry are 1) not 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. When laundry chutes are used, they must be maintained to minimize dispersion of aerosols from contaminated items [11]. The methods for handling, transporting, and laundering soiled textiles are determined by organizational policy and any applicable regulations [739]; guidance is provided in the Guidelines for Environmental Infection Control [11]. Rather than rigid rules and regulations, hygienic and common sense storage and processing of clean textiles is recommended [11, 857]. When laundering occurs outside of a healthcare facility, the clean items must be packaged or completely covered and placed in an enclosed space during transport to prevent contamination with outside air or construction dust that could contain infectious fungal spores that are a risk for immunocompromised patients [11].

Institutions are required to launder garments used as personal protective equipment and uniforms visibly soiled with blood or infective material [739]. There are few data to determine the safety of home laundering of HCW uniforms, but no increase in infection rates was observed in the one published study [858] and no pathogens were recovered from home- or hospital-laundered scrubs in another study [859]. 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 [11, 858, 859].

II.L. Solid waste

The management of solid waste emanating from the healthcare environment is subject to federal and state regulations for medical and non-medical waste [860, 861]. No additional precautions are needed for non-medical solid waste that is being removed from rooms of patients on Transmission-Based Precautions. Solid waste may be contained in a single bag (as compared to using two bags) of sufficient strength. [862].

II.M. Dishware and eating utensils

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

II.N. Adjunctive measures
Important adjunctive measures that are not considered primary components of programs to prevent transmission of infectious agents, but improve the effectiveness of such programs, include 1) antimicrobial management programs; 2) postexposure chemoprophylaxis with antiviral or antibacterial agents; 3) vaccines used both for pre 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 the topic is addressed in the MDRO section (Management of Multidrug-Resistant Organisms in Healthcare Settings 2006. www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf).

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* [17, 863], *N. meningitidis* [864], *B. anthracis* after environmental exposure to aeosolizable material[865], influenza virus[611], HIV [866], and group A streptococcus [160]. Orally administered antimicrobials may also be used under defined circumstances for MRSA decolonization of patients or healthcare personnel [867].
Another form of chemoprophylaxis is the use of topical antiseptic agents. For example, triple dye is used routinely on the umbilical cords of term newborns to reduce the risk of colonization, skin infections, and omphalitis caused by *S. aureus*, including MRSA, and group A streptococcus [868, 869]. Extension of the use of triple dye to low birth weight infants in the NICU was one component of a program that controlled one longstanding MRSA outbreak [22]. Topical antiseptics are also used for decolonization of healthcare personnel or selected patients colonized with MRSA, using mupirocin as discussed in the MDRO guideline[870] [867, 871-873].

II.N.2. Immunoprophylaxis Certain immunizations recommended for susceptible healthcare personnel have decreased the risk of infection and the potential for transmission in healthcare facilities [17, 874]. The OSHA mandate that requires employers to offer hepatitis B vaccination to HCWs played a substantial role in the sharp decline in incidence of occupational HBV infection [778, 875]. The use of varicella vaccine in healthcare personnel has decreased the need to place susceptible HCWs on administrative leave following exposure to patients with varicella [775]. Also, reports of healthcare-associated transmission of rubella in obstetrical clinics [33, 876] and measles in acute care settings [34] demonstrate the importance of immunization of susceptible healthcare personnel against childhood diseases. Many states have requirements for HCW vaccination for measles and rubella in the absence of evidence of immunity. Annual influenza vaccine campaigns targeted to patients and healthcare personnel in LTCFs and acute-care settings have been instrumental in preventing or limiting institutional

outbreaks and increasing attention is being directed toward improving influenza vaccination rates in healthcare personnel [35, 611, 690, 877, 878, 879].
Transmission of *B. pertussis* in healthcare facilities has been associated with large and costly outbreaks that include both healthcare personnel and patients [17, 36, 41, 100, 683, 827, 880, 881]. HCWs who have close contact with infants with pertussis are at particularly high risk because of waning immunity and, until 2005, the absence of a vaccine that could be used in adults. However, two acellular pertussis vaccines were licensed in the United States in 2005, one for use in individuals aged 11-18 and one for use in ages 10-64 years [882]. Provisional ACIP recommendations at the time of publication of this document include adolescents and adults, especially those with contact with infants < 12 months of age and healthcare personnel with direct patient contact [883 884].
Immunization of children and adults will help prevent the introduction of vaccine-preventable diseases into healthcare settings. The recommended immunization schedule for children is published annually in the January issues of the *Morbidity Mortality Weekly Report* with interim updates as needed [885, 886]. An adult immunization schedule also is available for healthy adults and those with special immunization needs due to high risk medical conditions [887].
Some vaccines are also used for postexposure prophylaxis of susceptible individuals, including varicella [888], influenza [611], hepatitis B [778], and smallpox [225] vaccines [17, 874]. In the future, administration of a newly developed *S. aureus* conjugate vaccine (still under investigation) to selected patients may provide a novel method of preventing healthcare-associated *S. aureus,* including MRSA, infections in high-risk groups (e.g., hemodialysis patients and candidates for selected surgical procedures) [889, 890].
Immune globulin preparations also are used for postexposure prophylaxis of certain infectious agents under specified circumstances (e.g., varicella-zoster virus [VZIG], hepatitis B virus [HBIG], rabies [RIG], measles and hepatitis A virus [IG] [17, 833, 874]). 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 [891].

II.N. 3. Management of visitors

II.N.3.a. Visitors as sources of infection Visitors have been identified as the source of several types of HAIs (e.g., pertussis [40, 41], *M. tuberculosis* [42, 892], influenza, and other respiratory viruses [24, 43, 44, 373] and SARS [21, 252-254]). However, effective methods for visitor screening in healthcare settings have not been studied. Visitor screening is especially important during community outbreaks of infectious diseases and for high risk patient units. Sibling visits are often encouraged in birthing centers, post partum rooms and in pediatric inpatient units, ICUs, and in residential settings for children; in hospital settings, a child visitor should visit only his or her own sibling. Screening of visiting siblings and other children before they are allowed into clinical areas is necessary to prevent the introduction of childhood illnesses and common respiratory infections.

Screening may be passive through the use of signs to alert family members and visitors with signs and symptoms of communicable diseases not to enter clinical areas. More active screening may include the completion of a screening tool or questionnaire which elicits information related to recent exposures or current symptoms. That information is reviewed by the facility staff and the visitor is either permitted to visit or is excluded [833].

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

Visitor screening is used consistently on HSCT units [15, 43]. However, considering the experience during the 2003 SARS outbreaks and the potential for pandemic influenza, developing effective visitor screening systems will be beneficial [9]. 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, or masks by visitors in healthcare settings has not been addressed specifically in the scientific literature. Some studies included the use of gowns and gloves by visitors in the control of MDRO's, but did not perform a separate analysis to determine whether their use by visitors had a measurable impact [893-895]. Family members or visitors who are providing care or having very close patient contact (e.g., feeding, holding) may have contact with other patients and could contribute to transmission if barrier precautions are not used correctly. Specific recommendations may vary by facility or by unit and should be determined by the level of interaction.

Part III:
Precautions to Prevent Transmission of Infectious Agents

There are two 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 healthcare settings, regardless of the suspected or confirmed presence of an infectious agent. **Implementation of *Standard Precautions* constitutes the primary strategy for the prevention of healthcare-associated transmission of infectious agents among patients and healthcare personnel**.

Transmission-Based Precautions are for patients who are known or suspected to be infected or colonized with infectious agents, including certain epidemiologically important pathogens, which require additional control measures to effectively prevent transmission. Since the infecting agent often is not known at the time of admission to a healthcare facility, Transmission-Based Precautions are used empirically, according to the clinical syndrome and the likely etiologic agents at the time, and then modified when the pathogen is identified or a transmissible infectious etiology is ruled out. 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. See Tables 4 and 5 for summaries of the key elements of these sets of precautions

III.A. Standard Precautions Standard Precautions combine the major features of Universal Precautions (UP) [780, 896] and Body Substance Isolation (BSI) [640] and 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 a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which healthcare is delivered (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 (e.g. wear gloves for direct contact, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient).

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

recommended practices are critical elements of Standard Precautions because they facilitate appropriate decision-making and promote adherence when HCWs are faced with new circumstances [655, 681-686]. 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 (e.g., 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 the Figure. Standard Precautions are also intended to protect patients by ensuring that healthcare personnel 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 via lumbar puncture procedures (e.g., myelogram, spinal or epidural anesthesia). While most elements of Standard Precautions evolved from Universal Precautions that were developed for protection of healthcare personnel, these new elements of Standard Precautions focus on protection of patients.

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 healthcare setting (e.g., reception and triage areas in emergency departments, outpatient clinics, and physician offices) [21, 254, 897]. The strategy proposed has been termed Respiratory Hygiene/Cough Etiquette [9, 828] and is intended to be incorporated into infection control practices as a new component of Standard Precautions. The strategy is targeted at patients and accompanying family members and friends with undiagnosed transmissible respiratory infections, and applies to any person with signs of illness including cough, congestion, rhinorrhea, or increased production of respiratory secretions when entering a healthcare facility [40, 41, 43]. 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 healthcare facility staff, patients, and visitors; 2) posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends; 3) source control measures (e.g., covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and

appropriate); 4) hand hygiene after contact with respiratory secretions; and 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, 898, 899]. Masking may be difficult in some settings, (e.g., pediatrics, in which case, the emphasis by necessity may be on cough etiquette [900]. Physical proximity of <3 feet has been associated with an increased risk for transmission of infections via the droplet route (e.g., *N. meningitidis* [103] and group A streptococcus [114] and therefore supports the practice of distancing infected persons from others who are not infected. The effectiveness of good hygiene practices, especially hand hygiene, in preventing transmission of viruses and reducing the incidence of respiratory infections both within and outside [901-903] healthcare settings is summarized in several reviews [559, 717, 904].

These measures should be effective in decreasing the risk of transmission of pathogens contained in large respiratory droplets (e.g., influenza virus [23], adenovirus [111], *B. pertussis* [827] and *Mycoplasma pneumoniae* [112]. Although fever will be present in many respiratory infections, patients with pertussis and mild upper respiratory tract infections are often afebrile. Therefore, the absence of fever does not always exclude a respiratory infection. Patients who have asthma, allergic rhinitis, or chronic obstructive lung disease also may be coughing and sneezing. While these patients often are not infectious, cough etiquette measures are prudent.

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

III.A.1.b. Safe Injection Practices The investigation of four large outbreaks of HBV and HCV among patients in ambulatory care facilities in the United States identified a need to define and reinforce safe injection practices [453]. The four outbreaks occurred in a private medical practice, a pain clinic, an endoscopy clinic, and a hematology/oncology clinic. The primary breaches in infection control practice that contributed to these outbreaks were 1) reinsertion of used needles into a multiple-dose vial or solution container (e.g., saline bag) and 2) use of a single needle/syringe to administer intravenous medication to multiple patients. In one of these outbreaks, preparation of medications in the same workspace where used needle/syringes were dismantled also may have been a contributing factor. These and other outbreaks of viral hepatitis could have been prevented by adherence to basic principles of aseptic technique for the preparation and administration of parenteral medications [453, 454]. 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 healthcare personnel are unaware of, do not understand, or do not adhere to basic principles of infection control and aseptic technique. A survey of US healthcare workers who provide medication through injection found that 1% to 3% reused the same needle and/or syringe on multiple patients [905]. Among the deficiencies identified in recent outbreaks were a lack of oversight of personnel and failure to follow-up on reported breaches in infection control practices in ambulatory settings. Therefore, to ensure that all healthcare workers understand and adhere to recommended practices, principles of infection control and aseptic technique need to be reinforced in training programs and incorporated into institutional polices that are monitored for adherence [454].

III.A.1.c. Infection Control Practices for Special Lumbar Puncture Procedues In 2004, CDC investigated eight cases of post-myelography meningitis that either were reported to 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 eight 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 (e.g., contrast media) were excluded as probable sources of contamination. Procedural details available for seven 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 oralpharyngeal flora was the most likely explanation for these infections. Bacterial meningitis following myelogram and other spinal procedures (e.g., lumbar puncture, spinal and epidural anesthesia, intrathecal chemotherapy) has been reported previously [906-915]. As a result, the question of whether face masks should be worn to prevent droplet spread of oral flora during spinal procedures (e.g., myelogram, lumbar puncture, spinal anesthesia) has been debated [916, 917]. Face masks are effective in limiting the dispersal of oropharyngeal droplets [918] and are recommended for the placement of central venous catheters [919]. In October 2005, the Healthcare Infection Control Practices Advisory Committee (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 three categories of Transmission-Based Precautions: Contact Precautions, Droplet Precautions, and Airborne Precautions. Transmission-Based Precautions are used when the route(s) of transmission is (are) not completely interrupted using Standard Precautions alone. For some diseases that have multiple routes of transmission (e.g., SARS), more than one Transmission-Based Precautions category may be used. When used either singly or in combination, they are always used in

addition to Standard Precautions. 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 (i.e., anxiety, depression and other mood disturbances [920-922], perceptions of stigma [923], reduced contact with clinical staff [924-926], and increases in preventable adverse events [565] in order 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 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 [927]. Contact Precautions also apply where the presence of excessive wound drainage, fecal incontinence, or other discharges from the body suggest an increased potential for extensive environmental contamination and risk of transmission. A single-patient room is preferred for patients who require Contact Precautions. When a single-patient room is not available, consultation with infection control personnel is recommended to assess the various risks associated with other patient placement options (e.g., cohorting, keeping the patient with an existing roommate). In multi-patient rooms, $\geq$3 feet spatial separation between beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients. Healthcare personnel caring for patients on Contact Precautions wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment. Donning PPE upon room entry and discarding before exiting the patient room is done to contain pathogens, especially those that have been implicated in transmission through environmental contamination (e.g., VRE, *C. difficile,* noroviruses and other intestinal tract pathogens; RSV) [54, 72, 73, 78, 274, 275, 740].

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 I.B.3.b. Because these pathogens do not remain infectious over long distances in a healthcare facility, special air handling and ventilation are not required to prevent droplet transmission. Infectious agents for which Droplet Precautions are indicated are found 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 (e.g., cohorting, keeping the patient with an existing roommate). Spatial separation of $\geq$ 3 feet and drawing

the curtain between patient beds is especially important for patients in multi-bed rooms with infections transmitted by the droplet route. Healthcare personnel wear a mask (a respirator is not necessary) for close contact with infectious patient; the mask is generally donned upon room entry. Patients on Droplet Precautions who must be transported outside of the room should wear a mask if tolerated and follow Respiratory Hygiene/Cough Etiquette.

III.B.3. Airborne Precautions Airborne Precautions prevent transmission of infectious agents that remain infectious over long distances when suspended in the air (e.g., rubeola virus [measles], varicella virus [chickenpox], *M. tuberculosis,* and possibly SARS-CoV) as described in I.B.3.c and Appendix A. The preferred placement for patients who require Airborne Precautions is in an airborne infection isolation room (AIIR). An AIIR is a single-patient room that is equipped with special air handling and ventilation capacity that meet the American Institute of Architects/Facility Guidelines Institute (AIA/FGI) standards for AIIRs (i.e., monitored negative pressure relative to the surrounding area, 12 air exchanges per hour for new construction and renovation and 6 air exchanges per hour for existing facilities, air exhausted directly to the outside or recirculated through HEPA filtration before return) [12, 13]. Some states require the availability of such rooms in hospitals, emergency departments, and nursing homes that care for patients with *M. tuberculosis*. A respiratory protection program that includes education about use of respirators, fit-testing, and user seal checks is required in any facility with AIIRs. In settings where Airborne Precautions cannot be implemented due to limited engineering resources (e.g., physician offices), masking the patient, placing the patient in a private room (e.g., office examination room) with the door closed, and providing N95 or higher level respirators or masks if respirators are not available for healthcare personnel will reduce the likelihood of airborne transmission until the patient is either transferred to a facility with an AIIR or returned to the home environment, as deemed medically appropriate. Healthcare personnel caring for patients on Airborne Precautions wear a mask or respirator, depending on the disease-specific recommendations (Respiratory Protection II.E.4, Table 2, and Appendix A), that is donned prior to room entry. Whenever possible, non-immune HCWs should not care for patients with vaccine-preventable airborne diseases (e.g., measles, chickenpox, and smallpox).

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

risk to warrant their use empirically while confirmatory tests are pending (Table 2). Infection control professionals 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 of time (i.e., while the risk for transmission of the infectious agent persists or for the duration of the illness (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 (e.g., pharyngeal or cutaneous diphtheria, RSV), Transmission-Based Precautions remain in effect until culture or antigen-detection test results document eradication of the pathogen and, for RSV, symptomatic disease is resolved. For other diseases, (e.g., *M. tuberculosis*) state laws and regulations, and healthcare facility policies, may dictate the duration of precautions[12]). In immunocompromised patients, viral shedding can persist for prolonged periods of time (many weeks to months) and transmission to others may occur during that time; therefore, the duration of contact and/or droplet precautions may be prolonged for many weeks [500, 928-933].

The duration of Contact Precautions for patients who are colonized or infected with MDROs remains undefined. MRSA is the only MDRO for which effective decolonization regimens are available [867]. However, carriers of MRSA who have negative nasal cultures after a course of systemic or topical therapy may resume shedding MRSA in the weeks that follow therapy [934, 935]. Although early guidelines for VRE suggested discontinuation of Contact Precautions after three stool cultures obtained at weekly intervals proved negative [740], subsequent experiences have indicated that such screening may fail to detect colonization that can persist for >1 year [27, 936-938]. Likewise, available data indicate that colonization with VRE, MRSA [939], and possibly MDR-GNB, can persist for many months, especially in the presence of severe underlying disease, invasive devices, and recurrent courses of antimicrobial agents.

It may be prudent to assume that MDRO carriers are colonized permanently and manage them accordingly. Alternatively, an interval free of hospitalizations, antimicrobial therapy, and invasive devices (e.g., 6 or 12 months) before reculturing patients to document clearance of carriage may be used. Determination of the best strategy awaits the results of additional studies. See the 2006 HICPAC/CDC MDRO guideline [927] for discussion of possible criteria to discontinue Contact Precautions for patients colonized or infected with MDROs.

III.E. Application of Transmission-Based Precautions in ambulatory and home care settings Although Transmission-Based Precautions generally apply in all healthcare settings, exceptions exist. For example, in home care, AIIRs are not available. Furthermore, family members already exposed to diseases such as varicella and tuberculosis would not use masks or respiratory protection, but visiting HCWs would need to use such protection. Similarly, management of patients colonized or infected with MDROs may necessitate

Contact Precautions in acute care hospitals and in some LTCFs when there is continued transmission, but the risk of transmission in ambulatory care and home care, has not been defined. Consistent use of Standard Precautions may suffice in these settings, but more information is needed.

III.F. Protective Environment A Protective Environment 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) [11, 13-15]. The need for such controls has been demonstrated in studies of aspergillus outbreaks associated with construction [11, 14, 15, 157, 158]. As defined by the American Insitute of Architecture [13] and presented in detail in the Guideline for Environmental Infection Control 2003 [11, 861], 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 $\geq$12 air changes per hour; 6) strategies to minimize dust (e.g., scrubbable surfaces rather than upholstery [940] and carpet [941], 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 hematologic malignancies and in potted plants in the vicinity of the patients [942-944]. The desired quality of air may be achieved without incurring the inconvenience or expense of laminar airflow [15, 157]. 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 advised that severely immunocompromised patients wear a high-efficiency respiratory-protection device (e.g., an N95 respirator) when they leave the Protective Environment [11, 14, 945]). The use of masks or respirators by HSCT patients when they are outside of the Protective Environment for prevention of environmental fungal infections in the absence of construction has not been evaluated. A Protective Environment does not include the use of barrier precautions beyond those indicated for Standard and Transmission-Based Precautions. No published reports support the benefit of placing solid organ transplants or other immunocompromised patients in a Protective Environment.

Part IV:

Recommendations

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

Healthcare organization administrators should ensure the implementation of recommendations in this section.

I.A. Incorporate preventing transmission of infectious agents into the objectives of the organization's patient and occupational safety programs [543-546, 561, 620, 626, 946]. *Category IB/IC*

I.B. Make preventing transmission of infectious agents a priority for the healthcare organization. Provide administrative support, including fiscal and human resources for maintaining infection control programs [434, 548, 549, 559, 561, 566, 662 552, 562-564, 946]. *Category IB/IC*

I.B.1. Assure that individuals with training in infection control are employed by or are available by contract to all healthcare facilities so that the infection control program is managed by one or more qualified individuals [552, 566 316, 575, 947 573, 576, 946]. *Category IB/IC*

I.B.1.a. Determine the specific infection control full-time equivalents (FTEs) according to the scope of the infection control program, the complexity of the healthcare 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 [434, 549 552, 566 316, 569, 573, 575 948 949]. *Category IB*

I.B.2. Include prevention of healthcare-associated infections (HAI) as one determinant of bedside nurse staffing levels and composition,

especially in high-risk units [585-589 590 592 593 551, 594, 595 418, 596, 597 583]. *Category IB*

I.B.3. Delegate authority to infection control personnel or their designees (e.g., patient care unit charge nurses) for making infection control decisions concerning patient placement and assignment of Transmission-Based Precautions [549 434, 857, 946]. *Category IC*

I.B.4. Involve infection control personnel in decisions on facility construction and design, determination of AIIR and Protective Environment capacity needs and environmental assessments [11, 13, 950 951 12]. *Category IB/IC*

I.B.4.a. Provide ventilation systems required for a sufficient number of AIIRs (as determined by a risk assessment) and Protective Environments in healthcare facilities that provide care to patients for whom such rooms are indicated, according to published recommendations [11-13, 15]. *Category IB/IC*

I.B.5. Involve infection control personnel in the selection and post-implementation evaluation of medical equipment and supplies and changes in practice that could affect the risk of HAI [952, 953]. *Category IC*

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 healthcare 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 on-site or in a reference laboratory) and use these resources according to facility-specific epidemiologic needs, in consultation with clinical microbiologists [553, 609, 610, 612, 617, 954 614 603, 615, 616 605 599 554 598, 606, 607]. *Category IB*

I.B.7. Provide human and fiscal resources to meet occupational health needs related to infection control (e.g., healthcare personnel immunization, post-exposure evaluation and care, evaluation and management of healthcare personnel with communicable infections [739 12 17, 879-881, 955 134 690]. *Category IB/IC*

I.B.8. In all areas where healthcare is delivered, provide supplies and equipment necessary for the consistent observance of Standard Precautions, including hand hygiene products and personal protective equipment (e.g., gloves, gowns, face and eye protection) [739 559 946]. *Category IB/IC*

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, 956 957, 958 959 836 87 11, 960 961]. *Category IA/IC*

I.C. Develop and implement processes to ensure oversight of infection control activities appropriate to the healthcare setting and assign responsibility for oversight of infection control activities to an individual or group within the healthcare organization that is knowledgeable about infection control [434, 549, 566]. *Category II*

I.D. Develop and implement systems for early detection and management (e.g., use of appropriate infection control measures, including isolation precautions, PPE) of potentially infectious persons at initial points of patient encounter in outpatient settings (e.g., triage areas, emergency departments, outpatient clinics, physician offices) and at the time of admission to hospitals and long-term care facilities (LTCF) [9, 122, 134, 253, 827]. *Category IB*

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 (e.g., oncology units, hematopoietic stem call transplant [HSCT] units, intensive care units, other severely immunocompromised patients) for possible infection [43 24, 41, 962, 963].*Category IB*

I.F. Identify performance indicators of the effectiveness of organization-specific measures to prevent transmission of infectious agents (Standard and Transmission-Based Precautions), establish processes to monitor adherence to those performance measures and provide feedback to staff members [704 739 705 708 666, 964 667 668 555]. *Category IB*

II. Education and Training

II.A. Provide job- or task-specific education and training on preventing transmission of infectious agents associated with healthcare during orientation to the healthcare facility; update information periodically during ongoing education programs. Target all healthcare personnel for education and training, including but not limited to medical, nursing, clinical technicians, 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 healthcare personnel employed by outside agencies meet these education and training requirements through programs offered by the agencies or by participation in the healthcare facility's program designed for full-time personnel [126, 559, 561, 562, 655, 681-684, 686, 688, 689, 702, 893, 919, 965]. *Category IB*

II.A.1. Include in education and training programs, information concerning use of vaccines as an adjunctive infection control measure [17, 611, 690, 874]. *Category IB*

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 [658, 694, 695, 697, 698, 700, 966]. *Category IB*

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 [9, 709, 710, 963]. *Category II*

III. Surveillance

III.A. Monitor the incidence of epidemiologically-important organisms and targeted HAIs that have 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 healthcare facility [566, 671, 672, 675, 687, 919, 967, 968 673 969 970]. *Category IA*

III.B. Apply the following epidemiologic principles of infection surveillance [671, 967 673 969 663 664]. *Category IB*

- 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 multi-unit 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 healthcare 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 [566, 673, 684, 970 963 971]. *Category IB*

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 healthcare epidemiology to review the situation and recommend additional measures for control [566 247 687]. *Category IB*

III.E. Review periodically information on community or regional trends in the incidence and prevalence of epidemiologically-important organisms (e.g., influenza, RSV, pertussis, invasive group A streptococcal disease, MRSA, VRE) (including in other healthcare facilities) that may impact transmission of organisms within the facility [398, 687, 972, 973 974]. *Category II*

IV. Standard Precautions

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

IV.A. Hand Hygiene

IV.A.1. During the delivery of healthcare, 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[72, 73 739, 800, 975{CDC, 2001 #970]. *Category IB/IC*

IV.A.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 [559]. *Category IA*

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 [562, 978]. Alternatively, hands may be washed with an antimicrobial soap and water. Frequent use of alcohol-based hand rub immediately following handwashing with nonantimicrobial soap may increase the frequency of dermatitis [559]. *Category IB*

Perform hand hygiene:

IV.A.3.a. Before having direct contact with patients [664, 979]. *Category IB*

IV.A.3.b. After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings [664]. *Category IA*

IV.A.3.c. After contact with a patient's intact skin (e.g., when taking a pulse or blood pressure or lifting a patient) [167, 976, 979, 980]. *Category IB*

IV.A.3.d. If hands will be moving from a contaminated-body site to a clean-body site during patient care. *Category II*

IV.A.3.e. After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient [72, 73, 88, 800, 981 982]. *Category II*

IV.A.3.f. After removing gloves [728, 741, 742]. *Category IB*

IV.A.4. Wash hands with non-antimicrobial soap and water or with antimicrobial soap and water if contact with spores (e.g., *C. difficile* or *Bacillus 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 [559, 956, 983]. *Category II*

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 (e.g., those in ICUs or operating rooms) [30, 31, 559, 722-724]. *Category IA*

IV.A.5.a. Develop an organizational policy on the wearing of non-natural nails by healthcare personnel who have direct contact with patients outside of the groups specified above [984]. *Category II*

IV.B. Personal protective equipment (PPE) (see Figure)

IV.B.1. Observe the following principles of use:

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 [739, 780, 896]. *Category IB/IC*

IV.B.1.b. Prevent contamination of clothing and skin during the process of removing PPE (see Figure). *Category II*

IV.B.1.c. Before leaving the patient's room or cubicle, remove and discard PPE [18, 739]. *Category IB/IC*

IV.B.2. Gloves

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 (e.g., of a patient incontinent of stool or urine) could occur [18, 728, 739, 741, 780, 985]. *Category IB/IC*

IV.B.2.b. Wear gloves with fit and durability appropriate to the task [559, 731, 732, 739, 986, 987]. *Category IB*

IV.B.2.b.i. Wear disposable medical examination gloves for providing direct patient care.

IV.B.2.b.ii. Wear disposable medical examination gloves or reusable utility gloves for cleaning the environment or medical equipment.

IV.B.2.c. Remove gloves after contact with a patient and/or the surrounding environment (including medical equipment) using proper technique to prevent hand contamination (see Figure). Do not wear the same pair of gloves for the care of more than one patient. Do not wash gloves for the purpose of reuse since this practice has been associated with transmission of pathogens [559, 728, 741-743, 988]. *Category IB*

IV.B.2.d. Change gloves during patient care if the hands will move from a contaminated body-site (e.g., perineal area) to a clean body-site (e.g., face). *Category II*

IV.B.3. Gowns

IV.B.3.a. Wear a gown, that is 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 [739, 780, 896]. *Category IB/IC*

IV.B.3.a.i. Wear a gown for direct patient contact if the patient has uncontained secretions or excretions [24, 88, 89, 739, 744] *Category IB/IC*

IV.B.3.a.ii. Remove gown and perform hand hygiene before leaving the patient's environment [24, 88, 89, 739, 744] *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 upon entrance into a high risk unit (e.g., ICU, NICU, HSCT unit) is not indicated [365, 747-750]. *Category IB*

IV.B.4. Mouth, nose, 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 each according to the need anticipated by the task performed [113, 739, 780, 896]. *Category IB/IC*

IV.B.5. During aerosol-generating procedures (e.g., 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 (e.g., *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) [95, 96, 113, 126 93 94, 134]. *Category IB*

IV.C. Respiratory Hygiene/Cough Etiquette

IV.C.1. Educate healthcare personnel 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 (e.g., influenza, RSV, adenovirus, parainfluenza virus) in communities [14, 24, 684 10, 262]. *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 healthcare setting (e.g., triage, reception and waiting areas in emergency departments, outpatient clinics and physician offices) [20, 24, 145, 902, 989].

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

IV.C.2.b. Provide tissues and no-touch receptacles (e.g.,foot-pedal• operated lid or open, plastic-lined waste basket) for disposal of tissues [20]. *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 [559, 903]. *Category IB*

IV.C.2.d. During periods of increased prevalence of respiratory infections in the community (e.g., as indicated by increased school absenteeism, increased number of patients seeking care for a

respiratory infection), offer masks to coughing patients and other symptomatic persons (e.g., persons who accompany ill patients) upon entry into the facility or medical office [126, 899 898] and encourage them to maintain special separation, ideally a distance of at least 3 feet, from others in common waiting areas [23, 103, 111, 114 20, 134]. *Category IB*

IV.C.2.d.i. 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 (e.g., uncontained secretions, excretions or wound drainage; infants with suspected viral respiratory or gastrointestinal infections) in a single-patient room when available [24, 430, 435, 796, 797, 806, 990 410, 793]. *Category IB*

IV.D.2. Determine patient placement based on the following principles:

- 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 (e.g., cohorting patients with the same infection) *Category II*

IV.E. Patient-care equipment and instruments/devices [956]

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 fluids [18, 739, 975]. *Category IB/IC*

IV.E.2. Remove organic material from critical and semi-critical instrument/devices, using recommended cleaning agents before high level disinfection and sterilization to enable effective disinfection and sterilization processes [836 991, 992]. *Category IA*

IV.E.3. Wear PPE (e.g., 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, 739, 975]. *Category IB/IC*

IV.F. Care of the environment [11]

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 that are likely to be contaminated with pathogens, including those that are in close proximity to the patient (e.g., bed rails, over bed tables) and frequently-touched surfaces in the patient care environment (e.g., door knobs, surfaces in and

surrounding toilets in patients' rooms) on a more frequent schedule compared to that for other surfaces (e.g., horizontal surfaces in waiting rooms) [11 73, 740, 746, 993, 994 72, 800, 835 995]. *Category IB*

IV.F.3. Use EPA-registered disinfectants that have microbiocidal (i.e., killing) activity against the pathogens most likely to contaminate the patient-care environment. Use in accordance with manufacturer's instructions [842-844, 956, 996]. *Category IB/IC*

IV.F.3.a. Review the efficacy of in-use disinfectants when evidence of continuing transmission of an infectious agent (e.g., rotavirus, *C. difficile,* norovirus) may indicate resistance to the in-use product and change to a more effective disinfectant as indicated [275, 842, 847]. *Category II*

IV.F.4. In facilities that provide health care to pediatric patients or have waiting areas with child play toys (e.g., obstetric/gynecology offices and clinics), establish policies and procedures for cleaning and disinfecting toys at regular intervals [379 80]. *Category IB*

- Use the following principles in 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 (e.g., 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 multi-use 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 (e.g., daily) [850 851, 852, 997]. *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 [739, 998, 999]. *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 [11, 13, 1000, 1001]. *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 [454]

IV.H.1. Use aseptic technique to avoid contamination of sterile injection equipment [1002, 1003]. *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, cannulae and syringes are sterile, single-use items; they should not be reused for another patient nor to access a medication or solution that might be used for a subsequent patient [453, 919, 1004, 1005]. *Category IA*

IV.H.3. Use fluid infusion and administration sets (i.e., intravenous bags, tubing and connectors) for one patient only and dispose appropriately after use. Consider a syringe or needle/cannula contaminated once it has been used to enter or connect to a patient's intravenous infusion bag or administration set [453]. *Category IB*

IV.H.4. Use single-dose vials for parenteral medications whenever possible [453]. *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 [369 453, 1005]. *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 [453, 1002]. *Category IA*

IV.H.7. Do not keep multidose vials in the immediate patient treatment area and store in accordance with the manufacturer's recommendations; discard if sterility is compromised or questionable [453, 1003]. *Category IA*

IV.H.8. Do not use bags or bottles of intravenous solution as a common source of supply for multiple patients [453, 1006]. *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 (i.e., during myelograms, lumbar puncture and spinal or epidural anesthesia [906 907-909 910, 911 912-914, 918 1007]. *Category IB*

IV.J. Worker safety

Adhere to federal and state requirements for protection of healthcare personnel from exposure to bloodborne pathogens [739]. *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) [24, 93, 126, 141, 306, 806, 1008]. *Category IA*

V.A.2. Extend duration of Transmission-Based Precautions, (e.g., Droplet, Contact) for immunosuppressed patients with viral infections due to

prolonged shedding of viral agents that may be transmitted to others [928, 931-933, 1009-1011].
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, go to the MDRO guideline: www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf [870].

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 [24, 687, 793, 796, 797, 806, 837, 893, 1012, 1013] *Category IB*

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 (e.g., uncontained drainage, stool incontinence) for single-patient room placement. *Category II*
- Place together in the same room (cohort) patients who are infected or colonized with the same pathogen and are suitable roommates [29, 638, 808, 811-813, 815, 818, 819] *Category IB*
- If it becomes necessary to place a patient who requires 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 (e.g., those who are immunocompromised, have open wounds, 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 direct contact.) *Category II*
  - Change protective attire and perform hand hygiene between contact with patients in the same room, regardless of whether one or both patients are on Contact Precautions [728, 741, 742, 988, 1014, 1015]. *Category IB*

V.B.2.b. 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 [920, 921]. *Category II*

V.B.2.c. 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 personal protective equipment

V.B.3.a. Gloves

Wear gloves whenever touching the patient's intact skin [24, 89, 134, 559, 746, 837] or surfaces and articles in close proximity to the patient (e.g., medical equipment, bed rails) [72, 73, 88, 837]. Don gloves upon entry into the room or cubicle. *Category IB*

V.B.3.b. Gowns

V.B.3.b.i. Wear a gown whenever anticipating that clothing will have direct contact with the patient or potentially contaminated environmental surfaces or equipment in close proximity to the patient. Don gown upon entry into the room or cubicle. Remove gown and observe hand hygiene before leaving the patient-care environment [24, 88, 134, 745, 837]. *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 healthcare 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 prior to 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 [739, 836]. *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 (e.g., 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, 796, 836, 837, 854, 1016]. *Category IB*

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

V.B.5.c.i. Limit the amount of non-disposable patient-care equipment brought into the home of patients 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 [11, 24, 88, 746, 837]. *Category IB*

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 to be infected with pathogens transmitted by respiratory droplets (i.e., large-particle droplets >5µ in size) that are generated by a patient who is coughing, sneezing or talking [14, 23, Steinberg, 1969 #1708, 41, 95, 103, 111, 112, 755, 756, 989, 1017]. *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 for making decisions on patient placement:

- Prioritize patients who have excessive cough and sputum production for single-patient room placement *Category II*
- Place together in the same room (cohort) patients who are infected the same pathogen and are suitable roommates [814 816]. *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, have 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 [103, 104 410]. *Category IB*
- Change protective attire and perform hand hygiene between contact with patients in the same room, regardless of whether one patient or both patients are on Droplet Precautions [741-743, 988, 1014, 1015]. *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 [410]. *Category II*

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 [447, 448 9, 828]. *Category II*

V.C.3. Use of personal protective equipment

V.C.3.a. Don a mask upon entry into the patient room or cubicle [14, 23, 41, 103, 111, 113, 115, 827]. *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 (www.**cdc**.gov/ncidod/**sars**/ ; www.**cdc**.gov/flu/**avian**/ ;www.**pandemicflu.gov**/) [134, 1018, 1019]

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 healthcare setting is necessary, instruct patient to wear a mask and follow Respiratory Hygiene/Cough Etiquette 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 (e.g., *M tuberculosis* [12], measles [34, 122, 1020], chickenpox [123, 773, 1021], disseminated herpes zoster [1022]. *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 six (existing facility) or 12 (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 (e.g., smoke tubes, flutter strips), regardless of the presence of differential pressure sensing devices (e.g., manometers) [11, 12, 1023, 1024].

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 [12]. *Category II*

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

- Consult infection control professionals before patient placement to determine the safety of alternative room that do not meet engineering requirements for an AIIR.
- Place together (cohort) patients who are presumed to have the same infection(based on clinical presentation and diagnosis when known) in areas of the facility that are away from other patients, especially patients who are at increased risk for infection (e.g., immunocompromised patients).
- Use temporary portable solutions (e.g., 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 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 (e.g., triage, signage) to identify patients with known or suspected infections that require Airborne Precautions upon entry into ambulatory settings [9, 12, 34, 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 him/her in an examination room. Once the patient leaves, the room should remain vacant for the appropriate time, generally one hour, to allow for a full exchange of air [11, 12, 122]. *Category IB/IC*

V.D.2.d.iii. Instruct patients 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 [12, 107, 145, 899]. *Category IB/IC*

V.D.3. Personnel restrictions

Restrict susceptible healthcare personnel from entering the rooms of patients known or suspected to have measles (rubeola), varicella (chickenpox), disseminated zoster, or smallpox if other immune healthcare personnel are available [17, 775]. *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 (e.g., irrigation, incision and drainage, whirlpool treatments) are performed [12, 1025, 1026]. *Category IB*
- Smallpox (vaccinated and unvaccinated). Respiratory protection is recommended for all healthcare personnel, 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 (e.g., from high-risk aerosol-generating procedures, immunocompromised patients, hemorrhagic or flat smallpox [108, 129]. *Category II*

V.D.4.b. No recommendation is made regarding the use of PPE by healthcare personnel 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 [1027, 1028]. *Unresolved issue*

V.D.4.c. No recommendation is made regarding the type of personal protective equipment (i.e., surgical mask or respiratory protection with a N95 or higher respirator) to be worn by susceptible healthcare personnel who must have contact with patients with known or suspected measles, chickenpox or disseminated herpes zoster. *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. *Category II*

V.D.5.b. If transport or movement outside an AIIR is necessary, instruct patients to wear a surgical mask, if possible, and observe Respiratory Hygiene/Cough Etiquette [12]. *Category II*

V.D.5.c. For patients with skin lesions associated with varicella or smallpox or draining skin lesions caused by *M. tuberculosis*, cover the affected areas to prevent aerosolization or contact with the infectious agent in skin lesions [108, 1025, 1026, 1029-1031]. *Category IB*

V.D.5.d. Healthcare personnel transporting patients who are on Airborne Precautions do not need to wear a mask or respirator during transport if the patient is wearing a mask and infectious skin lesions are covered. *Category II*

V.D.6. Exposure management

Immunize or provide the appropriate immune globulin to susceptible persons as soon as possible following unprotected contact (i.e., exposed) to a patient with measles, varicella or smallpox: *Category IA*

- Administer measles vaccine to exposed susceptible persons within 72 hours after the exposure or administer immune globulin within six days of the exposure event for high-risk persons in whom vaccine is contraindicated [17, 1032-1035].
- Administer varicella vaccine to exposed susceptible persons within 120 hours after the exposure or administer varicella immune globulin (VZIG or alternative product), when available, within 96 hours for high-risk persons in whom vaccine is contraindicated (e.g., immunocompromised patients, pregnant women, newborns whose mother's varicella onset was <5 days before or within 48 hours after delivery [888, 1035-1037]).
- Administer smallpox vaccine to exposed susceptible persons within 4 days after exposure [108, 1038-1040].

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

V.D.8. Consult CDC's "Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings, 2005" [12] and the "Guideline for Environmental Infection Control in Health-Care Facilities" [11] for additional guidance on environment strategies for preventing transmission of tuberculosis in healthcare settings. The environmental recommendations in these guidelines may be applied to patients with other infections that require Airborne Precautions.

VI. Protective Environment (Table 4)

VI.A. Place allogeneic hematopoietic stem cell transplant (HSCT) patients in a Protective Environment as described in the "Guideline to Prevent Opportunistic Infections in HSCT Patients" [15], the "Guideline for Environmental Infection Control in Health-Care Facilities" [11], and the "Guidelines for Preventing Health-Care-Associated Pneumonia, 2003" [14] to reduce exposure to environmental fungi (e.g., *Aspergillus* sp) [157, 158]. *Category IB*

VI.B. No recommendation for placing patients with other medical conditions that are associated with increased risk for environmental fungal infections (e.g., aspergillosis) in a Protective Environment [11]. *Unresolved issue*

VI.C. For patients who require a Protective Environment, 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 high efficiency particulate (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 [13]. *Category IB*

VI.C.1.c. Positive air pressure in room relative to the corridor (pressure differential of ≥12.5 Pa [0.01-in water gauge]) [13]. *Category IB*

VI.C.1.c.i. Monitor air pressure daily with visual indicators (e.g., smoke tubes, flutter strips) [11, 1024]. *Category IA*

VI.C.1.d. Well-sealed rooms that prevent infiltration of outside air [13]. *Category IB*

VI.C.1.e. At least 12 air changes per hour [13]. *Category IB*

VI.C.2. Lower dust levels by using smooth, nonporous surfaces and finishes that can be scrubbed, rather than textured material (e.g., upholstery). Wet dust horizontal surfaces whenever dust detected and routinely clean crevices and sprinkler heads where dust may accumulate [940, 941]. *Category II*

VI.C.3. Avoid carpeting in hallways and patient rooms in areas [941]. *Category IB*

VI.C.4. Prohibit dried and fresh flowers and potted plants [942-944]. *Category II*

VI.D. Minimize the length of time that patients who require a Protective Environment are outside their rooms for diagnostic procedures and other activities [11, 158, 945]. *Category IB*

VI.E. During periods of construction, to prevent inhalation of respirable particles that could contain infectious spores, provide respiratory protection (e.g., N95 respirator) to patients who are medically fit to tolerate a respirator when they are required to leave the Protective Environment [945 158]. *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 Protective Environment in the absence of construction. *Unresolved issue*

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

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 [930] [1010] [928, 932] [1011]. *Category IB*

VI.F.3. Barrier precautions, (e.g., masks, gowns, gloves) are not required for healthcare personnel in the absence of suspected or confirmed infection in the patient or if they are not indicated according to Standard Precautions [15]. *Category II*

VI.F.4. Implement Airborne Precautions for patients who require a Protective Environment room and who also have an airborne infectious disease (e.g., pulmonary or laryngeal tuberculosis, acute varicella-zoster). *Category IA*

VI.F.4.a. Ensure that the Protective Environment is designed to maintain positive pressure [13]. *Category IB*

VI.F.4.b. Use an anteroom to further support the appropriate air-balance relative to the corridor and the Protective Environment; 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 [13, 1041]. *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 [1042]. *Category II*

Appendix A:

Preamble The mode(s) and risk of transmission for each specific disease agent included in Appendix A were reviewed. Principle sources consulted for the development of disease-specific recommendations for Appendix A included infectious disease manuals and textbooks [833, 1043, 1044]. The published literature was searched for evidence of person-to-person transmission in healthcare and non-healthcare settings with a focus on reported outbreaks that would assist in developing recommendations for all settings where healthcare is delivered. Criteria used to assign Transmission-Based Precautions categories follow:

- A Transmission-Based Precautions category was assigned if there was strong evidence for person-to-person transmission via droplet, contact, or airborne routes in healthcare or non-healthcare settings and/or if patient factors (e.g., 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, Standard Precautions were assigned
- If there was a low risk for person-to-person transmission and no evidence of healthcare-associated transmission, Standard Precautions were assigned
- Standard Precautions were assigned for bloodborne pathogens (e.g., hepatitis B and C viruses, human immunodeficiency virus) as per CDC recommendations for Universal Precautions issued in 1988 [780]. Subsequent experience has confirmed the efficacy of Standard Precautions to prevent exposure to infected blood and body fluid [778, 779, 866].

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 (e.g., 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 Appendix B.

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Abscess			
Draining, major	C	DI	No dressing or containment of drainage; until drainage stops or can be contained by dressing
Draining, minor or limited	S		Dressing covers and contains drainage
Acquired human immunodeficiency syndrome (HIV)	S		Post-exposure chemoprophylaxis for some blood exposures [866].
Actinomycosis	S		Not transmitted from person to person
Adenovirus infection (see agent-specific guidance under gastroenteritis, conjuctivitis, pneumonia)			
Amebiasis	S		Person to person transmission is rare. Transmission in settings for the mentally challenged and in a family group has been reported [1045]. Use care when handling diapered infants and mentally challenged persons [1046].
Anthrax	S		Infected patients do not generally pose a transmission risk.
Cutaneous	S		Transmission through non-intact skin contact with draining lesions possible, therefore use Contact Precautions if large amount of uncontained drainage. Handwashing with soap and water preferable to use of waterless alcohol based antiseptics since alcohol does not

[1] 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

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			have sporicidal activity [983].
Pulmonary	S		Not transmitted from person to person
Environmental: aerosolizable spore-containing powder or other substance		DE	Until decontamination of environment complete [203]. Wear respirator (N95 mask or PAPRs), protective clothing; decontaminate persons with powder on them (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm) **Hand hygiene:** Handwashing for 30-60 seconds with soap and water or 2% chlorhexidene gluconate after spore contact (alcohol handrubs inactive against spores [983]. **Post-exposure prophylaxis following environmental exposure**: 60 days of antimicrobials (either doxycycline, ciprofloxacin, or levofloxacin) and post-exposure vaccine under IND
Antibiotic-associated colitis (see *Clostridium difficile*)			
Arthropod-borne viral encephalitides (eastern, western, Venezuelan equine encephalomyelitis; St Louis, California encephalitis; West Nile Virus) and viral fevers (dengue, yellow fever, Colorado tick fever)	S		Not transmitted from person to person except rarely by transfusion, and for West Nile virus by organ transplant, breastmilk or transplacentally [530, 1047]. Install screens in windows and doors in endemic areas Use DEET-containing mosquito repellants and clothing to cover extremities
Ascariasis	S		Not transmitted from person to person
Aspergillosis	S		Contact Precautions and Airborne Precautions if massive soft tissue infection with copious drainage and repeated irrigations required [154].
Avian influenza (see influenza, avian below)			
Babesiosis	S		Not transmitted from person to person except rarely by transfusion,
Blastomycosis, North American, cutaneous or pulmonary	S		Not transmitted from person to person
Botulism	S		Not transmitted from person to person
Bronchiolitis (see respiratory infections in infants and young children)	C	DI	Use mask according to Standard Precautions.

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Brucellosis (undulant, Malta, Mediterranean fever)	S		Not transmitted from person to person except rarely via banked spermatozoa and sexual contact [1048, 1049]. Provid antimicrobial prophylaxis following laboratory exposure [1050].
Campylobacter gastroenteritis (see gastroenteritis)			
Candidiasis, all forms including mucocutaneous	S		
Cat-scratch fever (benign inoculation lymphoreticulosis)	S		Not transmitted from person to person
Cellulitis	S		
Chancroid (soft chancre) (*H. ducreyi*)	S		Transmitted sexually from person to person
Chickenpox (see varicella)			
Chlamydia trachomatis			
Conjunctivitis	S		
Genital (lymphogranuloma venereum)	S		
Pneumonia (infants ≤ 3 mos. of age))	S		
Chlamydia pneumoniae	S		Outbreaks in institutionalized populations reported, rarely [1051, 1052]
Cholera (see gastroenteritis)			
Closed-cavity infection			
Open drain in place; limited or minor drainage	S		Contact Precautions if there is copious uncontained drainage
No drain or closed drainage system in place	S		
Clostridium			
C. botulinum	S		Not transmitted from person to person
C. difficile (see Gastroenteritis, *C. difficile)*	C	DI	
C. perfringens			
Food poisoning	S		Not transmitted from person to person
Gas gangrene	S		Transmission from person to person rare; one outbreak in a surgical setting reported [1053]. Use Contact Precautions if wound drainage is

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
			extensive.
Coccidioidomycosis (valley fever)			
Draining lesions	S		Not transmitted from person to person except under extraordinary circumstances because the infectious arthroconidial form of *Coccidioides immitis* is not produced in humans [1054].
Pneumonia	S		Not transmitted from person to person except under extraordinary circumstances, (e.g., inhalation of aerosolized tissue phase endospores during necropsy, transplantation of infected lung) because the infectious arthroconidial form of *Coccidioides immitis* is not produced in humans [1054, 1055].
Colorado tick fever	S		Not transmitted from person to person
Congenital rubella	C	Until 1 yr of age	Standard Precautions if nasopharyngeal and urine cultures repeatedly neg. after 3 mos. of age
Conjunctivitis			
Acute bacterial	S		
Chlamydia	S		
Gonococcal	S		
Acute viral (acute hemorrhagic)	C	DI	Adenovirus most common; enterovirus 70 [1056], Coxsackie virus A24 [1057]) 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. [460, 814, 1058, 1059 461, 1060].
Corona virus associated with SARS (SARS-CoV) (see severe acute respiratory syndrome)			

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
Coxsackie virus disease (see enteroviral infection)			
Creutzfeldt-Jakob disease CJD, vCJD	S		Use disposable instruments or special sterilization/disinfection for surfaces, objects contaminated with neural tissue if CJD or vCJD suspected and has not been R/O; No special burial procedures [1061]
Croup (see respiratory infections in infants and young children)			
Crimean-Congo Fever (see Viral Hemorrhagic Fever)	S		
Cryptococcosis	S		Not transmitted from person to person, except rarely via tissue and corneal transplant [1062, 1063]
Cryptosporidiosis (see gastroenteritis)			
Cysticercosis	S		Not transmitted from person to person
Cytomegalovirus infection, including in neonates and immunosuppressed patients	S		No additional precautions for pregnant HCWs
Decubitus ulcer (see Pressure ulcer)			
Dengue fever	S		Not transmitted from person to person
Diarrhea, acute-infective etiology suspected (see gastroenteritis)			
Diphtheria			
Cutaneous	C	CN	Until 2 cultures taken 24 hrs. apart negative
Pharyngeal	D	CN	Until 2 cultures taken 24 hrs. apart negative
Ebola virus (see viral hemorrhagic fevers)			
Echinococcosis (hydatidosis)	S		Not transmitted from person to person
Echovirus (see enteroviral infection)			
Encephalitis or encephalomyelitis (see specific etiologic agents)			
Endometritis (endomyometritis)	S		
Enterobiasis (pinworm disease, oxyuriasis)	S		
Enterococcus species (see multidrug-resistant organisms if			

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
epidemiologically significant or vancomycin resistant)			
Enterocolitis, *C. difficile* (see *C. difficile,* gastroenteritis)			
Enteroviral infections (i.e., Group A and B Coxsackie viruses and Echo viruses) (excludes polio virus)	S		Use Contact Precautions for diapered or incontinent children for duration of illness and to control institutional outbreaks
Epiglottitis, due to *Haemophilus influenzae* type b	D	U 24 hrs	See specific disease agents for epiglottitis due to other etiologies)
Epstein-Barr virus infection, including infectious mononucleosis	S		
Erythema infectiosum (also see Parvovirus B19)			
Escherichia coli gastroenteritis (see gastroenteritis)			
Food poisoning			
Botulism	S		Not transmitted from person to person
C. perfringens or welchii	S		Not transmitted from person to person
Staphylococcal	S		Not transmitted from person to person
Furunculosis, staphylococcal	S		Contact if drainage not controlled. Follow institutional policies if MRSA
Infants and young children	C	DI	
Gangrene (gas gangrene)	S		Not transmitted from person to person
Gastroenteritis	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks for gastroenteritis caused by all of the agents below
Adenovirus	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Campylobacter species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Cholera *(Vibrio cholerae)*	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
C. difficile	C	DI	Discontinue antibiotics if appropriate. Do not share electronic thermometers [853, 854]; ensure consistent environmental cleaning and

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			disinfection. Hypochlorite solutions may be required for cleaning if transmission continues [847]. Handwashing with soap and water preferred because of the absence of sporicidal activity of alcohol in waterless antiseptic handrubs [983].
Cryptosporidium species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
E. coli			
Enteropathogenic O157:H7 and other shiga toxin-producing Strains	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Other species	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Giardia lamblia	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Noroviruses	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks. Persons who clean areas heavily contaminated with feces or vomitus may benefit from wearing masks since 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 [273, 1064]). Hypochlorite solutions may be required when there is continued transmission [290-292]. Alcohol is less active, but there is no evidence that alcohol antiseptic handrubs are not effective for hand decontamination [294]. Cohorting of affected patients to separate airspaces and toilet facilities may help interrupt transmission during outbreaks.
Rotavirus	C	DI	Ensure consistent environmental cleaning and disinfection and frequent removal of soiled diapers. Prolonged shedding may occur in

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			both immunocompetent and immunocompromised children and the elderly [932, 933].
Salmonella species (including *S. typhi*)	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Shigella species (Bacillary dysentery)	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Vibrio parahaemolyticus	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Viral (if not covered elsewhere)	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
Yersinia enterocolitica	S		Use Contact Precautions for diapered or incontinent persons for the duration of illness or to control institutional outbreaks
German measles (see rubella; see congenital rubella)			
Giardiasis (see gastroenteritis)			
Gonococcal ophthalmia neonatorum (gonorrheal ophthalmia, acute conjunctivitis of newborn)	S		
Gonorrhea	S		
Granuloma inguinale (Donovanosis, granuloma venereum)	S		
Guillain-Barré' syndrome	S		Not an infectious condition
Haemophilus influenzae (see disease-specific recommendations)			
Hand, foot, and mouth disease (see enteroviral infection)			
Hansen's Disease (see Leprosy)			
Hantavirus pulmonary syndrome	S		Not transmitted from person to person
Helicobacter pylori	S		
Hepatitis, viral			
Type A	S		Provide hepatitis A vaccine post-exposure as recommended [1065]
Diapered or incontinent patients	C		Maintain Contact Precautions in infants and children <3 years of age

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			for duration of hospitalization; for children 3-14 yrs. of age for 2 weeks after onset of symptoms; >14 yrs. of age for 1 week after onset of symptoms [833, 1066, 1067].
Type B-HBsAg positive; acute or chronic	S		See specific recommendations for care of patients in hemodialysis centers [778]
Type C and other unspecified non-A, non-B	S		See specific recommendations for care of patients in hemodialysis centers [778]
Type D (seen only with hepatitis B)	S		
Type E	S		Use Contact Precautions for diapered or incontinent individuals for the duration of illness [1068]
Type G	S		
Herpangina (see enteroviral infection)			
Hookworm	S		
Herpes simplex (*Herpesvirus hominis*)			
Encephalitis	S		
Mucocutaneous, disseminated or primary, severe	C	Until lesions dry and crusted	
Mucocutaneous, recurrent (skin, oral, genital)	S		
Neonatal	C	Until lesions dry and crusted	Also, for asymptomatic, exposed infants delivered vaginally or by C-section and if mother has active infection and membranes have been ruptured for more than 4 to 6 hrs until infant surface cultures obtained at 24-36 hrs. of age negative after 48 hrs incubation [1069, 1070]
Herpes zoster (varicella-zoster) (shingles)			
Disseminated disease in any patient Localized disease in immunocompromised patient until disseminated infection ruled out	A,C	DI	Susceptible HCWs should not enter room if immune caregivers are available; no recommendation for protection of immune HCWs; no recommendation for type of protection, i.e. surgical mask or respirator; for susceptible HCWs.

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Localized in patient with intact immune system with lesions that can be contained/covered	S	DI	Susceptible HCWs should not provide direct patient care when other immune caregivers are available.
Histoplasmosis	S		Not transmitted from person to person
Human immunodeficiency virus (HIV)	S		Post-exposure chemoprophylaxis for some blood exposures [866].
Human metapneumovirus	C	DI	HAI reported [1071], but route of transmission not established [823]. 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..
Impetigo	C	U 24 hrs	
Infectious mononucleosis	S		
Influenza			
Human (seasonal influenza)			See www.cdc.gov/flu/professionals/infectioncontrol/healthcaresettings.htm for current seasonal influenza guidance.
Avian (e.g., H5N1, H7, H9 strains))			See www.cdc.gov/flu/avian/professional/infect-control.htm for current avian influenza guidance.
Pandemic influenza (also a human influenza virus)	D	5 days from onset of symptoms	See http://www.pandemicflu.gov for current pandemic influenza guidance.
Kawasaki syndrome	S		Not an infectious condition
Lassa fever (see viral hemorrhagic fevers)			

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Legionnaires' disease	S		Not transmitted from person to person
Leprosy	S		
Leptospirosis	S		Not transmitted from person to person
Lice			http://www.cdc.gov/ncidod/dpd/parasites/lice/default.htm
Head (pediculosis)	C	U 24 hrs	
Body	S		Transmitted person to person through infested clothing. Wear gown and gloves when removing clothing; bag and wash clothes according to CDC guidance above
Pubic	S		Transmitted person to person through sexual contact
Listeriosis (listeria monocytogenes)	S		Person-to-person transmission rare; cross-transmission in neonatal settings reported [1072, 1073 1074, 1075]
Lyme disease	S		Not transmitted from person to person
Lymphocytic choriomeningitis	S		Not transmitted from person to person
Lymphogranuloma venereum	S		
Malaria	S		Not transmitted from person to person except through transfusion rarely and through a failure to follow Standard Precautions during patient care [1076-1079]. Install screens in windows and doors in endemic areas. Use DEET-containing mosquito repellants and clothing to cover extremities
Marburg virus disease (see viral hemorrhagic fevers)			
Measles (rubeola)	A	4 days after onset of rash; DI in immune compromised	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, i.e., mask or respirator [1027, 1028]. For exposed susceptibles, post-exposure vaccine within 72 hrs. or immune globulin within 6 days when available [17, 1032, 1034]. Place exposed susceptible patients on Airborne Precautions and exclude susceptible healthcare personnel

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
			from duty from day 5 after first exposure to day 21 after last exposure, regardless of post-exposure vaccine [17].
Melioidosis, all forms	S		Not transmitted from person to person
Meningitis			
Aseptic (nonbacterial or viral; also see enteroviral infections)	S		Contact for infants and young children
Bacterial, gram-negative enteric, in neonates	S		
Fungal	S		
Haemophilus influenzae, type b known or suspected	D	U 24 hrs	
Listeria monocytogenes (See Listeriosis)	S		
Neisseria meningitidis (meningococcal) known or suspected	D	U 24 hrs	See meningococcal disease below
Streptococcus pneumoniae	S		
M. tuberculosis	S		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) [42]
Other diagnosed bacterial	S		
Meningococcal disease: sepsis, pneumonia, meningitis	D	U 24 hrs	Postexposure chemoprophylaxis for household contacts, HCWs exposed to respiratory secretions; postexposure vaccine only to control outbreaks [15, 17].
Molluscum contagiosum	S		
Monkeypox	A,C	A-Until monkeypox confirmed and smallpox excluded C-Until lesions crusted	Use See www.cdc.gov/ncidod/monkeypox for most current recommendations. Transmission in hospital settings unlikely [269]. Pre- and post-exposure smallpox vaccine recommended for exposed HCWs

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Mucormycosis	S		
Multidrug-resistant organisms (MDROs), infection or colonization (e.g., MRSA, VRE, VISA/VRSA, ESBLs, resistant *S. pneumoniae*)	S/C		MDROs judged by the infection control program, based on local, state, regional, or national recommendations, to be of clinical and epidemiologic significance. Contact Precautions 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 Healthcare Settings, 2006 [870]. Contact state health department for guidance regarding new or emerging MDRO.
Mumps (infectious parotitis)	D	U 9 days	After onset of swelling; susceptible HCWs should not provide care if immune caregivers are available. Note: (Recent assessment of outbreaks in healthy 18-24 year olds has indicated that salivary viral shedding occurred early in the course of illness and that 5 days of isolation after onset of parotitis may be appropriate in community settings; however the implications for healthcare personnel and high-risk patient populations remain to be clarified.)
Mycobacteria, nontuberculosis (atypical)			Not transmitted person-to-person
Pulmonary	S		
Wound	S		
Mycoplasma pneumonia	D	DI	
Necrotizing enterocolitis	S		Contact Precautions when cases clustered temporally [1080-1083].
Nocardiosis, draining lesions, or other presentations	S		Not transmitted person-to-person
Norovirus (see gastroenteritis)			
Norwalk agent gastroenteritis (see gastroenteritis)			
Orf	S		

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Parainfluenza virus infection, respiratory in infants and young children	C	DI	Viral shedding may be prolonged in immunosuppressed patients [1009, 1010]. Reliability of antigen testing to determine when to remove patients with prolonged hospitalizations from Contact Precautions uncertain.
Parvovirus B19 (Erythema infectiosum)	D		Maintain precautions for duration of hospitalization when chronic disease occurs in an immunocompromised patient. For patients with transient aplastic crisis or red-cell crisis, maintain precautions for 7 days. Duration of precautions for immunosuppressed patients with persistently positive PCR not defined, but transmission has occurred [929].
Pediculosis (lice)	C	U 24 hrs after treatment	
Pertussis (whooping cough)	D	U 5 days	Single patient room preferred. Cohorting an option. Post-exposure chemoprophylaxis for household contacts and HCWs with prolonged exposure to respiratory secretions [863]. Recommendations for Tdap vaccine in adults under development.
Pinworm infection (Enterobiasis)	S		
Plague *(Yersinia pestis)*			
Bubonic	S		
Pneumonic	D	U 48 hrs	Antimicrobial prophylaxis for exposed HCW [207].
Pneumonia			
Adenovirus	D, C	DI	Outbreaks in pediatric and institutional settings reported [376, 1084-1086]. In immunocompromised hosts, extend duration of Droplet and Contact Precautions due to prolonged shedding of virus [931]
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 CF Foundation guideline [20]

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
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 hrs	
Legionella spp.	S		
Meningococcal	D	U 24 hrs	See meningococcal disease above
Multidrug-resistant bacterial (see multidrug-resistant organisms)			
Mycoplasma (primary atypical pneumonia)	D	DI	
Pneumococcal pneumonia	S		Use Droplet Precautions if evidence of transmission within a patient care unit or facility [196-198, 1087]
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 hrs	See streptococcal disease (group A streptococcus) below Contact precautions if skin lesions present
Infants and young children	D	U 24 hrs	Contact Precautions if skin lesions present
Varicella-zoster (See Varicella-Zoster)			
Viral			
Adults	S		
Infants and young children (see respiratory infectious disease, acute, or specific viral agent)			
Poliomyelitis	C	DI	
Pressure ulcer (decubitus ulcer, pressure sore) infected			

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Major	C	DI	If no dressing or containment of drainage; until drainage stops or can be contained by dressing
Minor or limited	S		If dressing covers and contains drainage
Prion disease (See Creutzfeld-Jacob Disease)			
Psittacosis (ornithosis) (*Chlamydia psittaci)*	S		Not transmitted from person to person
Q fever	S		
Rabies	S		Person to person transmission rare; transmission via corneal, tissue and organ transplants has been reported [539, 1088]. If patient has bitten another individual or saliva has contaminated an open wound or mucous membrane, wash exposed area thoroughly and administer postexposure prophylaxis. [1089]
Rat-bite fever (*Streptobacillus moniliformis* disease, *Spirillum minus* disease)	S		Not transmitted from person to person
Relapsing fever	S		Not transmitted from person to person
Resistant bacterial infection or colonization (see multidrug-resistant organisms)			
Respiratory infectious disease, acute (if not covered elsewhere)			
Adults	S		
Infants and young children	C	DI	Also see syndromes or conditions listed in Table 2
Respiratory syncytial virus infection, in infants, young children and immunocompromised adults	C	DI	Wear mask according to Standard Precautions [24] CB [116, 117]. In immunocompromised patients, extend the duration of Contact Precautions due to prolonged shedding [928]). Reliability of antigen testing to determine when to remove patients with prolonged hospitalizations from Contact Precautions uncertain.
Reye's syndrome	S		Not an infectious condition
Rheumatic fever	S		Not an infectious condition
Rhinovirus	D	DI	Droplet most important route of transmission [104, 1090]. Outbreaks have

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			occurred in NICUs and LTCFs [413, 1091, 1092]. Add Contact Precautions if copious moist secretions and close contact likely to occur (e.g., young infants) [111, 833].
Rickettsial fevers, tickborne (Rocky Mountain spotted fever, tickborne typhus fever)	S		Not transmitted from person to person except through transfusion, rarely
Rickettsialpox (vesicular rickettsiosis)	S		Not transmitted from person to person
Ringworm (dermatophytosis, dermatomycosis, tinea)	S		Rarely, outbreaks have occurred in healthcare settings, (e.g., NICU [1093], rehabilitation hospital [1094]. Use Contact Precautions for outbreak.
Ritter's disease (staphylococcal scalded skin syndrome)	C	DI	See staphylococcal disease, scalded skin syndrome below
Rocky Mountain spotted fever	S		Not transmitted from person to person except through transfusion, rarely
Roseola infantum (exanthem subitum; caused by HHV-6)	S		
Rotavirus infection (see gastroenteritis)			
Rubella (German measles) (also see congenital rubella)	D	U 7 days after onset of rash	Susceptible HCWs should not enter room if immune caregivers are available. No recommendation for wearing face protection (e.g., a surgical mask) if immune. Pregnant women who are not immune should not care for these patients [17, 33]. Administer vaccine within three days of exposure to non-pregnant susceptible individuals. Place exposed susceptible patients on Droplet Precautions; exclude susceptible healthcare personnel from duty from day 5 after first exposure to day 21 after last exposure, regardless of post-exposure vaccine.
Rubeola (see measles)			
Salmonellosis (see gastroenteritis)			
Scabies	C	U 24	
Scalded skin syndrome, staphylococcal	C	DI	See staphylococcal disease, scalded skin syndrome below)
Schistosomiasis (bilharziasis)	S		

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Severe acute respiratory syndrome (SARS)	A, D,C	DI plus 10 days after resolution of fever, provided respiratory symptoms are absent or improving	Airborne Precautions preferred; D if AIIR unavailable. N95 or higher respiratory protection; surgical mask if N95 unavailable; eye protection (goggles, face shield); aerosol-generating procedures and "supershedders" highest risk for transmission via small droplet nuclei and large droplets [93, 94, 96].Vigilant environmental disinfection (see www.cdc.gov/ncidod/sars)
Shigellosis (see gastroenteritis)			
Smallpox (variola; see vaccinia for management of vaccinated persons)	A,C	DI	Until all scabs have crusted and separated (3-4 weeks). Non-vaccinated HCWs should not provide care when immune HCWs are available; N95 or higher respiratory protection for susceptible and successfully vaccinated individuals; postexposure vaccine within 4 days of exposure protective [108, 129, 1038-1040].
Sporotrichosis	S		
Spirillum minor disease (rat-bite fever)	S		Not transmitted from person to person
Staphylococcal disease (*S aureus*)			
Skin, wound, or burn			
Major	C	DI	No dressing or dressing does not contain drainage adequately
Minor or limited	S		Dressing covers and contains drainage adequately
Enterocolitis	S		Use Contact Precautions for diapered or incontinent children for duration of illness
Multidrug-resistant (see multidrug-resistant organisms)			
Pneumonia	S		
Scalded skin syndrome	C	DI	Consider healthcare personnel as potential source of nursery, NICU outbreak [1095].
Toxic shock syndrome	S		
Streptobacillus moniliformis disease (rat-bite fever)	S		Not transmitted from person to person

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Streptococcal disease (group A streptococcus)			
Skin, wound, or burn			
Major	C,D	U 24 hrs	No dressing or dressing does not contain drainage adequately
Minor or limited	S		Dressing covers and contains drainage adequately
Endometritis (puerperal sepsis)	S		
Pharyngitis in infants and young children	D	U 24 hrs	
Pneumonia	D	U 24 hrs	
Scarlet fever in infants and young children	D	U 24 hrs	
Serious invasive disease	D	U24 hrs	Outbreaks of serious invasive disease have occurred secondary to transmission among patients and healthcare personnel [162, 972, 1096-1098] Contact Precautions for draining wound as above; follow rec. for antimicrobial prophylaxis in selected conditions [160].
Streptococcal disease (group B streptococcus), neonatal	S		
Streptococcal disease (not group A or B) unless covered elsewhere	S		
Multidrug-resistant (see multidrug-resistant organisms)			
Strongyloidiasis	S		
Syphilis			
Latent (tertiary) and seropositivity without lesions	S		
Skin and mucous membrane, including congenital, primary, Secondary	S		
Tapeworm disease			
Hymenolepis nana	S		Not transmitted from person to person
Taenia solium (pork)	S		
Other	S		
Tetanus	S		Not transmitted from person to person
Tinea (e.g., dermatophytosis, dermatomycosis, ringworm)	S		Rare episodes of person-to-person transmission

APPENDIX A[1]

TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Toxoplasmosis	S		Transmission from person to person is rare; vertical transmission from mother to child, transmission through organs and blood transfusion rare
Toxic shock syndrome (staphylococcal disease, streptococcal disease)	S		Droplet Precautions for the first 24 hours after implementation of antibiotic therapy if Group A streptococcus is a likely etiology
Trachoma, acute	S		
Transmissible spongiform encephalopathy (see Creutzfeld-Jacob disease, CJD, vCJD)			
Trench mouth (Vincent's angina)	S		
Trichinosis	S		
Trichomoniasis	S		
Trichuriasis (whipworm disease)	S		
Tuberculosis *(M. tuberculosis)*			
Extrapulmonary, draining lesion)	A,C		Discontinue precautions only when patient is improving clinically, and drainage has ceased or there are three consecutive negative cultures of continued drainage [1025, 1026]. Examine for evidence of active pulmonary tuberculosis.
Extrapulmonary, no draining lesion, meningitis	S		Examine for evidence of pulmonary tuberculosis. For infants and children, use Airborne Precautions until active pulmonary tuberculosis in visiting family members ruled out [42]
Pulmonary or laryngeal disease, confirmed	A		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(MMWR 2005; 54: RR-17 http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm?s_cid=rr5417a1_e) [12].
Pulmonary or laryngeal disease, suspected	A		Discontinue precautions only when the likelihood of infectious TB

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
			disease is deemed negligible, and either 1) there is another diagnosis that explains the clinical syndrome or 2) the results of three sputum smears for AFB are negative. Each of the three sputum specimens should be collected 8-24 hours apart, and at least one should be an early morning specimen
Skin-test positive with no evidence of current active disease	S		
Tularemia			
Draining lesion	S		Not transmitted from person to person
Pulmonary	S		Not transmitted from person to person
Typhoid (*Salmonella typhi*) fever (see gastroenteritis)			
Typhus			
Rickettsia prowazekii (Epidemic or Louse-borne typhus)	S		Transmitted from person to person through close personal or clothing contact
Rickettsia typhi	S		Not transmitted from person to person
Urinary tract infection (including pyelonephritis), with or without urinary catheter	S		
Vaccinia (vaccination site, adverse events following vaccination) *			Only vaccinated HCWs have contact with active vaccination sites and care for persons with adverse vaccinia events; if unvaccinated, only HCWs without contraindications to vaccine may provide care.
Vaccination site care (including autoinoculated areas)	S		Vaccination recommended for vaccinators; for newly vaccinated HCWs: semi-permeable dressing over gauze until scab separates, with dressing change as fluid accumulates, ~3-5 days; gloves, hand hygiene for dressing change; vaccinated HCW or HCW without contraindication to vaccine for dressing changes [205, 221, 225].
Eczema vaccinatum	C	Until lesions dry and crusted, scabs separated	For contact with virus-containing lesions and exudative material
Fetal vaccinia	C		
Generalized vaccinia	C		

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	**Duration** †	**Comments**
Progressive vaccinia	C		
Postvaccinia encephalitis	S		
Blepharitis or conjunctivitis	S/C		Use Contact Precautions if there is copious drainage
Iritis or keratitis	S		
Vaccinia-associated erythema multiforme (Stevens Johnson Syndrome)	S		Not an infectious condition
Secondary bacterial infection (e.g., S. aureus, group A beta hemolytic streptococcus	S/C		Follow organism-specific (strep, staph most frequent) recommendations and consider magnitude of drainage
Varicella Zoster	A,C	Until lesions dry and crusted	Susceptible HCWs should not enter room if immune caregivers are available; no recommendation for face protection of immune HCWs; no recommendation for type of protection, i.e. surgical mask or respirator for susceptible HCWs. In immunocompromised host with varicella pneumonia, prolong duration of precautions for duration of illness. Post-exposure prophylaxis: provide post-exposure vaccine ASAP but within 120 hours; for susceptible exposed persons for whom vaccine is contraindicated (immunocompromised persons, pregnant women, newborns whose mother's varicella onset is ≤5days before delivery or within 48 hrs after delivery) provide VZIG, when available, within 96 hours; if unavailable, use IVIG, Use Airborne Precautions for exposed susceptible persons and exclude exposed susceptible healthcare workers beginning 8 days after first exposure until 21 days after last exposure or 28 if received VZIG, regardless of postexposure vaccination. [1036].
Variola (see smallpox)			
Vibrio parahaemolyticus (see gastroenteritis)			
Vincent's angina (trench mouth)	S		
Viral hemorrhagic fevers	S, D, C	DI	Single-patient room preferred. Emphasize: 1) use of sharps safety

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TYPE AND DURATION OF PRECAUTIONS RECOMMENDED FOR SELECTED INFECTIONS AND CONDITIONS

Infection/Condition	Precautions		
	Type *	Duration †	Comments
due to Lassa, Ebola, Marburg, Crimean-Congo fever viruses			devices and safe work practices, 2) hand hygiene; 3) barrier protection against blood and body fluids upon entry into room (single gloves and fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields); and 4) appropriate waste handling. Use N95 or higher respirators when performing aerosol-generating procedures. Largest viral load in final stages of illness when hemorrhage may occur; additional PPE, including double gloves, leg and shoe coverings may be used, especially in resource-limited settings where options for cleaning and laundry are limited. Notify public health officials immediately if Ebola is suspected [212, 314, 740, 772] Also see Table 3 for Ebola as a bioterrorism agent
Viral respiratory diseases (not covered elsewhere)			
Adults	S		
Infants and young children (see respiratory infectious disease, acute)			
Whooping cough (see pertussis)			
Wound infections			
Major	C	DI	No dressing or dressing does not contain drainage adequately
Minor or limited	S		Dressing covers and contains drainage adequately
Yersinia enterocolitica gastroenteritis (see gastroenteritis)			
Zoster (varicella-zoster) (see herpes zoster)			
Zygomycosis (phycomycosis, mucormycosis)	S		Not transmitted person-to-person

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

YEAR (Ref)	DOCUMENT ISSUED	COMMENT
1970 1099	Isolation Techniques for Use in Hospitals, 1st ed.	- Introduced seven isolation precaution categories with color-coded cards: Strict, Respiratory, Protective, Enteric, Wound and Skin, Discharge, and Blood - No user decision-making required - Simplicity a strength; over isolation prescribed for some infections
1975 1100	Isolation Techniques for Use in Hospitals, 2nd ed.	- Same conceptual framework as 1st edition
1983 1101	CDC Guideline for Isolation Precautions in Hospitals	- Provided two systems for isolation: category-specific and disease-specific - Protective Isolation eliminated; Blood Precautions expanded to include Body Fluids - Categories included Strict, Contact, Respiratory, AFB, Enteric, Drainage/Secretion, Blood and Body Fluids - Emphasized decision-making by users
1985-88 780, 896	Universal Precautions	- Developed in response to HIV/AIDS epidemic - Dictated application of Blood and Body Fluid precautions to all patients, regardless of infection status - Did not apply to feces, nasal secretions, sputum, sweat, tears, urine, or vomitus unless contaminated by visible blood - Added personal protective equipment to protect HCWs from mucous membrane exposures - Handwashing recommended immediately after glove removal - Added specific recommendations for handling needles and other sharp devices; concept became integral to OSHA's 1991 rule on occupational exposure to blood-borne pathogens in healthcare settings

1987 [1102]	Body Substance Isolation	- Emphasized avoiding contact with all moist and potentially infectious body substances except sweat even if blood not present - Shared some features with Universal Precautions - Weak on infections transmitted by large droplets or by contact with dry surfaces - Did not emphasize need for special ventilation to contain airborne infections - Handwashing after glove removal not specified in the absence of visible soiling
1996 [1]	Guideline for Isolation Precautions in Hospitals	- Prepared by the Healthcare Infection Control Practices Advisory Committee (HICPAC) - Melded major features of Universal Precautions and Body Substance Isolation into Standard Precautions to be used with all patients at all times - Included three transmission-based precaution categories: airborne, droplet, and contact - Listed clinical syndromes that should dictate use of empiric isolation until an etiological diagnosis is established

* Derived from Garner ICHE 1996

TABLE 2. CLINICAL SYNDROMES OR CONDITIONS WARRANTING EMPIRIC TRANSMISSION-BASED PRECAUTIONS IN ADDITION TO STANDARD PRECAUTIONS PENDING CONFIRMATION OF DIAGNOSIS*

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions (Always includes Standard Precautions)
DIARRHEA		
Acute diarrhea with a likely infectious cause in an incontinent or diapered patient	Enteric pathogens§	Contact Precautions (pediatrics and adult)
MENINGITIS	*Neisseria meningitidis*	Droplet Precautions for first 24 hrs of antimicrobial therapy; mask and face protection for intubation
	Enteroviruses	Contact Precautions for infants and children
	M. tuberculosis	Airborne Precautions if pulmonary infiltrate Airborne Precautions plus Contact Precautions if potentially infectious draining body fluid present
RASH OR EXANTHEMS, GENERALIZED, ETIOLOGY UNKNOWN		
Petechial/ecchymotic with fever (general)	*Neisseria meningitides*	Droplet Precautions for first 24 hrs of antimicrobial therapy
- If positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever	Ebola, Lassa, Marburg viruses	Droplet Precautions plus Contact Precautions, with face/eye protection, emphasizing safety sharps and barrier precautions when blood exposure likely. Use N95 or higher respiratory protection when aerosol-generating procedure performed

Vesicular	Varicella-zoster, *herpes simplex,* variola (smallpox), vaccinia viruses Vaccinia virus	Airborne plus Contact Precautions; Contact Precautions only if *herpes simplex,* localized zoster in an immunocompetent host or vaccinia viruses most likely
Maculopapular with cough, coryza and fever	Rubeola (measles) virus	Airborne Precautions

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions (Always includes Standard Precautions)
RESPIRATORY INFECTIONS		
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for human immunodeficiency virus (HIV) infection	*M. tuberculosis,* Respiratory viruses, *S. pneumoniae, S. aureus* (MSSA or MRSA)	Airborne Precautions plus Contact precautions
Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection	*M. tuberculosis,* Respiratory viruses, *S. pneumoniae, S. aureus* (MSSA or MRSA)	Airborne Precautions plus Contact Precautions Use eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated. If tuberculosis is unlikely and there are no AIIRs and/or respirators available, use Droplet Precautions instead of Airborne Precautions Tuberculosis more likely in HIV-infected individual than in HIV negative individual
Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10-21 days) to countries with active outbreaks of SARS, avian influenza	*M. tuberculosis,* severe acute respiratory syndrome virus (SARS-CoV), avian influenza	Airborne plus Contact Precautions plus eye protection. If SARS and tuberculosis unlikely, use Droplet Precautions instead of Airborne Precautions.
Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children	Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, Human metapneumovirus	Contact plus Droplet Precautions; Droplet Precautions may be discontinued when adenovirus and influenza have been ruled out

Skin or Wound Infection		
Abscess or draining wound that cannot be covered	*Staphylococcus aureus* (MSSA or MRSA), group A streptococcus	Contact Precautions Add Droplet Precautions for the first 24 hours of appropriate antimicrobial therapy if invasive Group A streptococcal disease is suspected

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

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

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

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

TABLE 3.
INFECTION CONTROL CONSIDERATIONS FOR HIGH-PRIORITY (CDC CATEGORY A) DISEASES THAT MAY RESULT FROM BIOTERRORIST ATTACKS OR ARE CONSIDERED TO BE BIOTERRORIST THREATS
(www.bt.cdc.gov) [a]

[a] Abbreviations used in this table: RT = respiratory tract; GIT = gastrointestinal tract; CXR = chest x-ray; CT = computerized axial tomography; CSF = cerebrospinal fluid; and LD_{50} – lethal dose for 50% of experimental animals; HCWs = healthcare worker; BSL = biosafety level; PAPR = powered air purifying respirator; PCR = polymerase chain reaction; IHC = immunohistochemistry

Disease	Anthrax
Site(s) of Infection; Transmission Mode Cutaneous and inhalation disease have occurred in past bioterrorist incidents	**Cutaneous** (contact with spores);**RT** (inhalation of spores);**GIT** (ingestion of spores - rare) **Comment:** Spores can be inhaled into the lower respiratory tract. The infectious dose of *B. anthracis* in humans by any route is not precisely known. In primates, the LD50 (i.e., the dose required to kill 50% of animals) for an aerosol challenge with *B. anthracis* is estimated to be 8,000–50,000 spores; the infectious dose may be as low as 1-3 spores
Incubation Period	**Cutaneous**: 1 to12 days; **RT**: Usually 1 to 7 days but up to 43 days reported; **GIT**: 15-72 hours
Clinical Features	**Cutaneous:** Painless, reddish papule, which develops a central vesicle or bulla in 1-2 days; over next 3-7 days lesion becomes pustular, and then necrotic, with black eschar; extensive surrounding edema. **RT:** initial flu-like illness for 1-3 days with headache, fever, malaise, cough; by day 4 severe dyspnea and shock, and is usually fatal (85%-90% if untreated; meningitis in 50% of RT cases. **GIT**: ; if intestinal form, necrotic, ulcerated edematous lesions develop in intestines with fever, nausea and vomiting, progression to hematemesis and bloody diarrhea; 25-60% fatal
Diagnosis	**Cutaneous:** Swabs of lesion (under eschar) for IHC, PCR and culture; punch biopsy for IHC, PCR and culture; vesicular fluid aspirate for Gram stain and culture; blood culture if systemic symptoms; acute and

	convalescent sera for ELISA serology **RT:** CXR or CT demonstrating wide mediastinal widening and/or pleural effusion, hilar abnormalities; blood for culture and PCR; pleural effusion for culture, PCR and IHC; CSF if meningeal signs present for IHC, PCR and culture; acute and convalescent sera for ELISA serology; pleural and/or bronchial biopsies IHC. **GIT:** blood and ascites fluid, stool samples, rectal swabs, and swabs of oropharyngeal lesions if present for culture, PCR and IHC
Infectivity	**Cutaneous:** Person-to-person transmission from contact with lesion of untreated patient possible, but extremely rare. **RT and GIT:** Person-to-person transmission does not occur. **Aerosolized powder, environmental exposures:** Highly infectious if aerosolized
Recommended Precautions	**Cutaneous**: Standard Precautions; Contact Precautions if uncontained copious drainage. **RT and GIT:** Standard Precautions. **Aerosolized powder, environmental exposures:** Respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm) **Hand hygiene:** Handwashing for 30-60 seconds with soap and water or 2% chlorhexidene gluconate after spore contact (alcohol handrubs inactive against spores [Weber DJ JAMA 2003; 289:1274]). **Post-exposure prophylaxis following environmental exposure**: 60 days of antimicrobials (either doxycycline, ciprofloxacin, or levofloxacin) and post-exposure vaccine under IND

Disease	Botulism
Site(s) of Infection; Transmission Mode	**GIT:** Ingestion of toxin-containing food, **RT:** Inhalation of toxin containing aerosol cause disease. **Comment:** Toxin ingested or potentially delivered by aerosol in bioterrorist incidents. LD_{50} for type A is 0.001 μg/ml/kg.
Incubation Period	1-5 days.
Clinical Features	Ptosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia followed by symmetrical descending paralysis and respiratory failure.

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

	occurring VHFs.

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

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

1. Wu L-T. A treatise on pneumonic plague. Geneva: League of Nations, 1926. III. Health.

2. Kool JL. Risk of person to person transmission of pneumonic plague. Clinical Infectious Diseases, 2005; 40 (8): 1166-1172

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

Disease	Smallpox
Site(s) of Infection; Transmission Mode	**RT** Inhalation of droplet or, rarely, aerosols; and skin lesions (contact with virus). **Comment:** If used as a biological weapon, natural disease, which has not occurred since 1977, will likely result.
Incubation Period	7 to 19 days (mean 12 days)
Clinical Features	Fever, malaise, backache, headache, and often vomiting for 2-3 days; then generalized papular or maculopapular rash (more on face and extremities), which becomes vesicular (on day 4 or 5) and then pustular; lesions all in same stage.
Diagnosis	Electron microscopy of vesicular fluid or culture of vesicular fluid by WHO approved laboratory (CDC); detection by PCR available only in select LRN labs, CDC and USAMRID
Infectivity	Secondary attack rates up to 50% in unvaccinated persons; infected persons may transmit disease from time rash appears until all lesions have crusted over (about 3 weeks); greatest infectivity during first 10 days of rash.
Recommended Precautions	Combined use of Standard, Contact, and Airborne Precautions[b] until all scabs have separated (3-4 weeks). Only immune HCWs to care for pts; post-exposure vaccine within 4 days. **Vaccinia:** HCWs cover vaccination site with gauze and semi-permeable dressing until scab separates (≥21 days). Observe hand hygiene. **Adverse events with virus-containing lesions:** Standard plus Contact Precautions until all lesions crusted

[b] Transmission by the airborne route is a rare event; Airborne Precautions is recommended when possible, but in the event of mass exposures, barrier precautions and containment within a designated area are most important [204, 212].

[c] Vaccinia adverse events with lesions containing infectious virus include inadvertent autoinoculation, ocular lesions (blepharitis, conjunctivitis), generalized vaccinia, progressive vaccinia, eczema vaccinatum; bacterial superinfection also requires addition of contact precautions if exudates cannot be contained [216, 217].

Disease	Tularemia
Site(s) of Infection; Transmission Mode	**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 10-50 bacteria
Incubation Period	2 to 10 days, usually 3 to 5 days
Clinical Features	Pneumonic: malaise, cough, sputum production, dyspnea; Typhoidal: fever, prostration, weight loss and frequently an associated pneumonia.
Diagnosis	Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by PCR (LRN) or isolated from blood and other body fluids on cysteine-enriched media or mouse inoculation.
Infectivity	Person-to-person spread is rare. Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed.
Recommended Precautions	Standard Precautions

TABLE 4.
RECOMMENDATIONS FOR APPLICATION OF STANDARD PRECAUTIONS FOR THE CARE OF ALL PATIENTS IN ALL HEALTHCARE SETTINGS
(See Sections II.D.-II.J. and III.A.1)

COMPONENT	RECOMMENDATIONS
Hand hygiene	After touching blood, body fluids, secretions, excretions, contaminated items; immediately after removing gloves; between patient contacts.
Personal protective equipment (PPE)	
Gloves	For touching blood, body fluids, secretions, excretions, contaminated items; for touching mucous membranes and nonintact skin
Gown	During procedures and patient-care activities when contact of clothing/exposed skin with blood/body fluids, secretions, and excretions is anticipated..
Mask, eye protection (goggles), face shield*	During procedures and patient-care activities likely to generate splashes or sprays of blood, body fluids, secretions, especially suctioning, endotracheal intubation
Soiled patient-care equipment	Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; perform hand hygiene.
Environmental control	Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient-care areas.
Textiles and laundry	Handle in a manner that prevents transfer of microorganisms to others and to the environment
Needles and other sharps	Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; place used sharps in puncture-resistant container
Patient resuscitation	Use mouthpiece, resuscitation bag, other ventilation devices to prevent contact with mouth and oral secretions

Patient placement	Prioritize for single-patient room if patient is at increased risk of transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk of acquiring infection or developing adverse outcome following infection.
Respiratory hygiene/cough etiquette (source containment of infectious respiratory secretions in symptomatic patients, beginning at initial point of encounter e.g., triage and reception areas in emergency departments and physician offices)	Instruct symptomatic persons to cover mouth/nose when sneezing/coughing; use tissues and dispose in no-touch receptacle; observe hand hygiene after soiling of hands with respiratory secretions; wear surgical mask if tolerated or maintain spatial separation, >3 feet if possible.

* * During aerosol-generating procedures on patients with suspected or proven infections transmitted by respiratory aerosols (e.g., SARS), wear a fit-tested N95 or higher respirator in addition to gloves, gown,and face/eye protection.

TABLE 5. COMPONENTS OF A PROTECTIVE ENVIRONMENT
(Adapted from MMWR 2003; 52 [RR-10])

I. Patients: allogeneic hematopoeitic stem cell transplant (HSCT) only

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

II. Standard and Expanded Precautions

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

III. Engineering

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

Figure.
Example of Safe Donning and Removal of Personal Protective Equipment (PPE)

DONNING PPE

GOWN

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

MASK OR RESPIRATOR

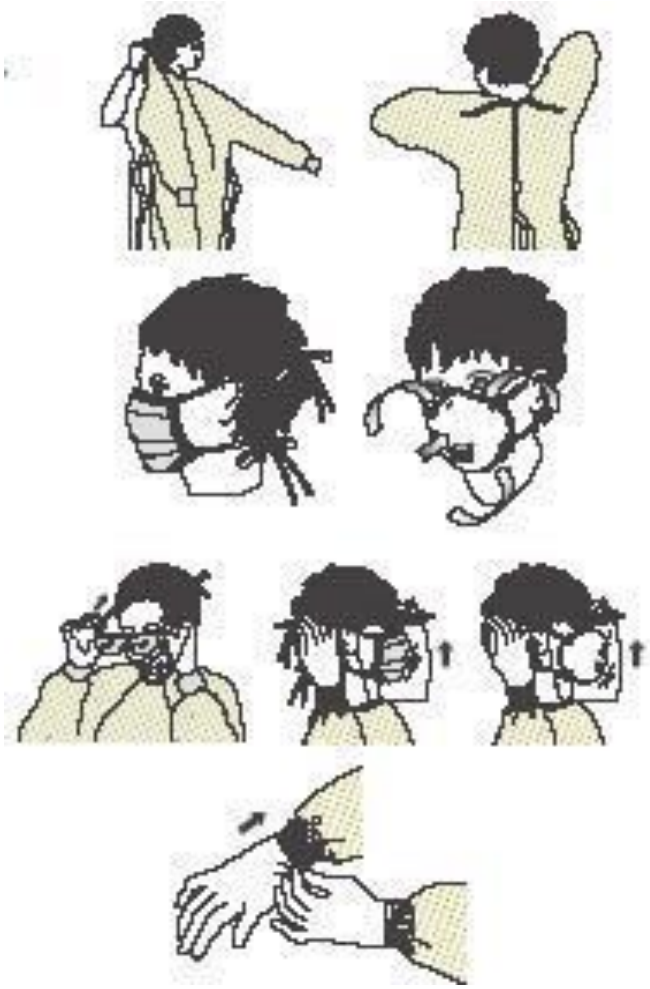
- Secure ties or elastic band at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator

GOGGLES/FACE SHIELD

- Put on face and adjust to fit

GLOVES

- Use non-sterile for isolation
- Select according to hand size
- Extend to cover wrist of isolation gown



SAFE WORK PRACTICES

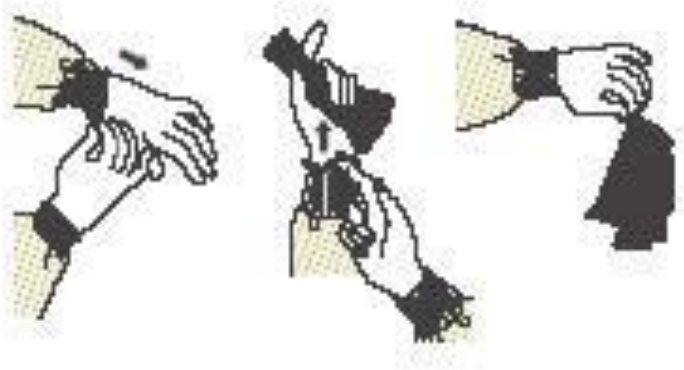
- Keep hands away from face
- Work from clean to dirty
- Limit surfaces touched
- Change when torn or heavily contaminated
- Perform hand hygiene

REMOVING PPE

Remove PPE at doorway before leaving patient room or in anteroom

GLOVES

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



GOGGLES/FACE SHIELD

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

GOWN

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

MASK OR RESPIRATOR

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

HAND HYGIENE

Perform hand hygiene immediately after removing all PPE!

GLOSSARY

Airborne infection isolation room (AIIR). Formerly, 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); **and** an air flow rate of 6-12 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 HEPA filter before retruning to circulation (MMWR 2005; 54 [RR-17]).

American Institute of Architects (AIA). A professional organization that develops 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, Facilities Guideline Institute, with assistance from the U.S. Department of Health and Human Services and the National Institutes of Health, is the primary source of guidance for creating airborne infection isolation rooms (AIIRs) and protective environments (www.aia.org/aah).

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

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

Caregivers.. All persons who are not employees of an organization, are not paid, and provide or assist in providing healthcare to a patient (e.g., family member, friend) and acquire technical training as needed based on the tasks that must be performed.

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, healthcare 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 duration, but may become a source of potential transmission. In many instances, colonization and carriage are synonymous.

Droplet nuclei. Microscopic particles < 5 µm 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 of time 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. AIIRs, a Protective Environment, engineered sharps injury prevention devices and sharps containers are examples of engineering controls.

Epidemiologically important pathogens . Infectious agents that have one or more of the following characteristics: 1) are readily transmissible; 2) have a proclivity toward causing outbreaks; 3) may be associated with a severe outcome; or 4) are difficult to treat. Examples include *Acinetobacter sp., Aspergillus* sp.*, Burkholderia cepacia*, *Clostridium difficile*, *Klebsiella* or *Enterobacter* sp., extended-spectrum-beta-lactamase producing gram negative bacilli [ESBLs], methicillin-resistant *Staphylococcus aureus* [MRSA]*, Pseudomonas aeruginosa,* vancomycin-resistant enterococci [VRE], methicillin resistant *Staphylococcus aureus* [MRSA]*,* vancomycin resistant *Staphylococcus aureus* [VRSA] influenza virus, respiratory syncytial virus [RSV], rotavirus, SARS-CoV, noroviruses and the hemorrhagic fever viruses).

Hand hygiene. A general term that applies to any one of the following: 1) handwashing with plain (nonantimicrobial) soap and water); 2) antiseptic handwash (soap containing antiseptic agents and water); 3) antiseptic handrub (waterless antiseptic product, most often alcohol-based, rubbed on all surfaces of hands); or 4) surgical hand antisepsis (antiseptic handwash or antiseptic handrub performed preoperatively by surgical personnel to eliminate transient hand flora and reduce resident hand flora) [559].

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

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

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

Hematopoietic stem cell transplantation (HSCT). Any transplantation of blood- or bone marrow-derived hematopoietic stem cells, regardless of donor type (e.g., allogeneic or autologous) or cell source (e.g., bone marrow, peripheral blood, or placental/umbilical cord blood); associated with periods of severe immunosuppression that vary with the source of the cells, the intensity of chemotherapy required, and the presence of graft versus host disease (MMWR 2000; 49: RR-10).

High-efficiency particulate air (HEPA) filter. An air filter that removes >99.97% of particles $\geq$ 0.3µm (the most penetrating particle size) at a specified flow rate of air. HEPA filters may be integrated into the central air handling systems, installed at the point of use above the ceiling of a room, or used as portable units (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 (e.g., 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 patients. Those patients whose immune mechanisms are deficient because of congenital or acquired immunologic disorders (e.g., human immunodeficiency virus [HIV] infection, congenital immune deficiency syndromes), chronic diseases such as diabetes mellitus, cancer, emphysema, or cardiac failure, ICU care, malnutrition, and immunosuppressive therapy of another disease process [e.g., 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 HSCT and those with chronic graft versus host disease are considered the most vulnerable to HAIs. Immunocompromised states also make it more difficult to diagnose certain infections (e.g., 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 special training in infection control. Responsibilities may include collection, analysis, and feedback of infection data and trends to healthcare providers; consultation on infection risk assessment, prevention and control strategies; performance of education and training activities; implementation of evidence-based infection control practices or those mandated by regulatory and licensing agencies; application of epidemiologic principles to improve patient outcomes; participation in planning renovation and construction projects (e.g., to ensure appropriate containment of construction dust); evaluation of new products or procedures on patient outcomes; oversight of employee health services related to infection prevention; implementation of preparedness plans; communication within the healthcare setting, with local and state health departments, and with the community at large concerning infection control issues; and participation in research. Certification in infection control (CIC) is available through the Certification Board of Infection Control and Epidemiology.

Infection control and prevention program**.** A multidisciplinary program that includes a group of activities to ensure that recommended practices for the prevention of healthcare-associated infections are implemented and followed by HCWs, making the healthcare setting safe from infection for patients and

healthcare personnel. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires the following five components of an infection control program for accreditation: 1) *surveillance*: monitoring patients and healthcare personnel for acquisition of infection and/or colonization; 2) *investigation:* identification and analysis of infection problems or undesirable trends; 3) *prevention*: implementation of measures to prevent transmission of infectious agents and to reduce risks for device- and procedure-related infections; 4) *control*: evaluation and management of outbreaks; and 5) *reporting:* provision of information to external agencies as required by state and federal law and regulation (www.jcaho.org). The infection control program staff has the ultimate authority to determine infection control policies for a healthcare organization with the approval of the organization's governing body.

Long-term care facilities (LTCFs). An array of residential and outpatient facilities designed to meet the bio-psychosocial 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 (www.fda.gov/cdrh/ode/guidance/094.html#4).

Multidrug-resistant organisms (MDROs). In general, bacteria that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents (e.g., MRSA, VRE, extended spectrum beta-lactamase [ESBL]-producing or intrinsically resistant gram-negative bacilli) [176].

Nosocomial infection. A term that is derived from two Greek words "nosos" (disease) and "komeion" (to take care of) and 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, that has a positive air flow relative to the corridor (i.e., air flows from the room to the outside adjacent space). The combination of high-efficiency particulate air (HEPA) filtration, high numbers ($\geq$12) of air changes per hour (ACH), and minimal leakage of air into the room creates an environment that can safely accommodate patients with a severely compromised immune system (e.g., those who have received allogeneic hemopoietic stem-cell transplant [HSCT]) 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 studies. Studies to evaluate interventions but do not use randomization as part of the study design. These studies are also referred to as nonrandomized, pre-post-intervention study designs. These studies aim to demonstrate causality between an intervention and an outcome but cannot achieve the level of confidence concerning 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 used commonly. 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 study design is used when it is not logistically feasible or ethically possible to conduct a randomized, controlled trial, (e.g., 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 healthcare personnel to protect them from inhalation exposure to airborne infectious agents that are < 5 μm in size. These include infectious droplet nuclei from patients with *M. tuberculosis,* variola virus [smallpox], SARS-CoV), and dust particles that contain infectious particles, such as spores of environmental fungi (e.g., *Aspergillus* sp.). The CDC's National Institute for Occupational Safety and Health (NIOSH) certifies respirators used in healthcare settings (www.cdc.gov/niosh/topics/respirators/). The N95 disposable particulate, air purifying, respirator is the type used most commonly by healthcare personnel. Other respirators used include N-99 and N-100 particulate respirators, powered air-purifying respirators (PAPRS) with high efficiency filters; and non-powered full-facepiece elastomeric negative pressure respirators. A listing of NIOSH-approved respirators can be found at www.cdc.gov/niosh/npptl/respirators/disp_part/particlist.html. Respirators must be used in conjunction with a complete Respiratory Protection Program, as

required by the Occupational Safety and Health Administration (OSHA), that includes fit testing, training, proper selection of respirators, medical clearance and respirator maintenance.

Respiratory Hygiene/ Cough Etiquette. A combination of measures designed to minimize the transmission of respiratory pathogens via droplet or airborne routes in healthcare settings. The components of Respiratory Hygiene/Cough Etiquette are 1) covering the mouth and nose during coughing and sneezing, 2) using tissues to contain respiratory secretions with prompt disposal into a no-touch receptacle, 3) offering a surgical mask to persons who are coughing to decrease contamination of the surrounding environment, and 4) turning the head away from others and maintaining spatial separation, ideally >3 feet, when coughing. These measures are targeted to all patients with symptoms of respiratory infection and their accompanying family members or friends beginning at the point of initial encounter with a healthcare setting (e.g., reception/triage in emergency departments, ambulatory clinics, healthcare provider offices) [126] (Srinivasin A ICHE 2004; 25: 1020; www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm).

Safety culture/climate. The shared perceptions of workers and management regarding the expectations of safety in the work environment. A hospital safety climate includes the following six organizational components: 1) senior management support for safety programs; 2) absence of workplace barriers to safe work practices; 3) cleanliness and orderliness of the worksite; 4) minimal conflict and good communication among staff members; 5) frequent safety-related feedback/training by supervisors; and 6) availability of PPE and engineering controls [620].

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, (e.g., 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 (e.g., 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 is a combination and expansion of Universal Precautions [780] and Body Substance Isolation [1102]. Standard Precautions is based on the principle that all blood, body fluids, secretions, excretions except sweat, nonintact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions includes hand hygiene, and depending on the anticipated exposure, use of gloves, gown, mask, eye protection, or face shield. Also, equipment or items in the patient environment

likely to have been contaminated with infectious fluids must be handled in a manner to prevent transmission of infectious agents, (e.g. wear gloves for handling, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient).

Surgical mask. A device worn over the mouth and nose by operating room personnel during surgical procedures to protect both surgical patients and operating room personnel from transfer of microorganisms and body fluids. Surgical masks also are used to protect healthcare 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 in order to mitigate the risks to health associated with the use of surgical masks. These specifications apply to any masks that are labeled surgical, laser, isolation, or dental or medical procedure (www.fda.gov/cdrh/ode/guidance/094.html#4). 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, (e.g., *Mycobacterium tuberculosis)*.

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