

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 programs⁵⁴³⁻⁵⁴⁷. 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 HAIs⁵⁵⁰. 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 nurse⁵⁵¹ and infection prevention and control professional (ICP) staffing levels⁵⁵², inclusion of ICPs in facility construction and design decisions¹¹, clinical microbiology laboratory support^{553, 554}, adequate supplies and equipment including facility ventilation systems¹¹, adherence monitoring⁵⁵⁵, 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 1970-76⁵⁶⁶. 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 1982⁵⁶⁷⁻⁵⁶⁹ 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 facilities⁵⁵⁸. 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 staffing⁵⁵². A survey of participants in the National

Nosocomial Infections Surveillance (NNIS) system found the average daily census per ICP was 115³¹⁶. 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 community⁵⁵². 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 level⁵⁷⁷⁻⁵⁸². 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, not a replacement for, fully trained ICPs. Furthermore, the infection control liaison nurses should not be counted when considering ICP staffing.

II.A.1.b. Bedside nurse staffing There is increasing evidence that the level of bedside nurse-staffing influences the quality of patient care^{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 consistently⁵⁵². 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 pneumonia⁵⁸³. 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 2001⁵⁵³. 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 outbreaks⁵⁹⁸. Outbreaks of infections may be recognized first by laboratorians¹⁶². 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 2005⁶⁰², for the detection of emerging resistance patterns^{603,604}, and for the preparation, analysis, and distribution of periodic cumulative antimicrobial susceptibility summary reports⁶⁰⁵⁻⁶⁰⁷. While not required, clinical laboratories ideally should have access to rapid genotypic identification of bacteria and their antibiotic resistance genes⁶⁰⁸.
- 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 outbreaks⁶⁰⁹.
- 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., influenza⁶¹⁰⁻⁶¹², B. pertussis⁶¹³, RSV^{614,615}, and enteroviruses⁶¹⁶). 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 workers⁶¹⁷.

- 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 recommendations²⁵⁷. 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 fluids⁶²⁶⁻⁶³². One study of hand hygiene practices concluded that improved adherence requires integration of infection control into the organization's safety culture⁵⁶¹. 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 facility⁶⁴¹ and between experienced and nonexperienced professionals⁶⁴⁵. 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 adherence⁶⁵⁷. 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 known⁶⁵⁴. 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 washing⁶⁶⁰, 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 study⁶⁶¹. 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 adherence⁶⁶². Improvement requires that the organizational leadership make prevention an institutional priority and integrate infection control practices into the organization's safety culture⁵⁶¹. 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 pathogens²⁵⁷.

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 health⁶⁶³. 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 agents⁶⁶⁴. 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 hospitals⁵⁶⁶; 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 care⁴⁷⁰⁻⁴⁷³. 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 caregivers⁶⁷¹⁻⁶⁷⁶. Data gathered through surveillance of high-risk populations, device use, procedures, and/or facility locations (e.g., ICUs) are useful for detecting transmission trends⁶⁷¹⁻⁶⁷³. 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 legislation⁶⁸⁰.

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 procedures⁶⁸⁹. 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 rates⁶⁹⁰⁻⁶⁹³.

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.ihl.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 microbicidal activity, reduced drying of the skin, and convenience⁵⁵⁹. 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 artificial nails have been shown to harbor more pathogenic organisms, especially gram negative bacilli and yeasts, on the nails and in the subungual area than those with native nails^{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 experts²⁰. 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 hands⁷³.

The extent to which gloves will protect healthcare personnel from transmission of bloodborne pathogens (e.g., HIV, HBV, HCV) following a needlestick or other puncture that penetrates the glove barrier has not been determined. Although gloves may reduce the volume 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 clearance⁷³⁰. Nonsterile disposable medical gloves made of a variety of materials (e.g., latex, vinyl, nitrile) are available for routine patient care⁷³¹. 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 protection⁷³⁴. However, there is considerable variability among gloves; both the quality of the manufacturing process and type of material influence their barrier effectiveness⁷³⁵. While there is little difference in the barrier properties of unused intact gloves⁷³⁶, 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 bacilli⁷⁴¹⁻⁷⁴³.

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 Standard⁷³⁹. 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 Standard⁷³⁹. 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 published⁷⁵⁹. 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 Precautions 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 goggles⁷⁵⁹. 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 2004⁷⁶³. 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-17¹²).

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 facepiece⁷⁶⁹. The optimal frequency of fit-testing has not been determined; re-testing may be indicated if there is a change in facial features of the wearer, onset of a medical condition that would affect respiratory function in the wearer, or a change in the model or size of the initially assigned respirator¹².

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 SARS²⁶² and smallpox^{108, 129, 772}, until inhalational transmission is better defined or healthcare-specific protective equipment more suitable 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 with SARS 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 alone⁷⁷³. 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 infections⁷⁷⁴⁻⁷⁷⁷. 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 elsewhere⁷⁸¹⁻⁷⁸⁵.

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 devices⁷⁸⁶. CDC has provided guidance on sharps injury prevention^{787, 788}, including for the design, implementation and evaluation of a comprehensive sharps injury prevention program⁷⁸⁹.

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 preferred when there is a concern about transmission of an infectious agent. Although some studies have failed to demonstrate the efficacy of single patient rooms to prevent HAIs⁷⁹¹, 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, commodes⁷⁹⁸, 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 room⁸⁰⁶. 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-ESBLs⁸¹⁰; *Pseudomonas aeruginosa*²⁹; methicillin-susceptible

*Staphylococcus aureus*⁸¹¹; RSV^{812, 813}; adenovirus keratoconjunctivitis⁸¹⁴; rotavirus⁸¹⁵; and SARS⁸¹⁶. Modeling studies provide additional support for cohorting patients to control outbreaks Talon⁸¹⁷⁻⁸¹⁹. 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 hospitals⁵⁸³ and residential healthcare sites⁸²⁰⁻⁸²². 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 metapneumovirus⁸²³, parainfluenza, influenza, other respiratory viruses⁸²⁴, 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 children⁸²⁵. For example, during the respiratory virus season, infants may be cohorted based solely on the clinical diagnosis of bronchiolitis due to the logistical difficulties and costs associated with requiring microbiologic confirmation prior to room placement, and the predominance of RSV during most of the season. However, when available, single patient rooms are always preferred since a common clinical presentation (e.g., bronchiolitis), can be caused by more than one infectious agent^{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 coughing patients to wear a surgical mask or cover their coughs with tissues) to prevent transmission of respiratory infections, beginning at the point of initial patient encounter^{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 cavitory 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 fibrosis²⁰) 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 available⁸³².

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* infections⁸⁴⁷. 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 Facilities¹¹ and in the Guideline for Disinfection and Sterilization⁸⁴⁸.

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 proteinaceous 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 summarized⁸⁵⁰ 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 aerosolizable material⁸⁶⁵, influenza virus⁶¹¹, HIV⁸⁶⁶, and group A streptococcus¹⁶⁰. Orally administered antimicrobials may also be used under defined circumstances for MRSA decolonization of patients or healthcare personnel⁸⁶⁷.

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 outbreak²². Topical antiseptics are also used for decolonization of healthcare personnel or selected patients colonized with MRSA, using mupirocin as discussed in the MDRO guideline⁸⁷⁰
^{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 varicella⁷⁷⁵. Also, reports of healthcare-associated transmission of rubella in obstetrical clinics^{33, 876} and measles in acute care settings³⁴ 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 years⁸⁸². 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 conditions⁸⁸⁷.

Some vaccines are also used for postexposure prophylaxis of susceptible individuals, including varicella⁸⁸⁸, influenza⁶¹¹, hepatitis B⁷⁷⁸, and smallpox²²⁵ 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 setting⁸⁹¹.

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 excluded⁸³³.

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 beneficial⁹. 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 impact⁸⁹³⁻⁸⁹⁵. 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. meningitidis*). 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 etiquette⁹⁰⁰. 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 streptococcus¹¹⁴ 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 outside⁹⁰¹⁻⁹⁰³ 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 virus²³, adenovirus¹¹¹, *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 practices⁴⁵³. 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 patients⁹⁰⁵. Among the deficiencies identified in recent outbreaks were a lack of oversight of personnel and failure to follow-up on reported breaches in infection control practices in ambulatory settings. Therefore, to ensure that all healthcare workers understand and adhere to recommended practices, principles of infection control and aseptic technique need to be reinforced in training programs and incorporated into institutional policies that are monitored for adherence⁴⁵⁴.

III.A.1.c. Infection Control Practices for Special Lumbar Puncture

Procedures 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 oropharyngeal 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 previously⁹⁰⁶⁻⁹¹⁵. 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 droplets⁹¹⁸ and are recommended for the placement of central venous catheters⁹¹⁹. 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 disturbances⁹²⁰⁻⁹²², perceptions of stigma⁹²³, reduced contact with clinical staff⁹²⁴⁻⁹²⁶, and increases in preventable adverse events⁵⁶⁵ 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 guideline⁹²⁷. 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, ≥ 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 ≥ 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 precautions¹²). The verification code for this document is 218681. 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 drop let 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 available⁸⁶⁷. 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 negative⁷⁴⁰, 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, MRSA⁹³⁹, 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 guideline⁹²⁷ 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 Institute of Architecture¹³ 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 ≥ 12 air changes per hour; 6) strategies to minimize dust (e.g., scrubbable surfaces rather than upholstery⁹⁴⁰ and carpet⁹⁴¹, 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 patients⁹⁴²⁻⁹⁴⁴. 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.