COURSE #98643 — 5 CONTACT HOURS/CREDITS RELEASE: 04/01/22 REVIEW: 6/15/2024 EXPIRATION: 03/31/26

Infection Control: The New York Requirement

HOW TO RECEIVE CREDIT

- Read the enclosed course.
- Complete the questions at the end of the course.
- Return your completed Evaluation to NetCE by mail or fax, or complete online at www.NetCE.com. (If you are a physician or Florida nurse, please return the included Answer Sheet/Evaluation.) Your postmark or facsimile date will be used as your completion date.
- Receive your Certificate(s) of Completion by mail, fax, or email.

Faculty

Lori L. Alexander, MTPW, ELS, MWC, is President of Editorial Rx, Inc., which provides medical writing and editing services on a wide variety of clinical topics and in a range of media. A medical writer and editor for more than 30 years, Ms. Alexander has written for both professional and lay audiences, with a focus on continuing education materials, medical meeting coverage, and educational resources for patients. She is the Editor Emeritus of the American Medical Writers Association (AMWA) Journal, the peer-review journal representing the largest association of medical communicators in the United States. Ms. Alexander earned a Master's degree in technical and professional writing, with a concentration in medical writing, at Northeastern University, Boston. She has also earned certification as a life sciences editor and as a medical writer.

Carol Shenold, RN, ICP, graduated from St. Paul's Nursing School, Dallas, Texas, achieving her diploma in nursing. Over the past thirty years she has worked in hospital nursing in various states in the areas of obstetrics, orthopedics, intensive care, surgery and general medicine.

Mrs. Shenold served as the Continuum of Care Manager for Vencor Oklahoma City, coordinating quality review, utilization review, Case Management, Infection Control, and Quality Management. During that time, the hospital achieved Accreditation with Commendation with the Joint Commission, with a score of 100.

Mrs. Shenold was previously the Infection Control Nurse for Deaconess Hospital, a 300-bed acute care facility in Oklahoma City. She is an active member of the Association for Professionals in Infection Control and Epidemiology (APIC). She worked for the Oklahoma Foundation for Medical Quality for six years.

Faculty Disclosure

Contributing faculty, Lori L. Alexander, MTPW, ELS, MWC, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Contributing faculty, Carol Shenold, RN, ICP, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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The division planners and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for physicians, physician assistants, nurses, and other healthcare professionals in New York required to complete education to enhance their knowledge of infection control.

Accreditations & Approvals

JOINTLY ACCREDITED PROVIDER™ INTERPROFESSIONAL CONTINUING EDUCATION

In support of improving patient care, NetCE is jointly accredited by the Accreditation Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialing Center (ANCC), to provide continuing education for the healthcare team.

Designations of Credit

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A complete Works Cited list begins on page 36.

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Successful completion of this CME activity, which includes participation in the evaluation component, enables the learner to earn credit toward the CME and Self-Assessment requirements of the American Board of Surgery's Continuous Certification program. It is the CME activity provider's responsibility to submit learner completion information to ACCME for the purpose of granting ABS credit.

This activity has been approved for the American Board of Anesthesiology's® (ABA) requirements for Part II: Lifelong Learning and Self-Assessment of the American Board of Anesthesiology's (ABA) redesigned Maintenance of Certification in Anesthesiology Program® (MOCA®), known as MOCA 2.0®. Please consult the ABA website, www.theABA.org, for a list of all MOCA 2.0 requirements. Maintenance of Certification in Anesthesiology Program® and MOCA® are registered certification marks of the American Board of Anesthesiology®. MOCA 2.0® is a trademark of the American Board of Anesthesiology®.

Successful completion of this CME activity, which includes participation in the activity with individual assessments of the participant and feedback to the participant, enables the participant to earn 5 MOC points in the American Board of Pediatrics' (ABP) Maintenance of Certification (MOC) program. It is the CME activity provider's responsibility to submit participant completion information to ACCME for the purpose of granting ABP MOC credit.

This activity has been designated for 5 Lifelong Learning (Part II) credits for the American Board of Pathology Continuing Certification Program.

Through an agreement between the Accreditation Council for Continuing Medical Education and the Royal College of Physicians and Surgeons of Canada, medical practitioners participating in the Royal College MOC Program may record completion of accredited activities registered under the ACCME's "CME in Support of MOC" program in Section 3 of the Royal College's MOC Program.

NetCE designates this continuing education activity for 5 ANCC contact hours.

IPCE CREDIT™

This activity was planned by and for the healthcare team, and learners will receive 5 Interprofessional Continuing Education (IPCE) credits for learning and change.

NetCE designates this continuing education activity for 6 hours for Alabama nurses.

NetCE designates this continuing education activity for 1 pharmacotherapeutic/pharmacology contact hour.

AACN Synergy CERP Category A.

Individual State Nursing Approvals

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Special Approvals

This course is approved by the New York State Department of Health to fulfill the requirement for Infection Control Training as mandated by Chapter 786 of the Laws of 1992. Provider #OT10781.

This activity is designed to comply with the requirements of California Assembly Bill 1195, Cultural and Linguistic Competency, and California Assembly Bill 241, Implicit Bias.

About the Sponsor

The purpose of NetCE is to provide challenging curricula to assist healthcare professionals to raise their levels of expertise while fulfilling their continuing education requirements, thereby improving the quality of healthcare.

Our contributing faculty members have taken care to ensure that the information and recommendations are accurate and compatible with the standards generally accepted at the time of publication. The publisher disclaims any liability, loss or damage incurred as a consequence, directly or indirectly, of the use and application of any of the contents. Participants are cautioned about the potential risk of using limited knowledge when integrating new techniques into practice.

Disclosure Statement

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Course Objective

The purpose of this course is to provide a review of current infection control practices and accepted standards, with an emphasis on the application of infection control standards and practices in outpatient and ambulatory settings.

Learning Objectives

Upon completion of this course, you should be able to:

1. Discuss the standards of professional conduct associated with infection control in the healthcare setting.
2. Outline the infectious disease process.
3. Describe various practices that can result in exposure to bloodborne pathogens.
4. Identify effective strategies to prevent or control infection, including precautions, isolation techniques, hand hygiene, standards for cleaning, and safe injection practices.
5. Describe the role of surveillance and reporting in an effective infection control program.
6. Discuss the impact of communicable diseases in healthcare professionals, including the necessity for preplacement evaluations, periodic health assessments, education, and postexposure prophylaxis.
7. Evaluate the impact and appropriate response to sepsis.

EVIDENCE-BASED PRACTICE RECOMMENDATION

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

The development of formal infection control programs in hospitals and other healthcare facilities was spurred by the Joint Commission accreditation standards for infection control, published in 1976. According to the standards, accredited facilities should have a program for the surveillance, prevention, and control of healthcare-associated infections (HAIs) [1]. The most important aspect of infection control is establishing multidisciplinary programs that promote teamwork and foster an organizational culture centered on patient safety.

HAIs are one of the leading causes of death and increased morbidity for hospitalized patients and are a significant problem for healthcare providers [2]. Historically, these infections have been known as nosocomial infections or hospital-acquired infections because they develop during hospitalization. As health care has increasingly expanded beyond hospitals into outpatient settings, nursing homes, long-term care facilities, and even home care settings, the more appropriate term has become healthcare-acquired or healthcare-associated infection.

Many factors have contributed to an increase in HAIs. Advances in medical treatments have led to more patients with decreased immune function or chronic disease. The increase in the number of these patients, coupled with a shift in health care to the outpatient setting, yields a hospital population that is both more susceptible to infection and more vulnerable once infected. In addition, the increased use of invasive devices and procedures has contributed to higher rates of infection [3].

According to data published in 2014, HAIs develop in an estimated 1 in 25 hospitalized patients (excluding skilled nursing facilities); this number varies from year to year and had previously been estimated at a high of 1 in 10 [1; 4; 5; 6]. HAI data from the Centers for Disease Control and Prevention (CDC) indicate that the number is higher, at 1 in 31 patients [5]. Based on CDC-sponsored hospital surveillance data from 2018, an estimated 633,000 hospitalized patients develop an HAI each year [7]. These infections are the cause of approximately 72,000 deaths and add approximately $28.4 to $33.8 billion in direct medical costs annually [4; 6; 8].

Between January 2015 and December 2017, the most common types of HAIs were surgical site infections (42.4%), catheter-associated urinary tract infections (29.7%), central-line-associated bloodstream infections (25.3%), and ventilator-associated pneumonia (2.6%) [9]. Of the 355,633 reported pathogens, *Escherichia coli* was the most common pathogen across all HAIs, accounting for nearly 18% of reported infections [9].

As HAIs have become a cause for increasing concern, many national organizations, state departments of health, and professional organizations have taken additional steps to prevent or control infection in the healthcare environment. According to data from the CDC, these steps appear to be working. The 2020 *National and State Healthcare-Associated Infections (HAI) Progress Report* provides national- and state-level data about HAI incidence across four healthcare settings: acute care hospitals, critical access hospitals, inpatient rehabilitation facilities, and long-term acute care hospitals [10]. The progress report includes data gathered by the CDC's National Healthcare Safety Network (NHSN), a national HAI surveillance system that gathers data from more than 25,000 hospitals and other healthcare facilities.

Prior to 2020, the prevalence of HAIs had been declining, the result of an ongoing national collaborative effort. However, an analysis of NHSN data from acute care hospitals in 12 U.S. states found that rates of central-line-associated bloodstream infections, catheter-related urinary tract infections, and ventilator-associated events increased significantly compared with 2019, largely as a result of the COVID-19 pandemic [11]. The analysis showed that national standard infection ratios for central-line-associated bloodstream infections initially declined in the first quarter of 2020 compared with the first quarter of 2019, but then rose by 27.9%, 46.4%, and 47.0% in the second, third, and fourth quarters of the year, respectively. Ventilator-associated events rose by 44.8% in the fourth quarter of 2020 compared with the same period for 2019 [11]. While acknowledging that 2020 was an unprecedented time for hospitals, the authors of the analysis emphasized the continued need for regular review of HAI surveillance data to identify gaps in prevention [11].

STANDARDS OF PROFESSIONAL CONDUCT

The increased focus on healthcare quality over the past decade has highlighted the need to prevent HAIs as part of overall efforts to enhance patient safety. These efforts have been developed by healthcare quality agencies, professional associations, advocacy organizations, healthcare regulating bodies, and policymakers [12; 13; 14; 15; 16; 17; 18; 19]. Prevention of HAIs and of methicillin-resistant *Staphylococcus aureus* (MRSA) infection are listed among safe healthcare practices established by the Agency for Healthcare Research and Quality (AHRQ) and the National Quality Forum, and prevention of HAIs was noted by the Institute of Medicine (IOM) to be one of 20 priority areas for enhancing the quality of health care [12; 13; 18].

In 2004, the Institute for Healthcare Improvement (IHI) established the 100,000 Lives Campaign as a challenge to save 100,000 patient lives through six healthcare interventions, three of which were related to HAIs: preventing central-line infections, surgical site infections, and ventilator-associated pneumonia [14]. Building on the success of the 100,000 Lives Campaign, the IHI established the 5 Million Lives Campaign in December 2006, adding six more interventions, one of which is to reduce MRSA infection [14]. In 2010, the Centers for Medicare & Medicaid Services (CMS) launched the Partnership for Patients with the goal of reducing all HAIs 40% compared to 2010 and reducing readmissions due to HAIs by 20% by focusing on transitions from one care setting to another [20]. According to data from the AHRQ, successful reductions in HAIs helped prevent 20,500 hospital deaths and saved $7.7 billion in healthcare costs from 2014 to 2017 [20].

Regulatory bodies have also focused on HAIs. Goal 7 of the National Patient Safety Goals developed by the Joint Commission is to reduce the risk of HAIs in hospitals as well as ambulatory care/office-based surgery, long-term care, and assisted living settings [19]. Perhaps the most aggressive campaign against HAIs has come from CMS, which has suspended reimbursement of hospital costs related to three categories of HAIs it considers "reasonably preventable:" catheter-related urinary tract infection, vascular catheter-associated infection, and various surgical site infections [16; 17; 21]. However, studies have shown that this policy has not been a contributor to any decrease in the rate of HAIs, and a survey indicated that adherence to only a few prevention strategies has increased as a result of the policy [22; 23]. The policy also has the potential to lead to increased unnecessary use of antimicrobials in an effort to prevent infections [24]. Additionally, one study found that many acute care hospitals commonly listed the reimbursement restricted HAIs as "present on admission," which mitigated the impact intended by CMS [25].

The New York Codes, Rules, and Regulations require that certain healthcare professionals who may influence the control and prevention of HAIs complete training or education regarding infection control and barrier precautions [26]. New York State has also established professional standards of conduct to ensure that infection prevention and control practices are adhered to. According to the Rules of the Board of Regents: Part 29, "failing to use scientifically accepted infection prevention techniques appropriate to each profession for the cleaning and sterilization or disinfection of instruments, devices, materials and work surfaces, utilization of protective garb, use of covers for contamination-prone equipment and the handling of sharp instruments" is considered unprofessional conduct [27]. Appropriate infection control techniques include, but are not limited to, wearing appropriate personal protective equipment, adhering to recommendations for Universal and Standard Precautions, following sterilization and disinfection standards, and using the correct equipment in the correct way [27].

Healthcare professionals have the responsibility to adhere to scientifically accepted principles and practices of infection control in all healthcare settings and to oversee and monitor those medical and ancillary personnel for whom the professional is responsible [27]. Healthcare professionals are expected to use scientifically accepted infection prevention techniques appropriate to each profession for handwashing; aseptic technique; cleaning and sterilization or disinfection of instruments, devices, materials, and work surfaces; use of protective garb; use of covers for contamination-prone equipment; and handling of sharp instruments [26; 27; 28].

CONSEQUENCES OF NONCOMPLIANCE WITH GUIDELINES

The results of the CDC Study of Efficacy of Nosocomial Infection Control suggested that 6% of all HAIs could be prevented by minimal infection control efforts and 32% by "well organized and highly effective infection control programs" [29; 30]. A later review estimated that as many as 65% to 70% of cases of catheter-associated infections and 55% of cases of surgical site infections are preventable [31].

Evidence-based guidelines are at the heart of strategies to prevent and control HAIs and drug-resistant infections and address a wide range of issues from architectural design of hospitals to hand hygiene. These guidelines have been developed primarily by the CDC and the World Health Organization (WHO), infection-related organizations, and other professional societies. Some specialty organizations and quality improvement groups have summarized the guidelines for easier use in practice [2; 28; 32; 33; 34; 35; 36; 37; 38; 39; 40; 41; 42; 43; 44; 45; 46; 47; 48; 49; 50; 51; 52; 53]. Adherence to individual guidelines varies but, in general, is low. Historically, 87% of hospitals have failed to implement all of the recommended guidelines for preventing HAIs [54]. Hand hygiene is the most basic and single most important preventive measure, yet compliance rates among healthcare workers have averaged only 30% to 50% [3; 25; 42; 55; 56; 57; 58]. Decreasing the number of HAIs will require research to better understand the reasons behind lack of compliance with guidelines and to develop strategies that target those reasons.

In addition, there are professional consequences for New York healthcare professionals who do not adhere to appropriate infection control efforts. Healthcare professionals who fail to use scientifically accepted barrier precautions and state-established infection control practices may be subject to charges of professional misconduct [59]. The Office of Professional Medical Conduct may investigate on its own any suspected professional misconduct and is required to investigate each complaint received regardless of the source. The charges must state the substance of the alleged misconduct and the material facts (but not the evidence). A hearing may be called, if warranted. The results of the hearing (i.e., findings, conclusions, determinations, order) will be made public upon issuance. Any professional found guilty of misconduct shall be subject to penalties, including [60]:

- Censure and reprimand
- Suspension of license or limitation of license to a specified area or type of practice

- Revocation of license
- Annulment of license or registration
- Limitation on registration or issuance of any further license
- A fine not to exceed $10,000 upon each specification of charges of which the respondent is determined to be guilty
- A requirement that a licensee pursue a course of education or training
- A requirement that a licensee perform up to 500 hours of public service in a manner and at a time and place as directed

METHODS OF COMPLIANCE

The education and training of healthcare personnel are prerequisites for ensuring that Standard Precautions are understood and practiced. 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. Education programs for healthcare personnel have been associated with sustained improvement in adherence to best practices [28].

Adherence to recommended infection control practices decreases transmission of infectious agents in healthcare settings; however, several observational studies have shown limited adherence to recommended practices by healthcare personnel. Improving adherence to infection control practices requires a multifaceted approach that incorporates continuous assessment of both the individual and the work environment. It also requires that the organizational leadership make prevention an institutional priority and integrate infection control practices into the organization's safety culture [28; 61; 62].

THE INFECTIOUS DISEASE PROCESS

A comprehensive description of the pathogenesis of infection is beyond the scope of this course. However, a broad overview of pathogen-host interaction will aid in the understanding of how infection develops in the healthcare setting.

A healthy human body has several defenses against infection: the skin and mucous membranes form natural barriers to infection, and immune responses (nonspecific and specific) are activated to resist micro-organisms that are able to invade. The skin can effectively protect the body from most micro-organisms unless there is physical disruption. For example, the human papillomavirus can invade the skin, and some parasites can penetrate intact skin, but bacteria and fungi cannot [63]. Other disrupters of the natural barrier are lesions (e.g., chapped, abraded, affected by dermatitis), injury, or in the healthcare setting, invasive procedures or devices [64].

In addition to breaks in the skin, other primary entry points for micro-organisms are mucosal surfaces, such as the respiratory, gastrointestinal, and genitourinary tracts [65]. The membranes lining these tracts comprise a major internal barrier to micro-organisms due to the antimicrobial properties of their secretions. The respiratory tract filters inhaled micro-organisms, and mucociliary epithelium in the tracheobronchial tree moves them out of the lung. In the gastrointestinal tract, gastric acid, pancreatic enzymes, bile, and intestinal secretions destroy harmful micro-organisms. Nonpathogenic bacteria (commensal bacteria) make up the normal flora in the gastrointestinal tract and act as protectants against invading pathogenic bacteria. Commensal bacteria are a source of infection only if they are transmitted to another part of the body or if they are altered by the use of antibiotics [2].

HAIs are commonly caused by bacteria, but can also be caused by viruses, fungi, and parasites. These types of infection occur less frequently and often do not carry the same risks of morbidity and mortality as bacterial infections. Viral infections are more common in children than in adults and carry a high epidemic risk [1]. Fungal infections frequently occur during prolonged treatment with antibiotics and in patients who have compromised immune systems [2]. Various pathogens have different levels of pathogenicity, virulence, and infectivity.

The transmission of infection follows the cycle (the "cycle of infection") that has been described for all diseases, and humans are at the center of this cycle [2; 66]. In brief, a micro-organism requires a reservoir (a human, soil, air, or water), or a host, in which to live. The micro-organism also needs an environment that supports its survival once it exits the host and a method of transmission. Inherent properties allow micro-organisms to remain viable during transmission from a reservoir to a susceptible host, another essential factor for transmission of infection. The primary routes of transmission for infections are through the air, blood (or body fluid), contact (direct or indirect), fecal-oral route, food, animals, or insects. Once inside a host, micro-organisms thrive because of adherent properties that allow them to survive against mechanisms in the body that act to flush them out. Bacteria adhere to cell surfaces through hair-like projections, such as fibrillae, fimbriae, or pili, as well as by proteins that serve as adhesions [65]. Fimbriae and pili are found on gram-negative bacteria, whereas other types of adhesions are found with both gram-negative and gram-positive bacteria. Receptor molecules in the body act as ligands to bind the adhesions, enabling bacteria to colonize skin and mucous membranes. The virulence of the micro-organism, the integrity of the skin and membrane barriers, and patient status will determine whether colonization is followed by invasive infection. With colonization, there is no damage to local or distant tissues and no immune reaction; with infection, bacterial toxins that break down cells and intracellular matrices are released, causing damage to local and distant tissues and prompting an immune response in the host. Bacteria continue to thrive within a host through strategies that enable them to acquire iron for nutrition and to defend against the immune response. These virulence factors enhance a micro-organism's potential for infection by interrupting or avoiding phagocytosis or living inside phagocytes [65].

A healthcare environment increases the risk of infection for two primary reasons. First, it is likely that normally sterile body sites will become exposed, allowing pathogens to cause infection through contact with mucous membranes, nonintact skin, and internal body areas [66]. Second, the likelihood of a susceptible host is high due to the vulnerable health status of patients. Especially in an era of decreased hospital stays and increased outpatient treatments, it is the sickest patients who are hospitalized, increasing the risk not only for infection to develop in these patients but also for their infection to be more severe and to be transmitted to others.

Infection is transmitted in a healthcare environment primarily through exogenous and endogenous modes. Exogenous transmission is through patient-to-patient or staff-to-patient contact. Patients who do not have infection but have bacterial colonization can act as vectors of transmission. Staff members can also act as vectors because of colonization or contamination. Endogenous infection occurs within an individual patient through displacement of commensal micro-organisms.

Factors specifically related to the healthcare environment are not common causes of HAIs [2; 67; 68]. However, consideration should be given to the prevention of infection with environmental pathogens. The CDC revised guideline related to environmental factors for infection provides clear recommendations for infection control measures according to several environment-related categories, including air (normal ventilation and filtration, as well as handling during construction or repair), water (water supply systems, ice machines, hydrotherapy tanks and pools), and environmental services (laundry, housekeeping) [41].

In general, the spread of infectious disease is prevented by eliminating the conditions necessary for the micro-organism to be transmitted from a reservoir to a susceptible host. This can be accomplished by:

- Destroying the micro-organism
- Blocking the transmission
- Protecting individuals from becoming vectors of transmission
- Decreasing the susceptibility of potential hosts

Antiseptic techniques and antibiotics will kill micro-organisms, while proper hand hygiene will block their transmission. Gloves, gowns, and masks remove healthcare professionals from the transmission cycle by protecting them from contact with micro-organisms. Contact Precautions and isolation techniques help patients avoid being vectors of transmission. Lastly, ensuring that patients and healthcare professionals are immune or vaccinated can help decrease the availability of potential hosts.

HIGH-RISK PRACTICES: EXPOSURE TO BLOODBORNE PATHOGENS

Healthcare professionals, emergency response personnel, and public safety personnel may be exposed to a variety of bloodborne pathogens, including human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Exposure may occur percutaneously, parenterally, or through contact with mucous membranes and nonintact skin [69].

PERCUTANEOUS EXPOSURE

Percutaneous exposures may occur through the handling, disassembly, disposal, or reprocessing of contaminated needles and other sharp objects. They may also be related to the performance of procedures in which there is poor visualization (e.g., blind suturing, placing the nondominant hand next to or opposing a sharp, or performing procedures where bone spicules or metal fragments are produced). Data from the CDC National Surveillance System for Hospital Health Care Workers (NaSH) have shown that approximately 70% of percutaneous injuries occur during use of a sharp, 15% occur after use and before disposal, and 3% occur during or after disposal [70].

PARENTERAL EXPOSURE

Parenteral exposures (i.e., injection with infectious material) may occur during administration of parenteral medications, sharing of blood monitoring devices (e.g., glucometers, lancets), or infusion of contaminated blood products or fluids. Generally, these exposures are the result of poor adherence to Standard Precautions and infection control guidelines.

MUCOUS MEMBRANE AND NONINTACT SKIN EXPOSURE

Mucous membrane and nonintact skin exposures may occur when blood or body fluids come in direct contact with the eyes, nose, mouth, or other mucous membranes via contaminated hands, open skin lesions, or splashes or sprays of blood or body fluids (e.g., during irrigation or suctioning). Again, following established infection control guidelines greatly reduces the risk of this type of exposure.

PRECAUTIONS AND ISOLATION TECHNIQUES

The CDC guideline for isolation precautions in hospitals, last updated in 2007, synthesizes a variety of recommendations for precautions based on the type of infection, the route of transmission, and the healthcare setting [28]. As defined by the CDC, Standard Precautions represent measures that should be followed for all patients in a healthcare facility, regardless of diagnosis or infection status. Standard Precautions apply to blood; all body fluids, secretions, and excretions except sweat, regardless of whether they contain visible blood; nonintact skin; and mucous membranes [28]. For patients who are known to have or are highly suspected to have colonization or infection, Contact Precautions should be followed. This type of precaution is designed to reduce exogenous transmission of micro-organisms through direct or indirect contact from healthcare professionals or other patients. Airborne Precautions are used for patients who have or are highly suspected of having infection that is spread by airborne droplet nuclei, such as tuberculosis, measles, or varicella. Droplet Precautions target infections that are transmitted through larger droplets generated through talking, sneezing, or coughing, such as invasive *Haemophilus influenzae* type b disease, diphtheria (pharyngeal), pertussis, group A streptococcal pharyngitis, influenza, mumps, and rubella [28].

EVIDENCE-BASED PRACTICE RECOMMENDATION

The Infectious Diseases Society of America and Society for Healthcare Epidemiology of America recommend patients with suspected *Clostridioides difficile* infection should be placed on preemptive contact precautions pending the *C. difficile* test results if test results cannot be obtained on the same day.

(https://www.idsociety.org/practice-guideline/clostridium-difficile. Last accessed June 15, 2024.)

Strength of Recommendation/Level of Evidence: Strong recommendation, moderate-quality evidence

The CDC guideline includes descriptions of all the elements involved in the four types of precautions, including hand hygiene; the use of personal protection equipment (i.e., gloves, gown, face protection); placement of the patient; handling of patient-care equipment; and environmental services and occupational health. New elements of Standard Precautions added to the 2007 guideline include infection control practices (i.e., use of masks) for special lumbar puncture procedures, safe injection practices (discussed later in this course), and respiratory hygiene/cough etiquette [28]. Recommendations in this area address the importance of educating healthcare professionals about adherence to measures to control the transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections. In addition, the guideline states that efforts should be made to contain respiratory secretions in patients and other individuals who have signs and symptoms of a respiratory infection, beginning at the point of initial encounter in a healthcare setting. Signs should be posted to instruct patients and visitors with symptoms of respiratory infection to cover their mouths/noses when coughing or sneezing, to use and dispose of tissues, and to perform hand hygiene after contact with respiratory secretions. Masks should be offered to coughing patients and other individuals with symptoms, and such persons should be encouraged to maintain an ideal distance of at least 3 feet from others in common waiting areas.

The following descriptions of precautions are summarized from the 2007 guideline for isolation precautions [28]. Although the 2007 guideline is the most recent version, guidance regarding Ebola virus precautions and isolation has been updated and will be discussed briefly [71].

STANDARD PRECAUTIONS

Hand Hygiene

The guideline includes recommendations found in the CDC guideline on hand hygiene [42]. Hand hygiene guidelines will be discussed in length later in this course.

Gloves

Wear gloves (clean, nonsterile gloves are adequate) when touching blood, body fluids, secretions, excretions, and contaminated items. Latex or nitrile gloves are preferable for clinical procedures that require manual dexterity and/or will involve more than brief patient contact. Put on clean gloves just before touching mucous membranes and nonintact skin. When worn in combination with other personal protective equipment, don gloves last.

Change gloves between tasks and procedures on the same patient after contact with material that may contain a high concentration of micro-organisms. Remove gloves promptly after use, before touching noncontaminated items and environmental surfaces and before going to another patient, and wash hands immediately to avoid transfer of micro-organisms to other patients or environments. Avoid contamination of clothing and skin when removing gloves. Do not reuse gloves or wash gloves for subsequent reuse.

Mask, Eye Protection, Face Shield

Wear a mask and eye protection or a face shield to protect mucous membranes of the eyes, nose, and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions.

Gowns

Wear a gown (a clean, nonsterile gown is adequate) to protect skin and to prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions. Select a gown that is appropriate for the activity and amount of fluid likely to be encountered. Remove a soiled gown as promptly as possible (turning outer "contaminated" side of the gown inward), roll gown into a bundle, and discard appropriately. Wash hands to avoid transfer of micro-organisms to other patients or environments. Do not reuse gowns, even for repeated tasks with the same patient.

Patient Placement

Use a private room for a patient who contaminates the environment or who does not (or cannot be expected to) assist in maintaining appropriate hygiene or environmental control. If a private room is not available, consult with infection control professionals regarding patient placement or other alternatives.

Patient-Care Equipment

Handle used patient-care equipment soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of micro-organisms to other patients and environments. Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and reprocessed appropriately. Ensure that single-use items are discarded properly.

Environmental Control

Ensure that the hospital has adequate procedures for the routine care, cleaning, and disinfection of environmental surfaces, beds, bedrails, bedside equipment, and other frequently touched surfaces, and ensure that these procedures are being followed.

Linen

Handle, transport, and process used linen soiled with blood, body fluids, secretions, and excretions in a manner that prevents contamination of air, surfaces, and individuals.

Occupational Health and Bloodborne Pathogens

Take care to prevent injuries when using needles, scalpels, and other sharp instruments or devices; when handling sharp instruments after procedures; when cleaning used instruments; and when disposing of used needles. Never recap used needles, or otherwise manipulate them using both hands, or use any other technique that involves directing the point of a needle toward any part of the body. Rather, use either a one-handed "scoop" technique or a

mechanical device designed for holding the needle sheath. Do not remove used needles from disposable syringes by hand, and do not bend, break, or otherwise manipulate used needles by hand. Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers, which are located as close as practical to the area in which the items were used, and place reusable syringes and needles in a puncture-resistant container for transport to the reprocessing area.

Use mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation methods in areas where the need for resuscitation is predictable.

CONTACT PRECAUTIONS

Patient Placement

Place the patient in a private room. When a private room is not available, place the patient in a room with a patient(s) who has active infection with the same micro-organism but with no other infection (cohorting). When a private room is not available and cohorting is not achievable, consider the epidemiology of the micro-organism and the patient population when determining patient placement. Consultation with infection control professionals is advised before patient placement.

Gloves and Handwashing

In addition to wearing gloves as outlined under Standard Precautions, wear gloves (clean, nonsterile gloves are adequate) when entering the room. During the course of providing care for a patient, change gloves after having contact with infective material that may contain high concentrations of micro-organisms (e.g., fecal material, wound drainage). Remove gloves before leaving the patient's room, and wash hands immediately with an antimicrobial agent or a waterless antiseptic agent. After glove removal and handwashing, ensure that hands do not touch potentially contaminated environmental surfaces or items in the patient's room, to avoid transfer of micro-organisms to other patients or environments.

Gown

In addition to wearing a gown as outlined under Standard Precautions, wear a gown (a clean, nonsterile gown is adequate) when entering the room if you anticipate that your clothing will have substantial contact with the patient, environmental surfaces, or items in the patient's room, or if the patient is incontinent or has diarrhea, an ileostomy, a colostomy, or wound drainage not contained by a dressing. Remove the gown before leaving the patient's environment. After gown removal, ensure that clothing does not contact potentially contaminated environmental surfaces, to avoid transfer of micro-organisms to other patients or environments.

Patient Transport

Limit the movement and transport of the patient from the room to essential purposes only. If the patient is transported out of the room, ensure that precautions are maintained to minimize the risk of transmission of micro-organisms to other patients and contamination of environmental surfaces or equipment.

Patient-Care Equipment

When possible, dedicate the use of noncritical patient-care equipment to a single patient (or cohort of patients infected or colonized with the pathogen requiring precautions) to avoid sharing between patients. If use of common equipment or items is unavoidable, then adequately clean and disinfect them before use for another patient.

AIRBORNE PRECAUTIONS

All precautions described for airborne pathogens are in addition to Standard Precautions.

Patient Placement

Place the patient in a private room that has (1) monitored negative air pressure in relation to the surrounding areas; (2) 6 to 12 air changes per hour; and (3) appropriate discharge of air outdoors or monitored high-efficiency filtration of room air before the air is circulated to other areas in the hospital.

Keep the room door closed and the patient in the room. When a private room is not available, place the patient in a room with a patient who has active infection with the same micro-organism, unless otherwise recommended, but with no other infection. When a private room is not available and cohorting is not desirable, consultation with infection control professionals is advised before patient placement.

Respiratory Protection

Wear respiratory protection (N95 respirator) when entering the room of a patient with known or suspected infectious pulmonary tuberculosis. Susceptible persons should not enter the room of patients known or suspected to have rubeola (measles) or varicella (chickenpox) if other immune caregivers are available. If susceptible persons must enter the room of a patient known or suspected to have rubeola or varicella, they should wear respiratory protection (N95 respirator). Persons immune to rubeola or varicella need not wear respiratory protection.

Patient Transport

Limit the movement and transport of the patient from the room to essential purposes only. If transport or movement is necessary, minimize patient dispersal of droplet nuclei by placing a surgical mask on the patient, if possible.

DROPLET PRECAUTIONS

All precautions described for droplet pathogens are in addition to Standard Precautions.

Patient Placement

Place the patient in a private room. When a private room is not available, place the patient in a room with a patient(s) who has active infection with the same micro-organism but with no other infection. When a private room is not available and cohorting is not achievable, maintain spatial separation of at least 3 feet between the infected patient and other patients and visitors. Special air handling and ventilation are not necessary, and the door may remain open.

Masks

In addition to wearing a mask as outlined under Standard Precautions, wear a mask when working within 3 feet of the patient. (Logistically, some hospitals may want to implement a policy of wearing a mask to enter the room.)

Patient Transport

Limit the movement and transport of the patient from the room to essential purposes only. If transport or movement is necessary, minimize patient dispersal of droplets by placing a surgical mask on the patient, if possible.

HAND HYGIENE

Hand hygiene is the most important preventive measure in hospitals, and the Joint Commission mandates that hospitals and other healthcare facilities comply with the Level I recommendations in the CDC guideline for hand hygiene [42]. The CDC guideline states the specific indications for washing hands, the recommended hand hygiene techniques, and recommendations about fingernails and the use of gloves (***Table 1***) [42]. The guideline also provides recommendations for surgical hand antisepsis, selection of hand-hygiene agents, skin care, educational and motivational programs for healthcare professionals, and administrative measures.

Despite the simplicity of the intervention, its substantial impact, and wide dissemination of the guideline, compliance with recommended hand hygiene has ranged from 16% to 81%, with an average of 30% to 50% [3; 42; 54; 56; 57; 58]. Among the reasons given for the lack of compliance are inconvenience, understaffing, and damage to skin [1; 42; 56; 72]. The development of effective alcohol-based handrub solutions addresses these concerns, and studies have demonstrated that these solutions have increased compliance [57; 73; 74]. The CDC guideline recommends the use of such solutions on the basis of several advantages, including [42]:

SUMMARY OF CDC RECOMMENDATIONS FOR HAND HYGIENE
Indications for Hand Hygiene
Wash hands with nonantimicrobial or antimicrobial soap and water when they are visibly dirty, contaminated, or soiled. If hands are not visibly soiled, use an alcohol-based handrub for routinely decontaminating hands.
Specific Indications
Wash hands before patient contact and before putting on gloves for insertion of invasive devices that do not require surgery (e.g., urinary catheters, intravascular devices). Wash hands after: • Contact with a patient's skin • Contact with body fluids or excretions, nonintact skin, or wound dressings • Removing gloves
Recommended Handrub Technique
Apply to palm of one hand, rub hands together, covering all surfaces until dry.
Recommended Handwashing Technique
• Wet hands with water, apply soap, and rub hands together for at least 15 seconds. • Rinse and dry with disposable towel. • Use towel to turn off faucet.
Fingernails and Artificial Nails
Keep tips of natural nails to a length of ¼ inch. Do not wear artificial nails during direct contact with high-risk patients (e.g., patients in intensive care unit or operating room).
Use of Gloves
Use gloves when there is potential for contact with blood or other potentially infectious materials, mucous membranes, or nonintact skin. Change gloves after use for each patient.
Source: [42] *Table 1*

- Better efficacy against both gram-negative and gram-positive bacteria, mycobacteria, fungi, and viruses than either soap and water or antimicrobial soaps (e.g., chlorhexidine)
- More rapid disinfection than other hand-hygiene techniques
- Less damaging to skin
- Time savings (18 minutes compared with 56 minutes per 8-hour shift)

The guideline suggests that healthcare facilities promote compliance by making the handrub solution available in dispensers in convenient locations (e.g., entrance to patients' room, at the bedside) and provide individual pocket-sized containers [42]. In one small survey of hand hygiene practices, healthcare workers indicated that they would be more likely to clean their hands as recommended if alcohol-based handrub solution was located near the patient [75]. The handrub solution may be used in all clinical situations except for when hands are visibly dirty or are contaminated with blood or body fluids. In such instances, soap (either antimicrobial or non-antimicrobial) and water must be used.

However, there are many other reasons for lack of adherence to appropriate hand hygiene, including denial about risks, forgetfulness, and belief that gloves provide sufficient protection [1; 42; 56]. These reasons demand education for healthcare professionals to emphasize the importance of hand hygiene.

Also necessary is research to determine which interventions are most likely to improve hand-hygiene practices, as no studies have demonstrated the superiority of any intervention [76]. Single interventions are unlikely to be effective [76]. Studies indicate that multimodal interventions (e.g., education, observation, provision of supplies, administrative support, reminders, surveillance, performance feedback) may be more effective in raising compliance [76; 77; 78].

Several single-institution studies have demonstrated that appropriate hand hygiene reduces overall rates of HAIs, including those caused by MRSA and vancomycin-resistant enterococci [57; 58; 73; 74]. However, rigorous evidence linking hand hygiene alone with the prevention of HAIs is lacking, making it difficult to evaluate the true impact of hand hygiene alone in reducing HAIs [79]. One challenge in evaluating the impact of hand hygiene is that a variety of methodologies (e.g., surveys, direct observation, measurement of product use) have been used to assess compliance, each with its own advantages and disadvantages [80]. Measuring the effect of appropriate hand hygiene alone is also difficult because the intervention is often one aspect of a multicomponent strategy to reduce infection [58]. Lastly, as noted previously, the development of HAIs is complex, with many contributing factors [58]. Although more research is needed to assess the individual impact of appropriate hand hygiene, this basic prevention measure is the essential foundation of an effective infection control strategy and is an element of every infection control guideline [2; 28; 36; 37; 39; 40; 42; 43; 44; 47; 49].

EBOLA VIRUS

Care of patients with Ebola requires Standard, Contact, and Airborne Precautions. Duration of these measures is determined on a case-by-case basis, in conjunction with local, state, and federal health authorities. A single-patient room with the door closed is preferred. A log of all people entering the patient's room is required. Avoid entry of visitors into the patient's room except as needed for the patient's well-being and on a case-by-case basis. Any visits should be scheduled and controlled. Barrier protections against blood and body fluids should be used upon entry into the room (i.e., gloves, fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields). Additional protective wear (i.e., double gloves, leg and shoe coverings) should be used during the final stages of illness when hemorrhage may occur. The use of dedicated disposable medical equipment is preferred for patient care. All nondedicated, nondisposable equipment should be cleaned and disinfected after use. Disinfection of environmental surfaces should be conducted using a U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant. Selection of a disinfectant product with a higher potency than is normally required for an enveloped virus is recommended. If possible, needles, sharps, and aerosol-generating procedures should be avoided as much as possible, and the number of procedures and tests should be limited. All needles and sharps should be handled with extreme care and disposed in puncture-proof, sealed containers. Ebola virus is classified as a Category A infectious substance regulated by the U.S. Department of Transportation's (DOT) Hazardous Materials Regulations (HMR, 49 C.F.R., Parts 171-180). Any item transported offsite for disposal that is contaminated or suspected of being contaminated with a Category A infectious substance must be packaged and transported in accordance with the HMR. Public health officials should be notified immediately if Ebola is suspected [28; 71; 81; 82].

STANDARDS FOR EQUIPMENT AND ENVIRONMENTAL SERVICES

The infection control manual should contain details on cleaning and disinfecting equipment and the healthcare environment. The procedures should follow those set forth by the CDC in its guidelines for environmental infection control and for disinfection and sterilization [37; 41]. These procedures are related to the routine cleaning, disinfection, and reprocessing of equipment; the cleaning and disinfection of environmental surfaces; the cleaning of spills of blood and other body fluids; the cleaning and maintenance of laundry and bedding, carpeting, and cloth furnishings; and the handling of medical waste.

CLEANING, DISINFECTING, AND REPROCESSING EQUIPMENT

The guideline on disinfection and sterilization published by the CDC in 2008 includes updated evidence-based recommendations on preferred methods for cleaning, disinfecting, and sterilizing medical devices and for cleaning and disinfecting the healthcare environment [37]. The guideline also addresses several new topics, including inactivation of antibiotic-resistant bacteria, bioterrorist agents, emerging pathogens, and bloodborne pathogens; toxicologic, environmental, and occupational concerns associated with disinfection and sterilization practices; disinfection of patient-care equipment used in ambulatory settings and home care; new sterilization processes, such as hydrogen peroxide gas plasma and liquid peracetic acid; and disinfection of complex medical instruments (e.g., endoscopes) [37].

Various levels of cleaning and disinfection have been defined, and decontamination and cleaning must be carried out before any of the higher level processes (***Table 2***) [2; 37; 66]. The cleaning and disinfection of devices varies according to the Spaulding classification, which categorizes devices as critical (i.e., enters normally sterile tissue or the vascular system), semicritical (i.e., comes into contact with intact mucous membranes and does not ordinarily penetrate sterile tissue), or noncritical (i.e., does not ordinarily touch a patient or touches only intact skin) [66; 83]. Critical devices require sterilization, and semicritical devices require high-level disinfection; noncritical devices may be cleaned with low-level disinfection [2; 48; 66; 83].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the Association of periOperative Registered Nurses, instruments should be cleaned and decontaminated as soon as possible after use. Preparation for decontamination of instruments should begin at the point of use, and instruments should be kept free of gross soil during the procedure. Instruments should be kept moist until they are cleaned. A towel moistened with water placed over the instruments may be used. Saline should not be used.

(https://apic.org/Resource_/TinyMceFileManager/Implementation_Guides/9_AORNGuidelineSummaryCleaning&CareofSurgicalInstruments.pdf. Last accessed June 15, 2024.)

Strength of Recommendation: Expert Opinion/ Consensus Statement

Endoscopic instruments present a challenge to proper reprocessing because of the complex internal design and long, narrow channels [2]. Reprocessing should be carried out by trained and accredited personnel according to the manufacturer's recommendations, and the process should be monitored regularly for quality control [84]. Guidelines and recommendations for reprocessing of gastrointestinal endoscopes have been developed by several federal agencies, such as the U.S. Food and Drug Administration (FDA) and the CDC, as well as many professional organizations [2; 48; 84; 85; 86; 87]. The reprocessing procedure should begin immediately after use to prevent secretions from drying [2; 37; 86; 87].

DEFINITIONS OF LEVELS OF CLEANING AND DISINFECTION	
Level	**Definition**
Decontamination	Use of a 0.5% chlorine solution to reduce the number of pathogenic organisms on the device
Cleaning	Use of soap and water to remove all visible dust, soil, blood, or other body fluids
Low-level disinfection	Use of disinfectant to destroy pathogenic organisms (may not eliminate resistant bacteria or most viruses or fungi)
Intermediate-level disinfection	Use of disinfectant to destroy pathogenic organisms (eliminates most bacteria, viruses, and fungi)
High-level disinfection	Use of chemical disinfectants, boiling, or steaming to destroy all micro-organisms
Sterilization	Use of high-pressure steam (autoclave), dry heat (oven), chemical sterilants, or radiation to eliminate all forms of viable micro-organisms
Reprocessing	A multistep procedure that consists of meticulous cleaning, high-level disinfection with a liquid chemical sterilant or disinfectant, and proper drying
Source: [2; 37; 66]	*Table 2*

Some inconsistencies across reprocessing guidelines and manufacturer recommendations have been found, primarily with regard to drying [86]. Also, various steps in the procedure have been emphasized as being the most critical. For example, one report notes that meticulous mechanical cleaning is the most important step because it removes the majority of the contaminating bacteria [84]. Another report emphasizes the importance of drying to avoid waterborne bacteria, such as Pseudomonas aeruginosa [86].

A report of four patients with infection with *P. aeruginosa* after transrectal ultrasound-guided prostate biopsies raised awareness about the need for thorough cleaning of equipment. Evaluation of the findings on the four patients demonstrated that the infection was caused by contamination of the needle guide as a result of inadequate cleaning (with a brush) and improper rinsing (with tap water) after reprocessing [88]. The report led to the FDA issuing a Public Health Notification on proper reprocessing of such devices [89].

Reprocessing of bronchoscopes has received less attention, perhaps because of the low risk of infection, but general recommendations, similar to those for gastrointestinal endoscopes, are available [32; 90].

CLEANING THE ENVIRONMENT

Every healthcare facility should have a written housekeeping schedule for the routine cleaning of the environment. Routine cleaning removes so-called visible dirt, which can harbor micro-organisms. Soap and water can be used to remove visible dirt from most surfaces, such as walls, doors, ceilings, and floors. A disinfectant should be used when there are signs of contamination. The level of asepsis in cleaning depends on the likelihood of contamination. WHO suggests classifying areas within a healthcare facility into four zones [2]:

- Zone A: No patient contact
- Zone B: Care of patients who are not infected and are not highly susceptible
- Zone C: Infected patients (isolation units)
- Zone D: Highly susceptible patients (protective isolation) or protected areas such as operating suites, delivery rooms, intensive care units, neonatal intensive care, transplant units, oncology units, and hemodialysis units

Cleaning according to this classification should be as follows [2]:

- Zone A: Normal cleaning
- Zone B: Cleaning procedures that do not raise dust. (Dry sweeping or vacuum cleaners are not recommended.) Use a detergent solution and disinfect any areas with visible contamination with blood or body fluids before cleaning.
- Zone C: Cleaning with a detergent/disinfectant solution, with separate cleaning equipment for each room
- Zone D: Cleaning with a detergent/disinfectant solution and separate cleaning equipment

Written policies should specify how frequently each area should be cleaned and should note the cleaning agents used for various surfaces and items such as beds, curtains, screens, fixtures, and furniture. In general, all surfaces in the environment (e.g., walls, doors, floors) must be cleaned daily to remove soil. Sinks, toilets, and baths should be scrubbed daily, or more often if needed, with a disinfectant cleaning solution using a separate mop, brush, or cloth. Patient rooms should also be cleaned daily and after each patient is discharged. Surfaces and countertops in procedure rooms, examination rooms, and the laboratory must be cleaned with a disinfectant solution after any activity.

Spills of blood or other body fluid should be removed and cleaned immediately. The area should first be cleaned with a 0.5% chlorine solution and then washed clean with a disinfectant solution. Gloves should be worn while cleaning.

MANAGING WASTE

Management of waste is a concern in healthcare facilities, but 75% to 90% of waste poses no risk of infection. The following types of waste are considered to be hazardous [2]:

- Infection-associated waste (from isolation units, laboratory cultures, tissue swabs)
- Pathologic waste (blood, body fluids, human tissue)
- Sharps (needles, scalpels, blades, knives)
- Pharmaceutical waste (expired pharmaceutical agents)
- Chemical waste (laboratory reagents, solvents)
- Heavy metal waste (broken blood pressure gauges, batteries)
- Radioactive waste

As with cleaning, written policies should document the appropriate handling, storage, and transportation of all types of waste.

SAFE INJECTION PRACTICES

Infection prevention also includes safe injection practices intended to prevent or reduce the risk of transmission of infectious diseases between one patient and another or between a patient and healthcare provider. A safe injection does not harm the recipient, does not expose the provider to any avoidable risks, and does not result in waste that is dangerous for the community [91].

Unsafe injection practices put patients and healthcare providers at unnecessary risk. A wide variety of procedures, such as the administration of anesthetics for outpatient procedures, the administration of other IV medications, flushing IV lines or catheters, and the administration of IM vaccines, have been associated with unsafe injection [91]. Outbreaks related to these practices indicate that some healthcare personnel do not adhere to basic principles of infection control and aseptic technique. A survey of U.S. healthcare professionals who provide medication through injection found that 1% to 3% reused the same needle and/or syringe on multiple patients [28].

The following guidelines should be considered with regards to injection practices [28]:

- Use aseptic technique to avoid contamination of sterile injection equipment.
- Never administer medications from a syringe to multiple patients, even if the needle or cannula on the syringe is changed. Needles, cannulae, and syringes are sterile, single-use items; they should not be reused for multiple patients.
- Use fluid infusion and administration sets (e.g., intravenous bags, tubing, connectors) for one patient only, and dispose appropriately after use.
- Use single-dose vials for parenteral medications whenever possible.
- If multidose vials must be used, both the needle or cannula and syringe used to access the multidose vial must be sterile.
- Do not keep multidose vials in the immediate patient treatment area, and store in accordance with the manufacturer's recommendations. Discard if sterility is compromised or questionable.
- Do not use bags or bottles of intravenous solution as a common source of supply for multiple patients.

SURVEILLANCE

Surveillance is an essential component of an infection control program. The infection control team has traditionally conducted surveillance through open communication with the nursing staff and physicians and meticulous review of patient records and microbiology results. The advent of electronic health systems has enabled some infection control programs to create algorithm-driven surveillance [1]. In addition, newer technology is adding to changes in the way surveillance is conducted. An electronic, laboratory-based marker has been developed and compared with traditional medical record review and accepted surveillance methods, including hospital-wide detection by the Study on the Efficacy of Nosocomial Infection Control chart review and intensive care unit detection by National Nosocomial Infections Surveillance System techniques. Analysis with the marker was significantly better than the hospital-wide detection methods and had sensitivity comparable to medical record review [92].

The infections most commonly targeted for surveillance are those difficult to treat and those associated with substantial costs in terms of morbidity, mortality, or economics [1]. In addition, infections with a predilection for epidemics are a focus. The data gathered should be evaluated in relation to regional and national norms, and temporal trends should also be noted. Continuing analysis of the data allows the infection control team to evaluate the efficacy of programs designed to enhance compliance with hospital-wide strategies to prevent HAIs.

EXPOSURE INCIDENTS

If an occupational exposure to a bloodborne pathogen or infectious material occurs, employers should follow all federal (including the Occupational Safety and Health Administration) and state requirements for recording and reporting. The circumstances surrounding the exposure and postexposure management strategies should be recorded in the exposed person's confidential medical record and should include [93]:

- Date and time of exposure
- Details of the procedure performed
- Details of the exposure
- Details about the exposure source
- Details about the exposed person and any need for counseling, postexposure management, or follow-up

COMMUNICABLE DISEASE EXPOSURES IN HEALTHCARE PROFESSIONALS

PREPLACEMENT EVALUATIONS AND PERIODIC HEALTH ASSESSMENTS

Medical evaluations before placement may reduce the undue risk of infection to employees, patients, and visitors. Preplacement evaluations should include a review of each employee's job description for duties that may affect the risk of acquiring or transmitting infections in healthcare settings [94]. A health inventory for all new healthcare professionals who have direct patient/family contact must be documented prior to the beginning of patient/family contact. The inventory should include [26; 94; 95]:

- A history of medical conditions and other factors that may affect the risk of acquiring or transmitting infections
- A certificate of immunization against vaccine-preventable diseases (e.g., rubella, measles), as recommended for healthcare personnel by the Advisory Committee on Immunization Practices (ACIP), or professionally certified medical exemption from immunization
- A purified protein derivative (PPD) (Mantoux) skin test for tuberculosis prior to employment, and no less than every year thereafter for negative findings. Positive findings require appropriate clinical follow-up but no repeat test.
- An annual (or more frequent, if needed) health status assessment to ensure freedom from any health impairment that might pose a risk for other workers, patients, or visitors
- Documentation of pre-employment and annual vaccination against influenza

Screening tests are available to determine susceptibility to vaccine-preventable diseases, such as measles, mumps, rubella, and varicella. The results of these tests should be included in personnel immunization records to ensure that susceptible personnel are promptly identified and appropriately vaccinated. All healthcare settings should conduct initial and ongoing risk assessments for the transmission of tuberculosis to determine the types of administrative, environmental, and respiratory-protection controls needed. Part of the assessment should include risk classification to determine the need for a screening program and the frequency of screening. All healthcare professionals with suspected or confirmed tuberculosis disease who have duties that involve face-to-face contact with patients should be included in a screening program [96].

All healthcare professionals experiencing fever, cough, rash, vesicular lesions, draining wounds, vomiting, or diarrhea require immediate evaluation by a licensed medical professional and possible restriction from patient care activities and return to work clearance [95]. The CDC recommends that all healthcare personnel obtain annual influenza vaccination to reduce infection of staff, patients, and family members and to decrease absenteeism [97]. Immunization against hepatitis B and pertussis (Tdap), in addition to all core vaccines, is also recommended [98]. Vaccination of healthcare personnel is considered an essential component of a patient safety program [97].

Management Strategies

Prompt diagnosis and management of job-related illnesses, appropriate postexposure prophylaxis, and implementation of measures to prevent further infection transmission are important aspects of an effective infection control program. Healthcare organization leaders and administrators are encouraged to establish a timely, confidential, and nonpunitive mechanism for healthcare personnel to report potentially infectious exposures and to

access exposure and illness management services 24 hours per day and seven days per week [94]. Exclusion of personnel from work or patient contact, depending on the mode of transmission and the pathogenesis of the disease, may also be necessary. In these cases, personnel should avoid contact with susceptible persons and should be encouraged to report illnesses or exposures, including any that occur outside the healthcare setting. Notification of emergency response personnel possibly exposed to selected infectious diseases is mandatory [95].

Education on best practices is a crucial aspect of preventing HAIs and is a recommendation in all infection control guidelines [2; 15; 28; 36; 37; 39; 40; 42; 43; 44; 47; 49]. Education should highlight the effect of prevention measures on the rates of HAIs, enhance knowledge about currently available guidelines, and provide instruction on carrying out guideline recommendations. Research has also suggested that education about prevention strategies may be more effective if patterns of care and levels of risk are incorporated into recommendations [99]. Numerous studies have shown that knowledge and practices related to HAIs and guidelines are improved after educational programs. The combination of a self-study module (with pretest and post-test), in-service lectures, posters, and fact sheets on the prevention of intravascular device-related bloodstream infections and appropriate practices led to substantial reductions in the prevalence of such infections [100; 101]. A small study showed that intensive care nurses' knowledge and practices were enhanced by education on the prevention of ventilator-associated pneumonia [102]. A Canadian study demonstrated that rates of nosocomial MRSA infection significantly decreased after a mandatory infection control education program on MRSA that included discussion of hospital-specific MRSA data and case-based practice [103].

It is important that all education campaigns, whether they target healthcare professionals, facility staff (e.g., janitorial staff), or the patient populations, take into consideration the special needs of the intended audience. Compounding this issue is the high rate of individuals with limited English proficiency. According to the U.S. Census Bureau data from 2019, more than 65 million Americans speak a language other than English at home, with more than 25.6 million (8.4%) of these individuals reporting that they speak English less than "very well" [104]. Even those who do speak English well may prefer to receive education in another language.

POSTEXPOSURE EVALUATION AND MANAGEMENT

When a healthcare provider has been exposed to particular infectious agents, it is important that recommended postexposure management guidelines are followed. This should reduce the risk of infection and of transmitting the infection to others [95].

Bloodborne Pathogens

Transmission of bloodborne pathogens due to occupational exposure of healthcare professionals has occurred in needlestick accidents (0.3% risk) and blood splashes to the mucous membranes (0.09% risk) [64]. Needlestick is the most common route, but the risk of infection even through this route is low, and most exposures do not result in infection [64; 105]. The risk for transmission increases based on the source patient's viral load and the quantity of blood transferred (e.g., a needle visibly contaminated with blood; a large-gauge hollow-bore needle; a procedure that involved the needle entering directly into the patient's artery or vein; a deep puncture from a contaminated needle). In order to decrease the risks associated with bloodborne pathogen exposures, postexposure prophylaxis should be initiated as soon as possible after the incident.

Hepatitis Viruses

Recommendations for HBV postexposure management include initiation of the hepatitis B vaccine series to any susceptible, unvaccinated person who sustains an occupational blood or body fluid exposure. Postexposure prophylaxis with hepatitis B immune globulin (HBIG) and/or hepatitis B vaccine series should be considered for occupational exposures after evaluation of the hepatitis B surface antigen status of the source as well as the vaccination and vaccine-response status of the exposed person [93].

Immune globulin and antiviral agents (e.g., interferon with or without ribavirin) are not recommended for postexposure prophylaxis of HCV. In this instance, the HCV status of the source and the exposed person should be determined as soon as possible (preferably within 48 hours) after the exposure, using one of two options: test for HCV RNA (preferred), or test for anti-HCV and then if positive, test for HCV RNA [106]. If the source patient is known or suspected to have recent behavior risks for HCV acquisition (e.g., injection drug use), or if the risk cannot be reliably assessed, the initial testing should include a nucleic acid test for HCV RNA. Persons with recently acquired acute infection typically have detectable HCV RNA levels as early as one to two weeks after exposure [106]. For healthcare professionals exposed to an HCV-positive source, follow-up HCV testing should be performed to determine if infection develops [93; 106]. The timing and type of follow-up testing recommended is included in guidance from the CDC published in 2020 [106].

Healthcare professionals exposed to hepatitis viruses should refrain from donating blood, plasma, organs, tissue, or semen [93]. When based only on exposure to HBV- or HCV-positive blood, modifications to an exposed healthcare professional's patient-care responsibilities are not necessary. Acutely infected healthcare professionals should be evaluated according to current guidelines; healthcare professionals chronically infected with HBV or HCV should follow all recommended infection control practices [93].

HIV

This section is from the Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HIV and Recommendations for Postexposure Prophylaxis as published by the CDC on September 25, 2013, in Infection Control and Hospital Epidemiology.

The following recommendations apply to situations where healthcare professionals have had exposure to a source person with HIV or where information suggests that there is likelihood that the source person is HIV-infected. Because most occupational HIV exposures do not result in the transmission of HIV, potential toxicity should be carefully considered when prescribing postexposure prophylaxis. The 2013 update focused on tolerability, side effects, toxicity, safety in pregnancy and lactation, pill burden, and frequency of dosing to maximize adherence to a postexposure prophylaxis (PEP) regimen [64]. When possible, these recommendations should be implemented in consultation with persons having expertise in antiretroviral therapy and HIV transmission, due to the complexity of selecting appropriate treatment.

The preferred regimen for PEP provided in the U.S. Public Health Service Guidelines for management of healthcare professionals' exposures to HIV is a basic regimen that should be appropriate for most HIV exposures: emtricitabine and tenofovir dispensed together as Truvada, a fixed-dose combination tablet, 1 mg once daily, plus raltegravir, 400 mg twice daily [64]. This preparation is available as a starter packet that should be stocked at every healthcare facility where exposure to HIV is possible. As discussed, the regimen has been selected for its tolerability and safety profile. There are several alternative regimens that may be selected due to individual patient concerns. For example, tenofovir is associated with renal toxicity, and an alternative nucleoside/nucleotide reverse-transcriptase inhibitor pair, such as zidovudine plus lamivudine (available as Combivir) would be selected for patients with renal disease [64].

Healthcare professionals with occupational exposure to HIV should receive follow-up counseling, postexposure testing, and medical evaluation regardless of whether they receive PEP. The 2013 guideline highlights the importance of follow-up within 72 hours to allow the initial shock to fade and to provide greater opportunity for full understanding of the risks and benefits of PEP; confirmation testing to ensure the necessity of PEP; increase adherence to PEP; monitoring for adverse reactions and side effects; and treating comorbidities and altering the regimen [64]. This window provides an opportunity to discuss the importance of preventing secondary transmission of HIV in the 6 to 12 weeks following initial infection. HIV-antibody testing should be performed for at least six months postexposure (e.g., at 6 weeks, 12 weeks, and 6 months). It is unclear whether an extended follow-up period (e.g., 12 months) is indicated for individuals not coinfected with HCV and HIV. If PEP is used, drug-toxicity monitoring should be performed at baseline and again two weeks after starting PEP. Clinical judgment, based on medical conditions that may exist in pre-exposure and/or as a result of the regimen, should determine the scope of testing. If the source patient is found to be HIV negative, PEP should be discontinued immediately [64].

Airborne/Droplet Pathogens

Tuberculosis

Healthcare professionals with known or presumed exposure to *Mycobacterium tuberculosis* should be asked whether they have experienced any signs or symptoms of tuberculosis (i.e., coughing for more than three weeks, loss of appetite, unexplained weight loss, night sweats, bloody sputum, hoarseness, fever, fatigue, or chest pain). Because a blood assay for *M. tuberculosis* (BAMT) conversion likely indicates recent infection, a BAMT result should be obtained to exclude tuberculosis [107]. If either the symptom screen or the BAMT result is positive, the exposed healthcare professional should be promptly evaluated for tuberculosis. If tuberculosis is excluded, additional medical and diagnostic evaluations for latent tuberculosis infection, including an assessment of the extent of exposure, should be obtained [96; 107]. Healthcare professionals with active tuberculosis should be excluded from duty until proved noninfectious [95].

Measles

According to the CDC and Hospital Infection Control Practices Advisory Committee (HICPAC), postexposure measles vaccine should be administered to measles-susceptible personnel who have had contact with persons with measles within 72 hours postexposure [95]. People at risk for severe illness and complications from measles (e.g., infants younger than 12 months of age, pregnant women with no evidence of immunity) and people with severely compromised immune systems should receive immunoglobulin [108]. Furthermore, adherence to Airborne Precautions (for suspected and proven cases) is also necessary [108]. Healthcare professionals without evidence of immunity who are not vaccinated after exposure should be removed from all patient contact and furloughed from day 5 after first exposure through day 21 after last exposure [98; 108].

Mumps

The CDC and HICPAC have also established postexposure protocols for mumps. The mumps vaccine should be administered to all personnel without documented evidence of mumps immunity, unless otherwise contraindicated [95; 98]. Routine serologic screening is not necessary unless the healthcare professional considers screening cost-effective or requests it. Susceptible personnel who are exposed to mumps should not work from the 12th day after first exposure through the 26th day after last exposure or, if symptoms develop, until five days after onset of parotitis [95].

Pertussis

The CDC/HICPAC guideline indicates that antimicrobial prophylaxis against pertussis should be immediately offered to personnel who have had unprotected, intensive contact with a patient who has clinical syndrome that suggests pertussis and whose cultures are pending [95; 98]. Other healthcare personnel should either receive postexposure antimicrobial prophylaxis or be monitored daily for 21 days after exposure and treated at the onset of signs and symptoms [98]. Prophylaxis may be discontinued if results of cultures or other tests are negative for pertussis and the clinical course suggests an alternate diagnosis.

Rubella

Susceptible personnel who are exposed to rubella should be excluded from duty from the 7th day after first exposure through the 21st day after last exposure [95; 98]. Those who acquire rubella should not work until seven days after the beginning of the rash.

Varicella

The Advisory Committee on Immunization Practices (ACIP) recommends postexposure prophylaxis (with vaccination or varicella-zoster immunoglobulin [VZIG], depending on immune status) of exposed healthcare personnel without evidence of immunity [98]. Healthcare professionals who have onset of varicella should be furloughed until all lesions have dried and crusted [95]. Personnel exposed to varicella who are not known to be immune (by history or serology) should be excused from work beginning on the 10th day after first exposure until the 21st day after last exposure.

Immunocompetent personnel with localized zoster should refrain from the care of high-risk patients until lesions are crusted. They may continue to care for other patients with lesions covered [95]. Susceptible personnel exposed to zoster should not engage in patient contact from the 10th day after first exposure through the 21st day after last exposure (or 28th day if VZIG was given) [95; 98].

Serologic screening is indicated for exposed personnel who have not had varicella or are unvaccinated; screening for immunity to varicella may be considered for exposed, vaccinated personnel whose antibody status is not known [95; 98]. If the initial test result is negative, retest five to six days postexposure to determine whether an immune response occurred.

All exposed susceptible personnel should receive postexposure prophylaxis [98]. If VZIG is given, exclude personnel from duty from the 8th day after first exposure through the 28th day after last exposure.

Norovirus

Although the most frequent routes of transmission of noroviruses are direct contact and food and waterborne routes, several reports suggest that noroviruses may be transmitted through infectious small-particle aerosols (e.g., vomitus, fecal material) over distances further than 3 feet, typically within a defined airspace (e.g., a patient's room) [109; 110; 111; 112; 113; 114]. It is hypothesized that the aerosolized particles are inhaled and subsequently swallowed. Because of its propensity for transmission within healthcare facilities, and its ability to have a disruptive impact in healthcare facilities, norovirus is an "epidemiologically important organism" [28].

The average incubation period for gastroenteritis caused by noroviruses is 12 to 48 hours, with a clinical course lasting 12 to 60 hours. There are no recommendations for postexposure prophylaxis for healthcare personnel with norovirus infection. However, recommendations for healthcare personnel who have symptoms consistent with norovirus infection include exemption from work for a minimum of 48 hours after the resolution of symptoms and exclusion of nonessential staff from areas in which outbreaks of norovirus gastroenteritis have occurred [28; 115].

NEW YORK DEPARTMENT OF HEALTH POLICY FOR TESTING POSSIBLE HIV SOURCES IN THE HEALTHCARE SETTING
Postexposure prophylaxis (PEP) is recommended for healthcare professionals following exposure to blood or visibly bloody fluid or other potentially infectious material associated with potential HIV transmission.
If HIV serostatus of the source is unknown, voluntary HIV testing of the source should be sought. In New York State, specific informed consent for HIV testing is required.
When the source is available and consents to HIV testing, use of an HIV-1/2 antigen (Ag)/Ab combination immunoassay is recommended, preferably with a fast turn-around time. Results from point-of-care assays are available in less than one hour, and results from laboratory-based screening tests are often available within one to two hours. Rapid oral testing is not recommended due to lack of sensitivity to identify recent infection and requirements regarding food, drink, and tobacco use.
When the source of any potential exposure to HIV is not known, not available, or cannot be HIV tested for any reason, the care provider should assess the exposed individual's level of risk, assume the source has HIV until proven otherwise, and respond accordingly.
Determining whether the exposure warrants PEP and promptly initiating PEP when indicated should be the focus at initial presentation, rather than the HIV status of the source.
Source: [38] *Table 3*

Cohorting of affected patients to separate airspaces and toilet facilities may help interrupt transmission during outbreaks. Contact Precautions should be used for diapered or incontinent persons for the duration of illness or to control outbreaks. Consistent environmental cleaning and disinfection is important, with focus on restrooms even when apparently unsoiled. Persons who clean heavily contaminated areas may benefit from wearing masks, as the virus can be aerosolized [28].

HEALTHCARE PROFESSIONALS INFECTED WITH BLOODBORNE PATHOGENS

Routine voluntary, confidential testing has been recommended for all healthcare providers, particularly for those whose clinical practice places them at higher risk for exposure and transmission [116]. The New York Department of Health has developed a policy regarding HIV testing of healthcare professionals (***Table 3***) [38]. It is important to note that New York State Public Health Law protects the confidentiality and privacy of anyone who has been tested for, exposed to, or treated for HIV [38]. In addition, according to the Americans with Disabilities Act, an individual is considered to have a disability if he or she has a physical or mental impairment that substantially limits one or more major life activities, has a record of such impairment, or is regarded as having such impairment [117]. Persons with HIV disease, both symptomatic and asymptomatic, have physical impairments that substantially limit one or more major life activities and are, therefore, protected by the law. Persons who are discriminated against because they are regarded as being HIV-positive are also protected.

In 2010, the Society for Healthcare Epidemiology of America (SHEA) updated its guidelines for the management of healthcare professionals who are infected with bloodborne pathogens [116]. According to these guidelines, healthcare providers with HBV, HCV, and/or HIV with greater viral loads ($\geq 10^4$ genome equivalents/mL for hepatitis viruses, $\geq 5 \times 10^2$ genome equivalents/mL for HIV) should be restricted from performing activities associated with a definite risk for provider-to-patient transmission of bloodborne pathogens, such as most surgeries, organ transplantation, and interactions with patients prone to biting [116]. These providers may engage in procedures for which the risk of transmission is insignificant (e.g., history taking, regular dental preventive procedures, minor surface suturing) or unlikely (e.g., locally anesthetized ophthalmologic surgery, percutaneous cardiac procedures, breast augmentation, minor oral surgery). Routine double gloving is also recommended [116].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the CDC, healthcare providers with active hepatitis B infection (i.e., those who are HBsAg-positive) who do not perform exposure-prone procedures but who practice non- or minimally invasive procedures should not be subject to any restrictions of their activities or study. They do not need to achieve low or undetectable levels of circulating HBV DNA, hepatitis e-antigen negativity, or have review and oversight by an expert review panel, as recommended for those performing exposure-prone procedures.

(https://www.cdc.gov/mmwr/PDF/rr/rr6210.pdf. Last accessed June 15, 2024.)

Strength of Recommendation: Expert Opinion/ Consensus Statement

Infected healthcare professionals with lower viral burdens ($<10^4$ genome equivalents/mL of hepatitis viruses, $<5 \times 10^2$ genome equivalents/mL for HIV) may engage in all clinical activities [116]. However, all healthcare providers with a bloodborne pathogen must obtain advice from an expert review panel about continued practice, undergo follow-up routinely by an appropriate public health official, receive follow-up by a personal physician who has expertise in the management of the infection, and adhere to strict infection control procedures [116]. Those with low viral burdens should undergo testing twice per year to demonstrate maintenance of viral level.

SEPSIS

Sepsis is a systemic pathophysiologic and clinical syndrome caused by infection and manifest by signs of inflammation, host immune response, and organ dysfunction. The causes of sepsis are myriad, and the scope of illness is broad. Most cases of sepsis syndrome arise from bacterial infection, but certain viral (e.g., Ebola and other hemorrhagic fevers) and fungal (e.g., candidiasis, histoplasmosis) infections induce a sepsis syndrome as well.

In simple terms, infection is the invasion of normally sterile host tissue by a micro-organism; clinically, infection is recognized by the constellation of symptoms and signs that issue from the host response to the invading micro-organism. Bacteremia is defined as the demonstrable presence (e.g., by culture) of viable bacteria within the general circulation.

It is important that clinicians and patients alike are aware that sepsis is a life-threatening medical emergency. Most patients who develop sepsis have recently used healthcare services or have a chronic condition requiring frequent medical care. Morbidity and mortality can be decreased by early recognition and intervention.

EPIDEMIOLOGY AND BURDEN OF SEPSIS

Sepsis, septic shock, and multiple organ failure are major causes of morbidity and mortality in the United States, resulting in an estimated 1.7 million hospitalizations and 270,000 deaths annually. One in three patients who die in a hospital has sepsis [118]. In New York, sepsis and septic shock impact approximately 50,000 patients each year, almost 30% of which will die from this syndrome [119]. It is estimated that 9.3% of all deaths in the United States, and nearly half of hospital deaths, are a result of sepsis, which equals the number of deaths resulting from myocardial infarction and far exceeds the mortality rates from acquired immune deficiency syndrome (AIDS) or breast cancer. The aggregate hospital cost of care for patients with septicemia totaled nearly $23.7 billion in 2013 [120; 121; 122; 123; 124].

A study of hospital emergency department visits between 2009 and 2011 found that of the more than 1.3 million visits, nearly 850,000 were attributed to sepsis [125]. The average length of stay in the emergency department is 4.7 hours. However, more than 20% of patients with sepsis had a length of stay that exceeded six hours, resulting in a substantial burden on facilities nationwide in providing sepsis care [126; 127].

The incidence of septicemia more than doubled between 1993 and 2009, increasing by an annual average of 6% [120]. Between 1993 and 2003, 8.4 million cases of sepsis and 2.4 million cases of severe sepsis were reported. The percentage of severe sepsis cases among all sepsis cases increased from 25.6% to 43.8% during the same time period [128]. Studies continue to report an increase in the incidence of septicemia; however, they also indicate that in-hospital mortality rates for sepsis appear to be declining. For example, according to the results of one retrospective cohort study, the incidence of septicemia as a proportion of medical and surgical admissions increased from 3.9% to 9.4% from 2010 to 2015, whereas the in-hospital mortality rate for sepsis hospitalizations declined from 24.1% to 14.8% during the same period. The percentage of patients at risk for hospital readmission after sepsis increased from 2.7% to 7.8%. Although 30-day readmission rates declined from 26.4% to 23.1% from 2010 to 2015, this was offset by an increase in emergency department visits, from 2.8% in 2010 to 5.4% in 2014 [124]. Another study that analyzed data from 2009 to 2014 also reported an increase in the incidence of sepsis but a decline in sepsis-related mortality rates [129]. The reported incidence of sepsis in the general population varies greatly and has been attributed to the data source, sepsis surveillance definition, and advances in supportive care for the critically ill [129; 130; 131; 132].

The reported incidence rates of sepsis increase with advanced age. Two-thirds of all sepsis cases occur in people 65 years of age and older, with case fatality rates as high as 40% [121]. Age-adjusted rates for sepsis hospitalization and mortality increased annually by 8.2% and 5.6%, respectively, between 1993 and 2003, whereas the fatality rate decreased by 1.4% [128]. Sepsis is more common among men than women, and the fatality rate is greater in men and nonwhite populations [133].

Mortality from sepsis of gram-negative etiology is the cause of 20% to 50% of the overall total number of septic deaths. The figures are now similar for sepsis of gram-positive etiology [134]. Mortality has been reported as high as 60% in patients with underlying medical problems. Among patients who develop the complications of shock and organ failure, mortality can reach 90% [135]. Extent of organ failure contributes to the prognosis, with a greater survival rate in patients with fewer than three failing organs. The risk of death increases as each organ fails [135].

Sepsis is among the leading causes of hospitalization and ranks as the most expensive inpatient condition treated in U.S. hospitals [136]. Data from the 2008 National Hospital Discharge Survey (now the National Hospital Care Survey) show that the rate of hospitalization for sepsis increased from 11.8 to 24 per 10,000 population during the period 2000 through 2008 [136]. Compared with other conditions, the hospital stay for sepsis was 75% longer and the likelihood of dying during hospitalization was eight times higher. The estimated annual cost of hospitalization for sepsis and septicemia in 2008 was $14.6 billion and increasing at the rate of 11.9% each year [136].

One retrospective study was conducted in 2018 to characterize the burden, outcomes, and costs of managing sepsis patients in U.S. hospitals [137]. The cohort consisted of adults 18 years of age and older with a hospital discharge diagnosis code of sepsis between January 2010 and September 2016. Of the more than 2.5 million patients included in the final study cohort, the mean age was 65 years and more than one-half were female (50.8%). The overall mortality was 12.5% but varied according to severity of sepsis (i.e., 5.6% for sepsis without organ dysfunction; 14.9% for severe sepsis; and 34.2% for septic shock). Economic costs also increased according to the severity level of sepsis ($16,324, $24,638, and $38,298, respectively) and varied widely by sepsis at presentation ($18,023) and not present at admission ($51,022) [137].

Despite immense clinical effort and high treatment expenditures, mortality rates remain high. Those who survive often sustain permanent organ damage, some degree of physical disability, and long-term cognitive impairment [138].

New York State Sepsis Improvement Initiative

In 2013, New York adopted new laws to combat sepsis, referred to as Rory's Regulations, in honor of Rory Staunton, who had died the previous year after multiple healthcare encounters failed to diagnose sepsis [139]. Specifically, amendments were made to sections 405.2 and 405.4 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations of the State of New York. Section 405.2 requires hospitals to have in place evidence-based protocols for the early recognition and treatment of patients with severe sepsis/septic shock that are based on generally accepted standards of care [140]. Section 405.4 further requires that these protocols include the following components [140]:

- A process for the screening and early recognition of patients with sepsis, severe sepsis, and septic shock
- A process to identify and document individuals appropriate for treatment through severe sepsis protocols, including explicit criteria defining those patients who should be excluded from the protocols, such as patients with certain clinical conditions or who have elected palliative care
- Guidelines for hemodynamic support with explicit physiologic and biomarker treatment goals, methodology for invasive or non-invasive hemodynamic monitoring, and timeframe goals
- For infants and children, guidelines for fluid resuscitation with explicit timeframes for vascular access and fluid delivery consistent with current, evidence-based guidelines for severe sepsis and septic shock with defined therapeutic goals for children
- A procedure for identification of infectious source and delivery of early antibiotics with timeframe goals
- Criteria for use, where appropriate, of an invasive protocol and for use of vasoactive agents

In addition, hospitals are required to report to the Department data that are used to calculate each hospital's performance on key measures of early treatment and protocol use.

As part of this movement, the New York State Sepsis Care Improvement Initiative was begun by the Department of Health as a resource for quality improvement in sepsis care by improving early detection and intervention, especially for patients with severe sepsis and shock [119]. The Initiative also publishes an annual public report detailing data collection, adherence to guidelines, improvements on quality measures and outcomes, and stakeholder collaborations.

RISK FACTORS AND PREVENTION

Factors considered important in the development of sepsis include: inappropriate broad-spectrum antibiotic therapy; immunosuppressive treatments, such as cancer chemotherapy; invasive procedures; transplantations; fungal organisms; burns or other trauma; anatomic obstruction; intestinal ulceration; age (the very young and the very old); and progressive clinical conditions, such as malignancy, diabetes, or AIDS [141].

Healthcare-associated infections are a major cause of sepsis among severely ill patients. Increased risk of nosocomial infection is associated with the presence of underlying chronic disease, alteration in host defenses, prolonged hospital stay, and the presence of invasive catheters or monitoring devices [142]. Pulmonary, urinary tract, gastrointestinal, and wound infections predominate [143; 144]. In hospitalized adult patients, the etiology of sepsis has shifted from being predominantly gram-negative nosocomial infections (*Escherichia coli*, *Klebsiella* spp., *Enterobacter* spp., and *Pseudomonas aeruginosa*) to gram-positive infections (*Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Streptococcus pyogenes*) [145].

The incidence of sepsis caused by gram-positive infections has increased by 26.3% per year over the last three decades [146]. Multidrug-resistant pathogens, such as *S. aureus*, now account for more than half of all sepsis cases. *S. aureus* is singly responsible for 40% of ventilator-associated pneumonia episodes and most cases of nosocomial pneumonia [146; 147]. Group B streptococcus is a leading cause of neonatal sepsis in the United States [148].

Vascular and monitoring catheters and infusion sets may become contaminated and lead to the development of nosocomial infections and sepsis. The risk of catheter-related sepsis is increased when the IV catheter is placed in a central vein, particularly if the catheter remains in place longer than three to five days or if the catheter is used for blood sampling [149]. The results of a Cochrane review originally revised in 2013 found evidence indicating that administration sets that do not contain lipids, blood, or blood products may be left in place for intervals of up to 96 hours without increasing the risk of infection [150; 151]. Generally, consideration should be given to changing the catheter and possibly the insertion site after 72 hours [152]. The risk of contamination of arterial catheters is higher than that observed with venous catheters. Contamination can occur if the system is entered frequently for blood sampling, if the infusate remains in place for more than 48 hours, or if inflammation develops near the catheterized artery [152]. Urinary catheters left in the bladder longer than two weeks often cause infection. Therefore, increased surveillance for signs of urinary tract infections when catheters remain in place beyond a few days is necessary [153].

Central venous catheters (CVCs) are increasingly used in the pediatric population, leading to an increase in CVC-related complications. Implanted ports may be the device of choice when long indwelling times are expected, with consideration given to the patient's age and need for sedation and analgesia during the insertion procedure. Radiograph following the insertion procedure is recommended to ensure correct catheter positioning. Full sterile barrier precautions, strict protocols for catheter care, and prompt removal of the catheter when it is no longer needed are recommended to prevent infectious complications [154]. A study conducted by the American Pediatric Surgical Association found that chlorhexidine skin prep and chlorhexidine-impregnated dressing and heparin and antibiotic-impregnated CVCs can decrease CVC colonization and bloodstream infection and that ethanol and vancomycin lock therapy can reduce the incidence of catheter-associated bloodstream infections [155].

Bacterial contamination of platelet units (estimated at 1 in 1,000–3,000) results in many occurrences of transfusion-associated sepsis in the United States each year. In 2017, two separate clusters of platelet transfusion-associated bacterial sepsis were reported in Utah and California, resulting in three deaths [156]. The AABB (formerly the American Association of Blood Banks) adopted a new standard in 2004 requiring member blood banks and transfusion services to implement detection measures and limit bacterial contamination in all platelet components [157]. The 33rd edition of the standard is available as of April 2022 [158; 159].

DIAGNOSIS AND MANAGEMENT

Methods to identify critically ill patients who are likely to die as a result of sepsis have become clearer, and increased awareness that sepsis is more common and lethal than previously understood has helped to promote the development of an organized approach to care. While the early diagnosis of sepsis continues to be a challenge (primarily because a rapid, sensitive, and specific diagnostic test is lacking), research indicates that improvements in outcomes are possible when treatment protocols are applied in a timely manner [160; 161].

An international consortium of critical care specialty societies has worked to standardize the definition and clinical parameters of sepsis and to develop evidence-based guidelines for optimal management of sepsis and septic shock. This is an ongoing effort, the goal of which is to improve care and reduce mortality worldwide. Clinical care guidelines have been developed by the Surviving Sepsis Campaign and published by the Society of Critical Care Medicine (SCCM) in 2008, 2013, and 2016. Detailed management strategies are provided for rapid diagnostic evaluation and antimicrobial treatment, fluid resuscitation, and the use of vasopressors in septic shock [162; 163; 164].

Initial funding of the Surviving Sepsis Campaign was provided by the SCCM. The ongoing work and the campaign's guidelines have no direct or indirect connection to industry support. The 2021 international guideline for the management of sepsis and septic shock are available online at https://www.sccm.org/Clinical-Resources/Guidelines/Guidelines/Surviving-Sepsis-Guidelines-2021 [165].

The 2021 guideline recommendations use the "Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach to identify outcomes that the authors considered important from a patient's perspective [165; 166].

Management of Sepsis

Fluid Resuscitation and Diagnosis

The SCCM guideline emphasizes that sepsis and septic shock are medical emergencies; treatment and resuscitation should begin immediately upon recognition [165]. Intravenous fluid resuscitation of a patient with sepsis-induced shock (defined as tissue hypoperfusion) should be initiated as soon as the hypoperfusion is recognized (i.e., not delayed pending admission to an ICU).

The principal recommendations for fluid resuscitation are [165]:

- Intravenous fluid resuscitation should be started immediately, beginning with crystalloids (grade weak [downgraded from strong], suggested).
- In the setting of sepsis-induced hypoperfusion, at least 30 mL/kg of intravenous crystalloid fluid should be given within the first three hours (grade weak [downgraded from strong], suggested).
- It is suggested that albumin be added when patients require substantial amounts of crystalloids (grade weak, suggested).
- Fluid resuscitation should initially target a mean arterial pressure (MAP) of 65 mm Hg in patients with septic shock requiring vasopressors (grade strong, recommended).

It is recommended that, following initial fluid resuscitation, additional fluid administration be guided by frequent reassessment of hemodynamic status. A reasonable set of treatment goals suggested for the first six hours of resuscitation are [163; 164; 165]:

- Central venous pressure of at least 8 mm Hg (12 mm Hg in mechanically ventilated patients)
- MAP of 65 mm Hg or greater
- Urine output of 0.5 mL/kg/hour or greater
- Central venous or mixed venous oxygen saturation of at least 70% or 65%, respectively

Antibiotic Therapy and Source Control

The SCCM recommends obtaining appropriate cultures before beginning antimicrobial therapy, but the process of doing so should not delay antibiotic administration. Whenever possible, this should be completed within three hours of presentation [165]. At least two sets (aerobic and anaerobic) of blood cultures should be obtained, including one drawn through any indwelling vascular catheter or device in place prior to onset of infection. Cultures from other suspected sites should be obtained as well. The guideline committee also recommends that imaging studies be performed to confirm the source of infection, assuming the patient's condition allows it [162; 163; 164; 165].

Intravenous antimicrobial therapy should be started as early as possible, ideally within the first hour of recognition of sepsis or septic shock (grade strong). Early administration of appropriate antimicrobials is one of the most effective interventions to reduce mortality in patients with sepsis. However, this must be balanced against the potential harms (e.g., allergic or hypersensitivity reactions, kidney injury, *C. difficile* infection, antimicrobial resistance) associated with administering unnecessary antimicrobial agents. The mortality reduction associated with early antimicrobial therapy appears strongest in patients with septic shock versus those without septic shock [165]. Clinical studies have shown that delay in antimicrobial therapy for serious infection and sepsis prolongs morbidity, lengthens hospital stay, and increases mortality [167]. A retrospective cohort study involving 2,731 patients with sepsis showed that initiation of antimicrobial therapy within the first hour of documented hypotension was associated with increased survival to discharge. Moreover, each hour of delay conferred an approximately 12% decreased probability of survival [168].

The initial choice of antibiotics will depend on the most likely pathogens associated with the source of infection as well as the prevalent micro-organisms in the local community and hospitals. The clinician should assess risk factors for multidrug-resistant pathogens, including prior hospitalization, health facility residence, recent antimicrobial use, and evidence of prior infection with resistant organism. The anticipated susceptibility profile of prevalent local pathogens and the ability of the antibiotic to penetrate to the source of the infection must also be considered. A combination of drugs with activity against all likely pathogens should be administered initially, but the regimen should be reassessed in light of culture results, the goal being to identify a single, narrow-spectrum antibiotic that will best control the infection [169; 170]. It has been found that combining an extended-spectrum beta-lactam antibiotic (e.g., penicillins, cephalosporins) with an aminoglycoside (e.g., gentamicin) was no more effective in reducing mortality than using the beta-lactam agent alone. In addition, the combination carries an increased risk of renal damage [169; 170]. A common approach is to initiate empiric therapy with a carbapenem or extended-spectrum penicillin/beta-lactamase inhibitor (e.g., ticarcillin/tazobactam) to cover gram-negative enteric bacilli and *Pseudomonas*, often in combination with vancomycin to cover *S. aureus* pending culture results.

The empirical antimicrobial regimen should be narrowed as soon as the pathogen has been identified and sensitivities are known. The duration of therapy will depend on the nature of the infection and other considerations specific to a given case. As a general rule, a 7- to 10-day course of bactericidal antimicrobial therapy is considered adequate for most serious infections associated with sepsis [164; 165]. For adults with an initial diagnosis of sepsis or septic shock and adequate source control where optimal duration of therapy is unclear, the SCCM suggests using procalcitonin in conjunction with clinical evaluation to decide when to discontinue antimicrobials over clinical evaluation alone [165]. In the event that the syndrome is due to something other than an infectious cause, such as trauma, antibiotics should be discontinued as soon as possible.

Source control requires that a specific anatomic diagnosis of infection (e.g., skin/soft tissue infection, pyelonephritis, cholangitis, peritonitis) be identified, or excluded, as soon as possible and preferably within the first six hours after presentation [165]. Small studies suggest that source control within 6 to 12 hours is advantageous [166; 171; 172]. Studies generally show reduced survival beyond that point [165]. Radiographic imaging is often necessary and should be undertaken promptly as soon as the patient's condition permits and antimicrobial therapy has been administered. Source control may be achieved by percutaneous drainage of an infected cyst or abscess, debridement of infected tissue, or removal of an infected device or catheter (removal should be prompt after other vascular access has been established) [164; 165; 169]. Surgical exploration also may be indicated when diagnostic uncertainty persists despite radiologic evaluation, when the probability of success with a percutaneous procedure is uncertain, or when the desirable effects of a failed procedure are high [165].

Vasopressors and Inotropic Therapy

If hypotension persists after intravascular volume repletion, then vasopressors may be required to restore and maintain adequate blood pressure and tissue perfusion (goal MAP 65 mg Hg) [165]. Such patients are considered to have the combination of vasodilation and reduced cardiac contractility, a condition best managed with a combined inotrope-vasopressor agent. In order to monitor arterial pressure accurately, it is suggested that all patients requiring vasopressors have an arterial catheter placed as soon as practical, if resources are available [164].

Historically, norepinephrine, dopamine, and epinephrine were three inotrope-vasopressors used to correct hypotension in septic shock [169]. Based on comparison studies and a meta-analysis of six randomized trials, norepinephrine is considered superior to dopamine and is now the recommended first choice for vasopressor therapy in septic shock (grade strong) [163; 164; 165; 173]. If a second agent is needed to maintain blood pressure, consider adding vasopressin (grade weak). If cardiac dysfunction with persistent hypoperfusion is present, despite adequate volume status and blood pressure, consider adding dobutamine or switching to epinephrine (grade weak) [165]. If dopamine is used, special attention should be given to patients at risk for arrhythmias [165]. For patient safety and effectiveness, intravenous vasopressor therapy should be administered via a central venous catheter.

As an alternative second drug, or to decrease the required effective dose of norepinephrine, vasopressin (up to 0.03 units/minute) may be added to norepinephrine. Vasopressin is usually started when the dose of norepinephrine is in the range of 0.25 – 0.5 mcg/kg/min [165]. Vasopressin should not be administered as the initial agent in septic shock.

Phenylephrine is a pure vasopressor that may be used in very select cases of septic shock [162; 163]. It reduces cardiac stroke volume, which can have deleterious effects in the patient with low cardiac output, and thus is not recommended as initial or additive therapy. Phenylephrine is reserved for the unusual case in which tachyarrhythmia limits norepinephrine use or the patient has known high cardiac output. Intravenous phenylephrine should be administered only by properly trained individuals familiar with its use [169; 174; 175].

Inotropic therapy may involve the use of dobutamine if the cardiac output remains low. If dobutamine is used, it should be combined with the vasopressors. All patients requiring vasopressors should have an arterial line placed for monitoring blood pressure [169; 174].

Monitoring Serum Lactate

If elevated, serum lactate provides a marker of tissue hypoperfusion, and serial measurements (of lactate clearance) can be used to monitor progress in resuscitation of the patient with sepsis or early septic shock. In cases in which elevated lactate levels are used as a marker of tissue hypoperfusion, it is recommended that resuscitation efforts target serum lactate with the goal to achieve normalization as rapidly as possible (grade weak) [162; 163; 164; 165].

Corticosteroids

Prior to the 1990s, there was evidence that the overall 28-day mortality was not impacted by the use of corticosteroids; consequently, their use was not advised. A review of studies conducted between 1992 and 2003 concluded that corticosteroids did not change the 28-day mortality in patients with sepsis and septic shock, but that the use of low-dose corticosteroids did reduce the all-cause mortality [176]. An update to this review found moderate-certainty evidence that corticosteroids reduce 28-day and hospital mortality in children and adults with sepsis and that the agents result in large reductions in ICU and hospital length of stay [177]. Corticosteroids are not recommended in adult patients with sepsis if hemodynamic stability has been achieved with fluid resuscitation and vasopressor therapy [164].

The patient with persistent hypotension despite fluids and vasopressors should be assessed for adrenal responsiveness and may benefit from corticosteroid therapy [165]. If corticosteroids are to be given, the 2021 SCCM guideline suggests IV hydrocortisone at a dose of 200 mg per day, in divided doses or by continuous infusion (grade weak, D) [165]. In 2017, a multispecialty task force of 16 international experts in critical care medicine, endocrinology, and guideline methods, all members of the SCCM and/or the European Society of Intensive Care Medicine, published a guideline for the management of corticosteroid insufficiency in critically ill patients. This group suggests using IV hydrocortisone <400 mg/day for three or more days at full dose in patients with septic shock that is not responsive to fluid and moderate- to high-dose vasopressor therapy. They suggest not using corticosteroids in adult patients with sepsis without shock [178].

Recombinant Human Activated Protein C

Drotrecogin alpha (activated), or recombinant human activated protein C (rhAPC), has been studied in patients with sepsis due to its antithrombotic, anti-inflammatory, and profibrinolytic properties. It was voluntarily withdrawn from the market in 2011 due to studies showing no improvement in mortality with treatment [179].

Blood Product Administration

In some cases, blood product administration may be required. The 2021 guideline recommends using a restrictive (over liberal) transfusion strategy (grade strong). A restrictive transfusion strategy typically includes a hemoglobin concentrations transfusion trigger of 70 g/L; however, RBC transfusion should not be guided by hemoglobin concentration alone. Assessment of the patient's overall clinical status and consideration of extenuating circumstances (e.g., acute myocardial ischemia) is required [165]. The routine use of erythropoietin is not recommended for treatment of anemia in patients with sepsis unless other conditions are present, such as the compromise of red blood cell production induced by renal failure. Prophylactic platelet transfusion is suggested when the platelet count is <10,000/mm^3 (10×10^9/L) in the absence of apparent bleeding and when counts are <20,000/mm^3 (20×10^9/L) if the patient has a significant risk of bleeding [164].

Patients who require invasive procedures or surgery typically require a platelet count that is in excess of 50,000/mm^3 [169]. The routine use of fresh frozen plasma is not recommended unless there is active bleeding or planned surgery. Direct administration of antithrombin agents for the treatment of sepsis or septic shock is not advised [164; 169].

Supportive Therapy for Sepsis and Septic Shock

Mechanical Ventilation

Patients who develop sepsis-induced acute lung injury (ALI) or acute respiratory distress syndrome (ARDS) may require assisted ventilation. The routine use of pulmonary artery catheters for patients with ALI/ARDS is not recommended, and it is important to remember to avoid high pressures and volumes.

The SCCM guideline committee recommends a target goal for maximum end-inspiratory plateau pressures of 30 cm H_2O and a target tidal volume of 6 mL/kg predicted body weight in adult patients with sepsis-induced ARDS (grade strong, A). In addition, the use of lower tidal volumes over higher tidal volumes is suggested for adult patients with sepsis-induced respiratory failure without ARDS [165].

Unless contraindicated, it is recommended that mechanically ventilated patients be kept with the head of the bed elevated (30–45 degrees is suggested) to limit aspiration and prevent the development of ventilator-associated pneumonia. In hospitals with advanced experience and equipment, it may be advantageous to treat patients with ARDS in a prone position if higher pressures are required and the patient's condition allows for the positional change [164; 169]. For adults with sepsis-induced moderate-to-severe ARDS, the SCCM recommends using prone ventilation for more than 12 hours daily [165].

A protocol for weaning patients from the ventilator should be developed for use following a successful spontaneous breathing trial. Extubation should be considered if the breathing trial is successful. A successful breathing trial is characterized by the following criteria [169]:

- Patient is arousable.
- Patient is hemodynamically stable (without vasopressor agents).
- Patient has developed no new potentially serious conditions.
- Ventilatory and end-expiratory pressure requirements are low.
- Fraction of inspired oxygen requirements are able to be safely delivered with a face mask or nasal cannula.

The SCCM recommends a conservative fluid strategy for patients with established ARDS and no evidence of tissue hypoperfusion in order to minimize fluid retention and weight gain (which have been shown to prolong mechanical ventilation and lengthen ICU stay) [164].

Sedation, Analgesia, and Neuromuscular Blockade

Sedation, whether intermittent or by continuous infusion, may be required for patients who are mechanically ventilated. In such cases, the practice of daily interruption or lightening of the sedation, preferably by established protocol, will serve to maintain the minimum degree of necessary sedation.

Neuromuscular blockade agents (NMBA) are sometimes used in the ICU to improve chest compliance, reduce airway pressures, and facilitate mechanical ventilation. Neuromuscular blockade agents should be used with caution in the patient with sepsis and only for brief periods, so as to avoid the risk of prolonged blockade when the drug is discontinued. The SCCM 2016 guideline issued a weak recommendation for using NMBA for 48 hours or less in adult patients with sepsis-induced ARDS and a PaO_2/FiO_2 ratio <150 mm Hg (grade weak, B) [164]. A review of randomized controlled trials published since 2016 produced conflicting results about important outcomes (e.g., mortality). This uncertainty about the outcomes and the balance between the benefits and potential harms of using NMBA led the 2021 guideline panel to issue a weak recommendation favoring intermittent NMBA boluses over a continuous infusion. Clinicians are reminded to ensure adequate patient sedation and analgesia if NMBA are used [165].

Glucose Control

Glucose control includes a regimen of appropriate nutrition, beginning with IV glucose and enteral feeding within 72 hours (grade weak, suggested) in critically ill patients with sepsis [165]. Following initial stabilization, patients with hyperglycemia should receive IV insulin therapy to reduce blood glucose levels. The 2016 version of the SCCM guideline recommended that blood glucose management be done by protocol: insulin dosing to commence when two consecutive blood glucose levels are greater than 180 mg/dL, and targeting an upper blood glucose of ≤180 mg/dL rather than an upper blood glucose ≤110 mg/dL [164]. In the 2021 guideline, the panel sought to identify what level of glucose (>180 mg/dL **or** >150 mg/dL) should trigger commencement of IV insulin [165]. After reviewing a network meta-analysis of 35 randomized controlled trials, the panel concluded that the balance of effects (e.g., hospital mortality, hypoglycemia) favored initiation of insulin therapy at a glucose level of >180 mg/dL and provided a strong recommendation to that effect [165]. Following initiation, a typical target blood glucose range is 144–180 mg/dL [165]. Note: The meta-analysis that the 2021 guideline panel reviewed compared four different blood glucose targets: <110 mg/dL; 110–144 mg/dL; 144–180 mg/dL; and >180 mg/dL. No significant difference in risk of hospital mortality was observed among the four targets. Concentrations of <110 mg/dL and 110–144 mg/dL were associated with a four- to nine-fold increase in the risk of hypoglycemia compared with the 144–180 mg/dL and the >180 mg/dL ranges. No significant difference in the risk of hypoglycemia was observed when the target range of 144–180 mg/dL was compared with the target range of >180 mg/dL [165].

Bicarbonate Therapy and Deep Vein Thrombosis Prophylaxis

Bicarbonate therapy to improve hemodynamics or reduce vasopressor requirements in patients with sepsis-induced lactic acidemia is not recommended for those patients with a pH equal to or greater than 7.15 [165]. While the 2016 recommendation is essentially unchanged, for patients with severe metabolic acidemia (pH ≤7.2 and acute kidney injury (AKI) [AKIN score 2 or 3]), the 2021 panel suggests (weak recommendation) using sodium bicarbonate therapy [165].

The use of anticoagulants to prevent deep vein thrombosis (DVT) has been well studied. For patients with sepsis, the SCCM guideline committee recommends the administration of low-dose unfractionated heparin (UFH), two to three times per day, or low-molecular-weight heparin (LMWH), once daily, unless there are contraindications, such as active bleeding, thrombocytopenia, or severe coagulopathy. LMWH has been found to be superior to UFH and is preferred in high-risk patients if there are no contraindications [165; 169].

When contraindications exist, other preventive measures, such as graduated compression stockings or an intermittent compression device, are recommended. In very high-risk patients, such as those who have sepsis and a history of DVT, trauma, or orthopedic surgery, a combination of both therapies is suggested [169; 174].

Stress Ulcer Prophylaxis

The SCCM guideline recommends stress ulcer prophylaxis for patients with sepsis who have risk factors for gastrointestinal bleeding, using either a proton pump inhibitor or a histamine-2 antagonist. It is recommended that stress ulcer prophylaxis not be used for patients without risk factors for gastrointestinal bleeding [165].

Patient Education

History-taking and examination are important aspects in the assessment of patients with suspected sepsis. All patients should be told of the importance of providing accurate and relevant information.

Also included in the supportive therapy points of care is the SCCM recommendation that advance care planning, including the communication of likely outcomes and realistic goals of treatment, be discussed with patients and families [165; 169]. As a result of the evolving racial and immigration demographics in the United States, interaction with patients for whom English is not a native language is inevitable. Because communication with patients and families is considered an essential aspect of care, it is each practitioner's responsibility to ensure that information regarding goals and potential outcomes are explained in such a way that allows for patient understanding. When there is an obvious disconnect in the communication process between the practitioner and patient due to the patient's lack of proficiency in the English language, an interpreter is required.

All patients should be given comprehensive education on their condition and instructions regarding when to seek help. Infection prevention strategies (e.g., appropriate handwashing, wound care, vaccination) are essential. Patients at high risk for sepsis should be informed of risk factors and warning signs/symptoms of the disease. These patients should be told to seek immediate care for worsening infections and sign/symptoms of sepsis.

Sepsis Bundle

Reducing mortality due to sepsis requires an organized process that guarantees early recognition and consistent application of evidence-based practice. To this end, carefully designed protocols and measurable quality indicators should be incorporated into hospital practice. Beginning in 2005 the Surviving Sepsis Campaign converted its guideline into protocols, with sets of quality indicators that could be implemented by hospitals working to improve out-

comes. The Sepsis Bundles are a series of therapies that, when implemented together, have been proven to achieve better outcomes than when implemented individually [162]. In conjunction with the 2013 guideline, two bundles (resuscitation and management) were released.

In order to reflect the changes in the 2016 guideline, in 2018 the Surviving Sepsis Campaign published the Hour-1 Bundle, taking the place of the previously separate resuscitation and management bundles [162]. This new bundle emphasizes the importance of beginning resuscitation and management immediately, then escalating care seamlessly (e.g., by adding vasopressor therapy) on the basis of ongoing clinical parameters rather than waiting or extending resuscitation measures over a longer period. The Hour-1 Bundle consists of five elements that are intended to be initiated within the first hour after the time of triage in the emergency department or, if referred from another care location, from the earliest chart annotation consistent with all elements of sepsis or septic shock. The five elements are [162]:

- Measure lactate level. Re-measure if initial lactate is >2 mmol/L.
- Obtain blood cultures prior to administration of antibiotics.
- Administer broad-spectrum antibiotics.
- Rapidly administer 30 mL/kg crystalloid for hypotension or lactate ≥4 mmol/L.
- Apply vasopressors if patient is hypotensive during or after fluid resuscitation to maintain MAP ≥65 mm Hg.

More than one hour may be required for resuscitation to be completed, but initiation of resuscitation and treatment should begin immediately [162]. The Hour-1 Bundle, based on the 2018 guideline, is evidence-based and intended for use by emergency department, hospital, and ICU staff as a tool for improving the care of patients with sepsis and septic shock. The Bundle is supported in the 2021 guidelines [165].

CONCLUSION

An effective infection control team is critical to reducing the incidence of HAIs in a healthcare facility. All departments within a healthcare facility should be represented on this team to ensure widespread adherence to prevention measures. The responsibilities of an infection control team are to conduct surveillance of infections; ensure compliance with infection control guidelines, including those for management of drug-resistant organisms; and establish response and control plans for outbreaks and epidemics. Most important is the development of an organizational culture that fosters a focus on patient safety and that emphasizes education on HAIs and infection control for healthcare professionals and patients and their families.

Implicit Bias in Health Care

The role of implicit biases on healthcare outcomes has become a concern, as there is some evidence that implicit biases contribute to health disparities, professionals' attitudes toward and interactions with patients, quality of care, diagnoses, and treatment decisions. This may produce differences in help-seeking, diagnoses, and ultimately treatments and interventions. Implicit biases may also unwittingly produce professional behaviors, attitudes, and interactions that reduce patients' trust and comfort with their provider, leading to earlier termination of visits and/or reduced adherence and follow-up. Disadvantaged groups are marginalized in the healthcare system and vulnerable on multiple levels; health professionals' implicit biases can further exacerbate these existing disadvantages.

Interventions or strategies designed to reduce implicit bias may be categorized as change-based or control-based. Change-based interventions focus on reducing or changing cognitive associations underlying implicit biases. These interventions might include challenging stereotypes. Conversely, control-based interventions involve reducing the effects of the implicit bias on the individual's behaviors. These strategies include increasing awareness of biased thoughts and responses. The two types of interventions are not mutually exclusive and may be used synergistically.

Works Cited

1. Weinstein RA. Infections acquired in health care facilities. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J (eds). *Harrison's Principles of Internal Medicine*. 20th ed. New York: McGraw Hill; 2018.
2. World Health Organization. *Prevention of Hospital-Acquired Infections: A Practical Guide*. 2nd ed. Geneva: WHO Press; 2002.
3. Burke JP. Infection control: a problem for patient safety. *N Engl J Med*. 2003;348(7):651-656.
4. Klevens RM, Edwards JR, Richards CL Jr, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Pub Health Rep*. 2007;122(2):160-166.
5. Centers for Disease Control and Prevention. HAI Data. Available at https://www.cdc.gov/hai/data. Last accessed June 15, 2024.
6. Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prevalence survey of health care-associated infections. *N Engl J Med*. 2014;370(13):1198-1208.
7. Magill SS, O'Leary E, Janelle SJ, et al. Changes in prevalence of health care-associated infections in U.S. hospitals. *N Engl J Med*. 2018;379:1732-1744.
8. Scott RD II. The Direct Medical Costs of Healthcare-Associated Infections in U.S. Hospitals and the Benefits of Prevention. Available at https://www.cdc.gov/hai/pdfs/hai/scott_costpaper.pdf. Last accessed June 15, 2024.
9. Weiner-Lastinger LM, Abner S, Edwards JR, et al. Antimicrobial-resistant pathogens associated with adult healthcare-associated infections: summary of data reported to the National Healthcare Safety Network, 2015–2017. *Infect Control Hosp Epidemiol*. 2019;41(1):1-18.
10. Centers for Disease Control and Prevention. Healthcare-associated Infections: Current HAI Progress Report. Available at https://www.cdc.gov/hai/data/portal/progress-report.html. Last accessed June 15, 2024.
11. Weiner-Lastinger LM, Pattabiraman V, Konnor RY, et al. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: a summary of data reported to the National Healthcare Safety Network. *Infect Control Hosp Epidemiol*. 2021;362:1-14.
12. Shojania KG, Duncan BW, McDonald KM, Wachter RM, Markowitz AJ (eds). *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*. Rockville, MD: Agency for Healthcare Research and Quality; 2001.
13. Adams K, Corrigan JM (eds). *Priority Areas for National Action: Transforming Health Care Quality*. Washington, DC: The National Academies Press; 2003.
14. McCannon CJ, Hackbarth AD, Griffin FA. Miles to go: an introduction to the 5 Million Lives Campaign. *Jt Comm J Qual Patient Safe*. 2007;33(8):477-484.
15. U.S. Department of Health and Human Services. HAI National Action Plan: National Action Plan to Prevent Healthcare-Associated Infections: Roadmap to Elimination. Available at https://www.hhs.gov/oidp/topics/health-care-associated-infections/hai-action-plan/index.html. Last accessed June 15, 2024.
16. Centers for Medicare & Medicaid Services. Medicare Program: hospital inpatient prospective payment systems for acute care hospitals and the long-term care hospital prospective payment system and policy changes and fiscal year 2020 rates; quality reporting requirements for specific providers; Medicare and Medicaid promoting interoperability programs requirements for eligible hospitals and critical access hospitals. *Fed Regist*. 2019;84(159):42044-42701.
17. Centers for Medicare & Medicaid Services. Hospital-Acquired Conditions. Available at https://www.cms.gov/medicare/medicare-fee-for-service-payment/hospitalacqcond/hospital-acquired_conditions. Last accessed June 15, 2024.
18. Agency for Healthcare Research and Quality. Safe Practices for Better Healthcare, 2010 Update. Available at https://psnet.ahrq.gov/issue/safe-practices-better-healthcare-2010-update. Last accessed June 15, 2024.
19. The Joint Commission. 2022 National Patient Safety Goals. Available at https://www.jointcommission.org/standards/national-patient-safety-goals/. Last accessed June 15, 2024.
20. Centers for Medicare & Medicaid Services. Partnership for Patients. Available at https://innovation.cms.gov/innovation-models/partnership-for-patients. Last accessed June 15, 2024.
21. AHCCCS. Provider Preventable Conditions. Available at https://www.azahcccs.gov/PlansProviders/RatesAndBilling/ManagedCare/providerpreventableconditions.html. Last accessed June 15, 2024.
22. Lee GM, Kleinman K, Soumerai SB, et al. Effect of nonpayment for preventable infections in U.S. hospitals. *N Engl J Med*. 2012;367(15):1428-1437.
23. Lee GM, Hartmann CW, Graham D, et al. Perceived impact of the Medicare policy to adjust payment for health care-associated infections. *Am J Infect Control*. 2012;40(4):314-319.
24. Edmond M, Eickhoff TC. Who is steering the ship? External influences on infection control programs. *Clin Infect Dis*. 2008;46(11):1746-1750.
25. Musu M, Lai A, Mereu NM, et al. Assessing hand hygiene compliance among healthcare workers in six intensive care units. *J Prev Med Hyg*. 2017;58(3):E231-E237.
26. New York State Department of Health. New York Codes, Rules and Regulations, Volume A-2, Title 10: Part 92: Infection Control Requirements. Available at https://regs.health.ny.gov/content/part-92-infection-control-requirements. Last accessed June 15, 2024.

27. New York State Education Department. Rules of the Board of Regents: Part 29, Unprofessional Conduct. 29.2(a)(13). General Provisions for Health Professions. Available at http://www.op.nysed.gov/title8/part29.htm. Last accessed June 15, 2024.
28. Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Available at https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf. Last accessed June 15, 2024.
29. Haley RW. *Managing Hospital Infection Control for Cost-Effectiveness*. Chicago, IL: American Hospital Association; 1986.
30. Haley RW. The development of infection surveillance and control programs. In: Bennett JV, Brachman PS (eds). *Hospital Infections*. Boston: Little, Brown, and Company; 1992: 63-78.
31. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associate infections that are reasonably preventable and the related mortality and costs. *Infect Control Hosp Epidemiol*. 2011;32(2):101-114.
32. Mehta AC, Prakash UB, Garland R, et al. American College of Chest Physicians and American Association for Bronchology consensus statement: prevention of flexible bronchoscopy-associated infection. *Chest*. 2005;128(3):1742-1755.
33. Kalil AC, Metersky ML, Klompas M, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by the Infectious Diseases Society of America and the American Thoracic Society. *Clin Infect Dis*. 2016;63(5):e61-e111.
34. Facility Guidelines Institute. 2018 *FGI Guidelines for Design and Construction of Hospitals and Outpatient Facilities*. Chicago, IL: American Hospital Association; 2018.
35. Muscedere J, Dodek P, Keenan S, et al. Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: prevention. *J Crit Care*. 2008;23(1):126-137.
36. Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA, and the Healthcare Infection Control Practices Advisory Committee. Guideline for Prevention of Catheter-Associated Urinary Tract Infections, 2009. Available at https://www.cdc.gov/infectioncontrol/pdf/guidelines/cauti-guidelines-H.pdf. Last accessed June 15, 2024.
37. Rutala WA, Weber DJ, the Healthcare Infection Control Practices Advisory Committee. Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. Available at https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf. Last accessed June 15, 2024.
38. New York State Department of Health AIDS Institute. PEP to Prevent HIV Infection. Available at https://www.hivguidelines.org/guideline/hiv-pep. Last accessed June 15, 2024.
39. Siegel JD, Rhinehart E, Jackson M, Chiarello L, the Healthcare Infection Control Practices Advisory Committee. Management of Multidrug-Resistant Organisms in Healthcare Settings. Available at https://www.cdc.gov/infectioncontrol/pdf/guidelines/mdro-guidelines.pdf.MDRO/index.html. Last accessed June 15, 2024.
40. Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R. Guidelines for preventing health-care-associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR*. 2004;53(RR3):1-36.
41. Sehulster L, Chinn RYW, Arduino MJ, et al. Guidelines for environmental infection control in health-care facilities. *MMWR*. 2003;52(RR10):1-48.
42. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings. *MMWR*. 2002;51(RR16):1-44.
43. O'Grady NP, Alexander M, Burns LA, et al. *Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011*. Atlanta, GA: Centers for Disease Control and Prevention; 2011.
44. Anderson DJ, Podgorny K, Berríos-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(6):605-627.
45. Nicolle LE, Gupta K, Bradley SF, et al. Clinical practice guideline for the management of asymptomatic bacteriuria: 2019 update by the Infectious Diseases Society of America. *Clin Infect Dis*. 2019;68(10):e83-e110.
46. Institute for Healthcare Improvement. Overview: 5 Million Lives. Available at http://www.ihi.org/engage/initiatives/completed/5MillionLivesCampaign/Pages/default.aspx. Last accessed June 15, 2024.
47. Muto CA, Jernigan JA, Ostrowsky BE, et al. SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of Staphylococcus aureus and Enterococcus. *Infect Control Hosp Epidemiol*. 2003;24(5):362-386.
48. ASGE Quality Assurance in Endoscopy Committee, Petersen BT, Chennat J, et al. Multisociety guideline on reprocessing flexible GI endoscopes: 2016 update. Available at https://www.sgna.org/Portals/0/MS_guideline_reprocessing_GI_endoscopes.pdf. Last accessed June 15, 2024.
49. Dellit TH, Owens RC, McGowan JE Jr, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis*. 2007;44(2):159-177.
50. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central-line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(7):753-771.
51. Klompas M, Branson R, Eichenwald EC. Strategies to prevent ventilator-associated pneumonia in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(8):915-936.

52. Lo E, Nicolle LE, Coffin SE, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(5):464-479.
53. Anderson DJ, Podgorny K, Berrios-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(6):605-627.
54. The Leapfrog Group. Eighty-Seven Percent of U.S. Hospitals Do Not Take Recommended Steps to Prevent Avoidable Infections. Press release: September 7, 2007: Washington, DC.
55. McGuckin M, Waterman R, Govednik J. Hand hygiene compliance rates in the United States: a one-year multicenter collaboration using product/volume usage measurement and feedback. *Am J Med Qual*. 2009;24(3):205-213.
56. Clark AP, Houston S. Nosocomial infections: an issue of patient safety: part 2. *Clin Nurse Spec*. 2004;18(2):62-64.
57. Pittet D, Hugonnet S, Harbarth S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet*. 2000;356(9238):1307-1312.
58. Larson EL, Quiros D, Lin SX. Dissemination of the CDC's hand hygiene guideline and impact on infection rates. *Am J Infect Control*. 2007;35(10):666-675.
59. New York State Department of Health. New York State Education § 6530. Definitions of Professional Misconduct. Available at https://www.health.ny.gov/professionals/office-based_surgery/law/6530.htm. Last accessed June 15, 2024.
60. New York Public Health Law Section 230-A: Penalties for Professional Misconduct. Available at https://law.onecle.com/new-york/public-health/PBH0230-A_230-A.html.new-york/public-health/PBH0230-A_230-A.html. Last accessed June 15, 2024.
61. Huis A, Schoonhoven L, Grol R, et al. Helping hands: a cluster randomised trial to evaluate the effectiveness of two different strategies for promoting hand hygiene in hospital nurses. *Implement Sci*. 2011;6:101.
62. Boyce JM. Hand hygiene compliance monitoring: current perspectives from the USA. *J Hosp Infect*. 2008;70(Suppl 1):2-7.
63. Porter RS. *The Merck Manual of Diagnosis and Therapy*. 19th ed. Hoboken, NJ: John Wiley and Sons, Inc.; 2011.
64. Kuhar DT, Henderson DK, Struble KA, et al. Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HIV and Recommendations for Postexposure Prophylaxis. Available at https://stacks.cdc.gov/view/cdc/20711. Last accessed June 15, 2024.
65. Pier GB. Molecular mechanisms of microbial pathogenesis. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J (eds). *Harrison's Principles of Internal Medicine*. 20th ed. New York, NY: McGraw Hill; 2018.
66. Tietjen L, Bossemeyer D, McIntosh N. *Infection Prevention: Guidelines for Healthcare Facilities with Limited Resources*. Baltimore, MD: JHPIEGO; 2003.
67. Clark AP, John LD. Nosocomial infections and bath water: any cause for concern? *Clin Nurse Spec*. 2006;20(3):119-123.
68. Anaissie EJ, Penzak SR, Dignani MC. The hospital water supply as a source of nosocomial infections: a plea for action. *Arch Intern Med*. 2002;162(13):1483-1492.
69. Centers for Disease Control and Prevention. Bloodborne Infectious Diseases: HIV/AIDS, Hepatitis B, Hepatitis C. Available at https://www.cdc.gov/niosh/topics/bbp. Last accessed June 15, 2024.
70. Centers for Disease Control and Prevention. The National Surveillance System for Healthcare Workers (NaSH). Available at https://www.cdc.gov/nhsn/PDFs/NaSH/NaSH-Report-6-2011.pdf. Last accessed June 15, 2024.
71. Centers for Disease Control and Prevention. Infection Prevention and Control Recommendations for Hospitalized Patients under Investigation (PUIs) for Ebola Virus Disease (EVD) in U.S. Hospitals. Available at https://www.cdc.gov/vhf/ebola/clinicians/evd/infection-control.html. Last accessed June 15, 2024.
72. Kingston LM, Slevin BL, O'Connell NH, Dunne CP. Hand hygiene: attitudes and practices of nurses, a comparison between 2007 and 2015. *Am J Infect Control*. 2017;45(12):1300-1307.
73. Johnson PDR, Rhea M, Burrell LJ, et al. Efficacy of an alcohol/chlorhexidine hand hygiene program in a hospital with high rates of nosocomial methicillin-resistant Staphylococcus aureus (MRSA) infection. *Med J Aust*. 2005;183(10):509-514.
74. Gordin FM, Schultz ME, Huber RA, Gill JA. Reduction in nosocomial transmission of drug-resistant bacteria after introduction of an alcohol-based handrub. *Infect Control Hosp Epidemiol*. 2005;26(7):650-653.
75. Kirk J, Kendall A, Marx JF, et al. Point of care hand hygiene—where's the rub? A survey of U.S. and Canadian health care workers' knowledge, attitudes, and practices. *Am J Infect Control*. 2016;44(10):1095-1101.
76. Gould DJ, Moralejo D, Drey N, Chudleigh JH, Taljaard M. Interventions to improve hand hygiene compliance in patient care. *Cochrane Database Syst Rev*. 2017;9:CD005186.
77. Alshehari AA, Parks S, Rashid H. Strategies to improve hand hygiene compliance among healthcare workers in adult intensive care units: a mini systematic review. *J Hosp Infect*. 2018;100(2):152-158.
78. Luangasanatip N, Hongsuwan M, Lubell Y, et al. Cost-effectiveness of interventions to improve hand hygiene in healthcare workers in middle-income hospital settings: a model-based analysis. *J Hosp Infect*. 2018;100(2):165-175.
79. Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med*. 2006;355(26):2725-2732.

80. The Joint Commission. Measuring Hand Hygiene Adherence: Overcoming the Challenges. Available at https://www.jointcommission.org/-/media/tjc/documents/resources/hai/hh_monograph.pdf. Last accessed June 15, 2024.
81. Centers for Disease Control and Prevention. Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus. Available at https://www.cdc.gov/vhf/ebola/clinicians/cleaning/hospitals.html. Last accessed June 15, 2024.
82. Centers for Disease Control and Prevention. Ebola (Ebola Virus Disease): For Clinicians. Available at https://www.cdc.gov/vhf/ebola/clinicians/index.html. Last accessed June 15, 2024.
83. Favero MS, Bond WW. Disinfection of medical and surgical materials. In: Block SS (ed). *Disinfection, Sterilization, and Preservation*. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2001: 881-917.
84. Leung JW. Reprocessing of flexible endoscopes. *J Gastroenterol Hepatol*. 2000;15(Suppl):G73-G77.
85. Nelson DB, Muscarella LF. Current issues in endoscope reprocessing and infection control during gastrointestinal endoscopy. *World J Gastroenterol*. 2006;12(25):3953-3964.
86. Muscarella LF. Inconsistencies in endoscope-reprocessing and infection-control guidelines: the importance of endoscope drying. *Am J Gastroenterol*. 2006;101(9):2147-2154.
87. Rutala WA, Weber DJ. Reprocessing endoscopes: United States perspective. *J Hosp Infect*. 2004;56(Suppl 2):S27-S39.
88. Gillespie J, Arnold KE, Kainer MA, et al. Pseudomonas aeruginosa infections associated with transrectal ultrasound-guided prostate biopsies—Georgia, 2005. *MMWR*. 2006;55(28):776-777.
89. U.S. Food and Drug Administration. [Archive]. Reprocessing of Reusable Ultrasound Transducer Assemblies Used for Biopsy Procedures. Available at https://wayback.archive-it.org/7993/20170112170658/http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm151526.htm. Last accessed June 15, 2024.
90. Srinivasan A, Wolfenden LL, Song X, Perl TM, Haponik EF. Bronchoscope reprocessing and infection prevention and control: bronchoscopy-specific guidelines are needed. *Chest*. 2004;125(1):307-314.
91. Centers for Disease Control and Prevention. Injection Safety. Available at https://www.cdc.gov/injectionsafety. Last accessed June 15, 2024.
92. Brossette SE, Hacek DM, Gavin PJ, et al. A laboratory-based, hospital-wide, electronic marker for nosocomial infection: the future of infection control surveillance? *Am J Clin Pathol*. 2006;125(1):34-39.
93. Kuhar DT, Henderson DK, Struble KA, for the U.S. Public Health Service Working Group. Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HIV and Recommendations for Postexposure Prophylaxis. Available at https://stacks.cdc.gov/view/cdc/20711. Last accessed June 15, 2024.
94. Centers for Disease Control and Prevention. Infection Control. Infrastructure and Routine Practices: Recommendations Only. Available at https://www.cdc.gov/infectioncontrol/pdf/guidelines/infection-control-HCP-recommendations-only-H.pdf. Last accessed June 15, 2024.
95. Centers for Disease Control and Infection. Infection Control in Healthcare Personnel. Available at https://www.cdc.gov/infectioncontrol/guidelines/healthcare-personnel/index.html. Last accessed June 15, 2024.
96. Jensen PA, Lambert LA, Iademarco MF, Ridzon R. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. *MMWR*. 2005;54(RR17):1-141.
97. Pearson ML, Bridges CB, Harper SA, et al. Influenza vaccination of health-care personnel: recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2006;55(RR2):1-16.
98. Advisory Committee on Immunization Practices. Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2011;60(RR07):1-45.
99. Raboud J, Saskin R, Wong K, et al. Patterns of handwashing behavior and visits to patients on a general medical ward of healthcare workers. *Infect Control Hosp Epidemiol*. 2004;25(3):198-202.
100. Warren DK, Zack JE, Cox MJ, Cohen MM, Fraser VJ. An educational intervention to prevent catheter-associated bloodstream infections in a nonteaching, community medical center. *Crit Care Med*. 2003;31(7):1959-1963.
101. Coopersmith CM, Rebmann TL, Zack JE, et al. Effect of an education program on decreasing catheter-related bloodstream infections in the surgical intensive care unit. *Crit Care Med*. 2002;30(1):59-64.
102. Tolentino-DelosReyes AF, Ruppert SD, Shiao S-YPK. Evidence-based practice: use of the ventilator bundle to prevent ventilator-associated pneumonia. *Am J Crit Care*. 2007;16(1):20-27.
103. Lee TC, Moore C, Raboud JM, et al. Impact of a mandatory infection control education program on nosocomial acquisition of methicillin-resistant Staphylococcus aureus. *Infect Control Hosp Epidemiol*. 2009;30(3):249-256.
104. U.S Census Bureau. American Community Survey: Selected Social Characteristics in the United States: 2019: ACS 1-Year Estimates Data Profiles. Available at https://data.census.gov/cedsci/table?q=DP02#. Last accessed June 15, 2024.
105. Centers for Disease Control and Prevention. *Exposure to Blood: What Healthcare Personnel Need to Know*. Rockville, MD: U.S. Department of Health and Human Services; 2003.

106. Moorman AC, de Perio MA, Goldschmidt R, et al. Testing and clinical management of health care personnel potentially exposed to hepatitis C virus – CDC guidance, United States. 2020. *MMWR*. 2020;69(6):1-8.

107. Centers for Disease Control and Prevention. Latent Tuberculosis Infection: A Guide for Primary Health Care Providers. Available at https://www.cdc.gov/tb/publications/ltbi/pdf/LTBIbooklet508.pdf. Last accessed June 15, 2024.

108. Centers for Disease Control and Prevention. Measles (Rubeola) For Healthcare Professionals. Available at https://www.cdc.gov/measles/hcp/index.html. Last accessed June 15, 2024.

109. Sawyer LA, Murphy JJ, Kaplan JE, et al. 25- to 30-nm virus particle associated with a hospital outbreak of acute gastroenteritis with evidence for airborne transmission. *Am J Epidemiol*. 1988;127(6):1261-1271.

110. Marks PJ, Vipond IB, Carlisle D, Deakin D, Fey RE, Caul EO. Evidence for airborne transmission of Norwalk-like virus (NLV) in a hotel restaurant. *Epidemiol Infect*. 2000;124(3):481-487.

111. Cheesbrough JS, Green J, Gallimore CI, Wright PA, Brown DW. Widespread environmental contamination with Norwalk-like viruses (NLV) detected in a prolonged hotel outbreak of gastroenteritis. *Epidemiol Infect*. 2000;125(1):93-98.

112. Marks PJ, Vipond IB, Regan FM, Wedgwood K, Fey RE, Caul EO. A school outbreak of Norwalk-like virus: evidence for airborne transmission. *Epidemiol Infect*. 2003;131(1):727-736.

113. Makison BC. Vomiting Larry: a simulated vomiting system for assessing environmental contamination from projectile vomiting related to norovirus infection. *J Infect Prev*. 2014;15(5):176-180.

114. Booth CM, Frost G. Potential distribution of viable Norovirus post simulated vomiting. *J Hosp Infect*. 2019;102(3):304-310.

115. MacCannell T, Umscheid CA, Agarwal RK, Lee I, Kuntz G, Stevenson KB, and the Healthcare Infection Control Practices Advisory Committee. Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings, 2011. Available at https://www.cdc.gov/infectioncontrol/guidelines/norovirus/index.html. Last accessed June 15, 2024.

116. Henderson DK, Dembry L, Fishman NO, et al. SHEA guideline for management of healthcare workers who are infected with hepatitis B virus, hepatitis C virus, and/or human immunodeficiency virus. *Infect Control Hosp Epidemiol*. 2010;31(3):203-232.

117. U.S. Department of Justice, Civil Rights Division. Fighting Discrimination Against People with HIV/AIDS. Available at https://www.ada.gov/hiv/index.htm. Last accessed June 15, 2024.

118. Centers for Disease Control and Prevention. Sepsis: What is Sepsis? Available at https://www.cdc.gov/sepsis/what-is-sepsis.html.index.html. Last accessed June 15, 2024.

119. New York State Department of Health. New York State Report on Sepsis Care Improvement Initiative: Hospital Quality Performance, 2016. Available at https://www.health.ny.gov/press/reports/docs/2016_sepsis_care_improvement_initiative.pdf. Last accessed June 15, 2024.

120. Elixhauser A, Friedman B, Stranges E. Septicemia in U.S. Hospitals, 2009. Available at https://www.hcup-us.ahrq.gov/reports/statbriefs/sb122.pdf. Last accessed June 15, 2024.

121. BMJ Group Clinical Evidence. Sepsis. Available at https://bestpractice.bmj.com/topics/en-gb/245/epidemiology. Last accessed June 15, 2024.

122. Novosad SA, Sapiano MRP, Grigg C, et al. Epidemiology of sepsis: prevalence of health care factors and opportunities for prevention. *MMWR*. 2016;65(33):864-869.

123. Liu V, Escobar GJ, Greene JD. Hospital deaths in patients with sepsis from two independent cohorts. *JAMA*. 2014;312(1):90-92.

124. Meyer N, Harhay M, Small D, et al. Temporal trends in incidence, sepsis-related mortality, and hospital-based acute care after sepsis. *Crit Care Med*. 2018;46(3):354-360.

125. Wang HE, Jones AR, Donnelly JP. Revised national estimates of emergency department visits for sepsis in the United States. *Crit Care Med*. 2017;45(9):1443-1449.

126. Wang HE, Devereaux RS, Yealy DM, Safford MM, Howard G. National variation in United States sepsis mortality: a descriptive study. *Int J Health Geogr*. 2010;9:9.

127. Wang HE, Shapiro NI, Angus DC, Yealy DM. National estimates of severe sepsis in United States emergency departments. *Crit Care Med*. 2007;35(8):1928-1936.

128. Dombrovskiy VY, Martin AA, Jagadeeshan S, Paz HL. Rapid increase in hospitalization and mortality rates for severe sepsis in the United States: a trend analysis from 1993 to 2003. *Crit Care Med*. 2007;35(5):1244-1250.

129. Rhee C, Dantes R, Epstein L, et al. Incidence and trends of sepsis in U.S. hospitals using clinical vs claims data, 2009 – 2014. *JAMA*. 2017;318(13):1241-1249.

130. Epstein L, Dantes R, Magill S, Fiore A. Varying estimates of sepsis mortality using death certificates and administrative codes—United States, 1999–2014. *MMWR*. 2016;65(13):342-345.

131. Gaieski DF, Edwards JM, Kallan MJ, Carr BG. Benchmarking the incidence and mortality of severe sepsis in the United States. *Crit Care Med*. 2013;41(5):1167-1174.

132. Zimmerman JE, Kramer AA, Knaus WA. Changes in hospital mortality for United States intensive care unit admissions from 1988 to 2012. *Crit Care*. 2013;17(2):R81.

133. Melamed A, Sorvillo FJ. The burden of sepsis-associated mortality in the United States from 1999 to 2005: an analysis of multiple-cause-of-death data. *Crit Care*. 2009;13:R28.

134. Vincent JL, Abraham E. The last 100 years of sepsis. *Am J Resp Crit Care Med*. 2006;173:256-263.

135. Al-Khafaji AH. Multiple Organ Dysfunction Syndrome in Sepsis. Available at https://emedicine.medscape.com/article/169640-overview. Last accessed June 15, 2024.

136. Hall MJ, Williams SN, DeFrances CJ, Golosinskiy A. *Inpatient Care for Septicemia or Sepsis: A Challenge for Patients and Hospitals*. NCHS Data Brief, No. 62. Hyattsville, MD: National Center for Health Statistics; 2011.

137. Paoli CJ, Reynolds MA, Sinha M, Gitlin M, Crouser E. Epidemiology and costs of sepsis in the United States: an analysis based on timing of diagnosis and severity level. *Crit Care Med*. 2018;46(12):1889-1897.

138. Iwashyna TJ, Ely EW, Smith DM, Langa KM. Long-term cognitive impairment and functional disability among survivors of severe sepsis. *JAMA*. 2010;304(16):1787-1794.

139. End Sepsis: The Legacy of Rory Staunton. Sepsis Protocols. Available at https://www.endsepsis.org/work/sepsis-protocols. Last accessed June 15, 2024.

140. New York State Department of Health. 2013 Meeting Document. Available at https://www.health.ny.gov/facilities/public_ health_ and_health_planning_council/meetings/2013-02-07/docs/13-01.pdf. Last accessed June 15, 2024.

141. Kali A. Septic Shock. Available at https://emedicine.medscape.com/article/168402-overview. Last accessed June 15, 2024.

142. López-Mestanza C, Andaluz-Ojeda D, Gómez-López JR, Bermejo-Martin JF. Clinical factors influencing mortality risk in hospital-acquired sepsis. *J Hosp Infect*. 2018;98(2):194-201.

143. Wang L, Zhou KH, Chen W, Yu Y, Feng SF. Epidemiology and risk factors for nosocomial infection in the respiratory intensive care unit of a teaching hospital in China: a prospective surveillance during 2013 and 2015. *BMC Infect Dis*. 2019;19(1):145.

144. National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control*. 2004;32(8):470-485.

145. Mayr FB, Yende S, Angus DC. Epidemiology of severe sepsis. *Virulence*. 2014;591:4-11.

146. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States from 1979 through 2000. *N Engl J Med*. 2003;348(16):1546-1554.

147. Warner EA, Moldawer LL. Using innate immunity to characterize the host response to microbial invasion in severe sepsis. *Future Microbiol*. 2008;3(2):177-189.

148. Gollehon NS. Neonatal Sepsis. Available at https://emedicine.medscape.com/article/978352-overview. Last accessed June 15, 2024.

149. Pinilla JC, Ross DF, Martin T, Crump H. Study of the incidence of intravascular catheter infection and associated septicemia in critically ill patients. *Crit Care Med*. 1983;11(1):21-25.

150. Gillies D, O'Riordan L, Wallen M, Morrison A, Rankin K, Nagy S. Optimal timing for intravenous administration set replacement. *Cochrane Database Syst Rev*. 2005;4:CD003588.

151. Ullman AJ, Cooke ML, Gillies D, et al. Optimal timing for intravascular administration set replacement. *Cochrane Database Syst Rev*. 2013;9:CD003588.

152. Maki DG, Botticelli JT, LeRoy ML, Thielke TS. Prospective study of replacing administration sets for intravenous therapy at 48- vs 72-hour intervals: 72 hours is safe and cost-effective. *JAMA*. 1987;258:1777-1781.

153. Kunin CM. *Urinary Tract Infections: Detection, Prevention and Management*. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 1997.

154. de Jonge RCJ, Polderman KH, Gemke RJBJ. Central venous catheter use in the pediatric patient: mechanical and infectious complications. *Pediatr Crit Care Med*. 2005;6(3):329-339.

155. Huang EY, Chen C, Abdullah F, et al. Strategies for the prevention of central venous catheter infections: an American Pediatric Surgical Association Outcomes and Clinical Trials Committee systematic review. *J Pediatr Surg*. 2011;46(10):2000-2011.

156. Horth RZ, Jones JM, Kim JJ, et al. Fatal sepsis associated with bacterial contamination of platelets—Utah and California, August 2017. *MMWR*. 2018;67(25):718-722.

157. Centers for Disease Control and Prevention. Fatal bacterial infections associated with platelet transfusions—United States, 2004. *MMWR*. 2005;54(7):168-170.

158. American Association of Blood Banks. *Standards for Blood Banks and Transfusion Services*. 32nd ed. Bethesda, MD: AABB; 2020.

159. AABB. Standards for Blood Banks and Transfusion Services, 33rd Edition – Print. Available at https://www.aabb.org/aabb-store/product/standards-for-blood-banks-and-transfusion-services-33rd-edition--print-15998348. Last accessed June 15, 2024.

160. Wheeler AP. Recent developments in the diagnosis and management of severe sepsis. *Chest*. 2007;132:1967-1976.

161. Evans T. Diagnosis and management of sepsis. *Clin Med*. 2018;18(2):146.

162. Society of Critical Care Medicine. Hour-1 Bundle. Available at https://www.sccm.org/getattachment/SurvivingSepsisCampaign/Guidelines/Adult-Patients/Surviving-Sepsis-Campaign-Hour-1-Bundle.pdf?lang=en-US. Last accessed June 15, 2024.

163. Dellinger RP, Levy MM, Rhodes A, et al.; Surviving Sepsis Campaign Guidelines Committee including the Pediatric Subgroup. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock, 2012. *Intensive Care Med.* 2013;39:165-228.

164. Rhodes A, Evans LE, Alhazzani W, et al. Surviving Sepsis Campaign: international guidelines for managing sepsis and septic shock 2016. *Intensive Care Med.* 2017;43(3):304-377.

165. Society of Critical Care Medicine. Surviving Sepsis Campaign Guidelines 2021. Available at https://www.sccm.org/Clinical-Resources/Guidelines/Guidelines/Surviving-Sepsis-Guidelines-2021. Last accessed June 15, 2024.

166. Azuhata T, Konoshita K, Kawano D, et al. Time from admission to initiation of surgery for source control is a critical determinant of survival in patients with gastrointestinal perforation with associated septic shock. *Crit Care.* 2014;18:R87.

167. Ferrer R, Artigas A, Levy MM, et al. Improvement in process of care and outcome after a multicenter severe sepsis education program. *JAMA.* 2008;299(19):2294-2303.

168. Kumar A, Roberts D, Wood K, Light B, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. *Crit Care Med.* 2006;34(6):1589-1596.

169. Dellinger RP, Levy MM, Carlet JM, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2008. *Intensive Care Med.* 2008;34(1):17-60.

170. Paul M, Lador A, Grozinsky-Glasberg S, Leibovici L. Beta lactam antibiotic monotherapy versus beta lactam-aminoglycoside antibiotic combination therapy for sepsis. *Cochrane Database Syst Rev.* 2014;1:CD003344.

171. Bloos F, Thomas Rüddel D, Rüddel H, et al. MEDUSA Study Group: impact of compliance with infection management guidelines on outcome in patients with severe sepsis: a prospective observational multi-center study. *Crit Care.* 2014;18:R42.

172. Karvellas CJ, Abraldes JG, Zepeda-Gomez S, et al. Cooperative Antimicrobial Therapy of Septic Shock (CATSS) Database Research Group. The impact of delayed biliary decompression and anti-microbial therapy in 260 patients with cholangitis-associated septic shock. *Aliment Pharmacol Ther.* 2016;44:755-766.

173. De Backer D, Aldecoa C, Mjimi H, Vincent JL. Dopamine versus norepinephrine in the treatment of septic shock: a meta-analysis. *Crit Care Med.* 2012;40:725-730.

174. Hollenberg SM, Ahrens TS, Annane D, et al. Practice parameters for hemodynamic support of sepsis in adult patients: 2004 update. *Crit Care Med.* 2004;32(9):1928-1948.

175. LexiComp Online. Available at https://online.lexi.com/lco/action/login. Last accessed June 15, 2024.

176. Annane D, Bellissant E, Bollaert PE, Briegel J, Kupfer Y. Corticosteroids for treating sepsis. *Cochrane Database Syst Rev.* 2015;12:CD002243.

177. Annane D, Bellissant E, Bollaert PE, et al. Corticosteroids for treating sepsis in children and adults. *Cochrane Database Syst Rev.* 2019;(12):CD002243.

178. Annane D, Pastores SM, Rochwerg B, et al. Guidelines for the diagnosis and management of critical illness-related corticosteroid insufficiency (CIRCI) in critically ill patients (Part I). Society of Critical Care Medicine (SCCM) and European Society of Intensive Care Medicine (ESICM) 2017. *Crit Care Med.* 2017;45(12):2078-2088.

179. U.S. Food and Drug Administration. FDA Drug Safety Communication: Voluntary Market Withdrawal of Xigirs [Drotrecogin Alfa (Activated)] Due to Failure to Show a Survival Benefit. Available at https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-voluntary-market-withdrawal-xigris-drotrecogin-alfa-activated-due. Last accessed June 15, 2024.

Evidence-Based Practice Recommendations Citations

McDonald LC, Gerding DN, Johnson S, et al. Clinical practice guidelines for *Clostridium difficile* infection in adults and children: 2017 update by the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA). *Clin Infect Dis.* 2018;66(7):e1-e48 Available at https://www.idsociety.org/practice-guideline/clostridium-difficile. Last accessed June 15, 2024.

Association of periOperative Registered Nurses. Guideline Summary: Cleaning and Care of Surgical Instruments. Available at https://apic.org/Resource_/TinyMceFileManager/Implementation_Guides/9_AORNGuidelineSummaryCleaning&CareofSurgicalInstruments.pdf. Last accessed June 15, 2024.

Centers for Disease Control and Prevention. Updated CDC recommendations for the management of hepatitis B virus-infected health-care providers and students. *MMWR.* 2012;61(RR3):1-12. Available at https://www.cdc.gov/mmwr/PDF/rr/rr6210.pdf. Last accessed June 15, 2024.