Healthcare-Associated Infections: Preventing the Preventable
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About the Author/Editor

Diana Harland, BS, CCRC, received her degree in microbiology from the University of Texas at El Paso. She worked in preclinical research in retrovirology while in undergraduate school and again after graduation at the Texas Biomedical Research Institute (formerly Southwest Foundation for Biomedical Research) in San Antonio, Texas. While at the Southwest Foundation, she worked in the Department of Virology and Immunology at biosafety level 3-4 (BSL-3/BSL-4). She has extensive training in NIH, OSHA, and CDC guidelines for sterility and asepsis in tissue culture and retrovirology. She holds a certificate in bioterrorism from Tulane University School of Public Health and Tropical Medicine and the University of Alabama at Birmingham School of Public Health. She is a member of the Austin Disaster Relief Network (infrastructure for the city of Austin, Texas, disaster response) and the Association for Clinical Research Professionals.

Editing done by Cheryl Duksta, RN, ADN, M.Ed., a critical care nurse in an intermediate care unit in Austin, Texas. Cheryl is an active member of the American Association of Critical-Care Nurses (AACN) Greater Austin chapter. A master’s prepared teacher and former public school teacher, she frequently serves as a continuing education facilitator. She has 15 years of experience in education and medical publishing, including writer and editor at the National Center of Continuing Education.

Purpose and Goals

The goal of this course is to educate healthcare professionals in the fundamental aspects of HAIs, with concentration on the most common HAIs, their associated risk factors, and the measures necessary to prevent and control them.

Objectives

1. Define healthcare-associated infection (HAI).
2. Paraphrase important societal ideas in the history of HAIs.
3. Summarize the risk factors for HAIs.
4. Explain how HAIs are transmitted.
5. Describe the causes, symptoms, risk factors, treatment, and prevention techniques for the most common HAIs.
6. Relate the risk factors for HAI in long-term care facilities (LTCFs).
7. Recognize the challenges LTCFs face regarding HAIs.
8. Compare resident flora, transient flora, and colonization.
9. Outline proper handwashing technique.
10. Differentiate various types of personal protective equipment.
11. Describe the types of transmission-based precautions and clinical practice guidelines for use.

Introduction

Recent medical advances save countless lives each year in the United States, but they have come with a price. Procedures and medications that help heal many patients also put them at risk for serious and sometimes deadly infections. Healthcare-associated infections (HAIs), also known as nosocomial infections, hospital-acquired infections, and hospital-onset infections, are infections acquired by patients while they are in a healthcare facility and receiving care and treatment for another condition. HAIs are those infections that manifest 48 hours after a patient has been admitted to a hospital or other healthcare facility. Patients who have been discharged from a healthcare facility can also have a HAI if the causative organism was contracted during their stay in the facility.

The encouraging news is that HAIs can be prevented. Campaigns by health agencies and hard work of healthcare staff have helped in national efforts to eliminate all cases of HAI. But more work remains to be done. Wherever patient care is provided, knowledge about commonly transmitted microbes and adherence to infection prevention guidelines is needed to ensure that all care is safe care.

The Cost of HAIs

Americans visit physicians and hospitals about 1 billion times each year. According to the Centers for Disease Control and Prevention (CDC), 1 in 20, or 5%, of these hospitalized patients will contract a HAI. This represents about 2 million infections per year. According to a 2009 Direct Medical Cost Report released by the CDC, the overall annual direct medical costs of HAIs to U.S. hospitals ranges from $28.4–$33.8 billion for urban consumers and $35.7–$45 billion for inpatient hospital services.

HAIs are responsible for significant morbidity and mortality, as well as the cost and suffering associated with unanticipated infection, additional diagnostic and therapeutic interventions, and extended hospital stays. Also cited in the CDC’s Direct Medical Cost Report is the number of deaths from HAIs in hospitals alone—approximately 90,000 per year. Estimates of HAIs and their annual cost to U.S. hospitals are shown in Table 1.

History of HAIs

In England in the 1830s, the term hospitalism was coined by Sir James Simpson to describe HAIs. In those days, it was believed that infection was spread because of inadequate ventilation and stagnant air. To prevent infection, windows were opened, and whenever possible care was taken to prevent overcrowding of hospital rooms. Little was

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Table 1

<table>
<thead>
<tr>
<th>Device-related Infections</th>
<th>Number of Infections</th>
<th>National Cost Billion $</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary tract infections</td>
<td>560,000</td>
<td>0.4-0.5</td>
<td>8,000</td>
</tr>
<tr>
<td>Bloodstream infections</td>
<td>250,000</td>
<td>2-8</td>
<td>31,000</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>250,000</td>
<td>5-7</td>
<td>36,000</td>
</tr>
<tr>
<td>Procedure-related infections</td>
<td>Surgical site infections</td>
<td>290,000</td>
<td>3-8</td>
</tr>
</tbody>
</table>

Source: CDC (2009).
known about microbes and their pathogenicity, and consequently little was done about personal hygiene. In Victorian society, the idea of one’s personal hygiene being connected to infection was taken personally and was met with great resistance.

Despite the efforts of medical personnel, many patients died of overwhelming sepsis following preventable infections. In the late 1860s after much persistence, Joseph Lister, a British surgeon, introduced the concept of antisepsis, which significantly decreased death from postoperative infection. After penicillin was introduced in 1941, postsurgical infection rates and deaths from postsurgical pneumonia were both dramatically decreased.

Today, modern medicine has brought a more thorough understanding of pathogens and the epidemiology of the diseases they cause. Unfortunately, in spite of the vast amounts of medical advances that have occurred over the years, the healthcare industry is still faced with the enormous task of preventing and reducing the risk of HAIs.

**Risk Factors for and Transmission of HAIs**

Harmful microbes are all around us, and although infection poses a threat to everyone, certain people are more at risk of infection. For example, people in healthcare facilities are more at risk than those in the community simply because they are exposed to others who are infected with disease-causing organisms. Even more at risk are special populations of patients, such as those with compromised immune systems, those who have undergone recent surgery, those with poor nutritional status, and those with open wounds. Patients undergoing certain medical procedures, such as intubations and central lines, are also at increased risk. Medical devices also carry a risk of infection. Urinary catheters, central lines, mechanical ventilation equipment, and surgical drains all put patients at risk for infection. Further, certain medications and various chemotherapies weaken patients’ immune systems, leaving patients more vulnerable to infection. The length of time spent in a healthcare facility also affects the risk of infection. The longer the stay, the greater a patient’s chances of acquiring a HAI.

To understand the full picture of risk, nurses need to understand how microbes are transmitted in healthcare facilities. The most common method of transmission is by direct contact with an infectious microorganism. Sputum, blood, and feces are common vehicles for microbe transmission. Healthcare workers and patients spread microbes via droplets generated by talking, sneezing, or coughing. Small particles of evaporated droplets (droplet nuclei) and dust particles carry microorganisms and spread infection over long distances.

Infection can also be spread through inanimate objects known as fomites, such as improperly sterilized medical equipment that is used on more than one patient. Healthcare workers who move from patient to patient carry infectious organisms on their clothes, stethoscopes, and phones. Other modes of transmission include the spread of infectious agents through food and water or through vectors, such as mosquitoes, flies, and rats.

**Common Types of HAIs**

Healthcare facilities, including hospitals, acute care facilities, and long-term care facilities, contain many organisms and methods of transfer of bacteria; however, certain infections occur more frequently than others in healthcare environments. In this course, the most common infections, as well as the most virulent, are discussed.

**Catheter-Associated Urinary Tract Infections**

Catheter-associated urinary tract infections, or CAUTIs, are the most common type of HAI, representing more than 30% of all hospital-reported infections. CAUTIs are the leading cause of secondary, hospital-acquired bloodstream infections (about 17% of hospital-acquired bacteremias), and the mortality associated with these infections is about 10%.

The most common pathogens causing CAUTIs are *E. coli*, *Candida* spp., *Enterococcus* spp., *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Enterobacter* spp. Pathogens may gain access to the urinary system during insertion, manipulation, maintenance, or removal of a urinary catheter. Pathogens enter the urinary tract via the extraluminal route, by moving along the outside of the catheter in the periurethral mucous sheath, or the intraluminal route, by moving along the internal lumen of the catheter from a contained collection bag or catheter drainage tube junction.

Studies show that by the 30th day of catheterization, which is also considered the demarcation between short- and long-term catheterization, the daily risk of bacteriuria approaches 100%. Over time, a thin layer of microorganisms along with their DNA, proteins, and polysaccharides (known as extra-cellular polymorphic substances or EPS) form a biofilm on the surface of the catheter (see Figure 1). The longer the catheter remains in place, the greater the chance of biofilm production and thus urinary tract infection. Microbes composing a biofilm are tightly bound to the surface of the catheter and extremely resistant to antimicrobial therapy, making removal of the catheter necessary to effectively eliminate the infection.

**Figure 1.** Electron micrograph showing biofilm formation by *Staphylococcus aureus* bacteria on the inside lumen of an indwelling catheter. Source: CDC Public Health Image Library PHIL #7483, photo credit Janice Haney Carr, CDC.

Although anyone with a urinary catheter can suffer a urinary tract infection, certain people are more at risk, including women, older adults and those with prolonged catheterization. Medical conditions that increase the risk of a CAUTI include diabetes, diarrhea, renal insufficiency, and a compromised immune system. Colonization of the catheter drainage bag can also increase a patient’s risk for a CAUTI.

Symptoms of CAUTI are often nonspecific. Patients may have fever and leukocytosis. To diagnose a CAUTI after a catheter has been removed, urine cultures are obtained from a clean-catch midstream specimen. When a catheter has been in place longer than 2 weeks, the catheter should be replaced first, and then the urine specimen should be obtained from the new catheter. In some cases, removal of the catheter may be the only necessary treatment. If asymptomatic bacteriuria continues after the catheter has been removed for 48 hours, antibiotic treatment may be necessary. Duration of treatment is generally 7–14 days.

To help prevent CAUTIs, the CDC recommends healthcare workers follow these guidelines:

- Insert catheters only for the appropriate indications and minimize their use in those at high risk of CAUTIs, especially the elderly, women, and immunocompromised patients.
- Leave catheters in place only for as long as
needed. Remove catheters on postoperative patients as soon as possible, preferably within 24 hours unless there are appropriate indications for continued use.

- Avoid use of urinary catheters in patients and nursing home residents for the management of incontinence.
- Ensure that only properly trained persons insert and maintain catheters.
- Insert catheters using aseptic technique and sterile equipment. Use proper CDC hand hygiene and standard or appropriate isolation precautions (see discussion of these topics later in this course) when inserting or handling catheters. Perform hand hygiene immediately before and after insertion or any manipulation of the catheter site or device.
- Maintain a closed drainage system with unobstructed urine flow. Urinary catheter systems with preconnected, sealed catheter-tubing junctions are suggested for use.
- Do not clamp indwelling catheters prior to removal and do not change indwelling catheters or drainage bags at routine intervals. Catheters and drainage bags should be changed based on clinical indications, such as infection, obstruction, or when the closed system is compromised.
- Avoid use of systemic antimicrobials for routine prophylaxis of CAUTIs unless clinical indications exist. Routine screening of catheterized patients for asymptomatic bacteriuria is not recommended.
- Unless obstruction of the catheter is suspected, do not irrigate the bladder.
- Do not clean the periurethral area with antiseptics to prevent a CAUTI while the catheter is in place or instill antiseptic or antimicrobial solutions into the drainage bag. Routine hygiene (e.g., cleansing of the exposed tubing during daily bathing) is appropriate.

In addition, facility-wide quality improvement programs should be implemented to ensure appropriate use of indwelling catheters and reduce the risk of CAUTI. Nurses can assist in risk-reduction and surveillance measures by providing regular feedback of unit-specific CAUTI rates and considering alternatives to indwelling urinary catheterization.

Central Line–Associated Bloodstream Infections

Perhaps the most deadly HAI, central line–associated bloodstream infections (CLABSIs) are transmitted via a central venous catheter (CVC) directly to a patient’s bloodstream. A CVC is any intravascular catheter that terminates at or close to the heart or in one of the great vessels and is used for infusion of medications, nutrition, and blood; withdrawal of blood; hemodialysis access; and hemodynamic monitoring. CVCs may be placed in the large veins of the chest (through axillary or subclavian veins), the neck (through the internal jugular vein), or the groin (through the femoral vein).

The CDC defines a CLASI as recovery of a pathogen from a blood culture (a single blood culture for organisms not commonly present on the skin and two or more blood cultures for organisms commonly present on the skin) in a patient who had a central line at the time of infection or within the 48-hour period before infection. The infection cannot be related to any other infection the patient might have and must not have been present or incubating when the patient was admitted to the healthcare facility.

Tens of thousands of CLABSIs occur in U.S. hospitals each year, with deadly results: Up to 25% of those diagnosed with a CLASI will die from the infection. The cost of a CLASI is also profound, with an estimated medical cost of more than $16,000. Fortunately, in the United States the number of ICU patients diagnosed with CLABSIs fell from 43,000 in 2001 to 18,000 in 2009. However, a significant number of these infections continue to occur in inpatient settings and in hemodialysis facilities, even though most CLABSIs, especially those occurring in ICUs, are preventable.

To prevent CAUTIs, the Centers for Disease Control and Prevention (CDC) recommends that hospitals follow the guidelines below:

- Choose proper central line insertion sites that minimize infections and mechanical complications. Avoid the femoral site in adult patients.
- Follow proper insertion practices, including complying with hand hygiene recommendations; using maximum sterile barrier precautions, including mask, cap, gown, sterile gloves, and a sterile full-body drape; performing adequate skin antisepsis with > 0.5% chlorhexidine with alcohol; and covering the site with sterile gauze or sterile, transparent, semi-permeable dressings.
- Perform daily audits to determine if a central line is still needed, and remove unnecessary central lines.

The type of material the catheter is made from also affects infection transmission. The rate of infection for polytetrafluoroethylene (Teflon®) and polyurethane catheters is lower than that of catheters made from polyvinylchloride or polyethylene. Infection risk is also increased in patients with concurrent infection and those treated in the ICU.

Symptoms of a CLASI may include fever, chills, hypotension, and pain or erythema at the catheter site. Diagnosis is made based on signs and symptoms in conjunction with lab confirmation of a recognized pathogen cultured from one or more blood cultures, with the cultured pathogen not being related to an infection at another site. Treatment of CLASI includes a multilevel approach: administration of an empiric antibiotic, such as vancomycin; isolation of the causative organism with narrowing of the antibiotic choice; and determination of whether to remove the infected catheter. Patients in an immunocompromised state and those with severe illness, sepsis, a femoral catheter, or an infection with a suspected multidrug-resistant organism may require additional empiric antibiotics until lab results are available.

Prevention is key to eliminating CLABSIs in healthcare facilities. The CDC recommends that healthcare professionals follow these guidelines to reduce CLABSIs in the workplace:

- Choose proper central line insertion sites that minimize infections and mechanical complications. Avoid the femoral site in adult patients.
- Follow proper insertion practices, including complying with hand hygiene recommendations; using maximum sterile barrier precautions, including mask, cap, gown, sterile gloves, and a sterile full-body drape; performing adequate skin antisepsis with > 0.5% chlorhexidine with alcohol; and covering the site with sterile gauze or sterile, transparent, semi-permeable dressings.
- When accessing the line, scrub the hub/port with an appropriate antiseptic (e.g., chlorhexidine, povidone iodine, an iodophor, or 70% alcohol) and access lines only with sterile devices.
- Replace dressings that are wet, soiled, or dislodged. When changing dressings, use aseptic technique, including clean and sterile gloves, as per facility policy.
- Perform daily audits to determine if a central line is still needed, and remove unnecessary central lines.
thus maintain sterility and aseptic technique. Facilities should also consider implementing chlorhexidine bathing of ICU patients and use of antimicrobial-impregnated catheters and chlorhexidine-impregnated dressings.

**Surgical Site Infections**

Anytime the skin barrier is broken, the risk for infection rises, so it is only logical that surgery will increase a patient’s risk for a HAI. Surgical site infections (SSIs) occur at the location where a surgery was previously performed. To be diagnosed as a SSI, the infection must occur within 30 days of surgery if no implant is left in place or within 1 year if the implant is in place and the infection appears to be related to the operative procedure. SSIs occur in 2–5% of surgeries and number about 300,000 per year. The CDC estimates costs for SSIs to be $3,000–$29,000 per infection, with 7–10 additional days of hospital stay per patient, and an overall cost to the healthcare industry of $10 billion annually.

SSIs vary in severity. They may be superficial incisional infections, which involve only the skin and subcutaneous tissue at the incision site, or they may be deep incisional infections, which occur in the deep soft tissues of the muscle or fascia. An organ or space SSI occurs in any part of the body (excluding skin, muscle, and fascia) that is opened or manipulated during the operative procedure.

Pathogens responsible for SSIs may originate from the patient’s skin, mucous membranes, or gastrointestinal tract, or they may be transmitted via hospital personnel, the hospital environment, or medical devices and surgical tools. Common causative organisms include *Staphylococcus aureus*, coagulase negative staphylococci, *Enterococcus* spp., *Escherichia coli*, *Pseudomonas aeruginosa*, and *Enterobacter* spp.

Many factors increase the risk of SSIs. Long surgeries (duration greater than 2 hours), emergency surgery, and abdominal surgery carry a higher infection risk as does preoperative shaving of the surgical site. Older adults, obese people, and those with diabetes, a concurrent disease, or a compromised immune system are at greater risk for SSIs. Colonization of the nares with *Staphylococcus aureus* creates an increased risk for SSI, as do radiation, chemotherapy, steroid use, and smoking.

Symptoms of a SSI may include erythema, pain, tenderness, edema, heat, and abscess formation or purulent discharge at the surgery site. The patient may also be febrile. Treatment may include drainage of abscesses, surgical debridement, decolonization strategies, and appropriate antibiotic therapy.

To prevent SSIs, the CDC issued the following recommendations for healthcare professionals:

**Prior to Surgery**

- Administer prophylactic antibiotics in accordance with evidence-based standards and guidelines. Appropriate agents should be selected on the basis of surgical procedure, the most common SSI pathogens for the procedure, and published recommendations. These medications should be administered within 1 hour prior to incision; vancomycin and fluoroquinolones should be given 2 hours prior.
- Whenever possible, identify and treat remote infections before elective surgery, or postpone surgery until the infection has resolved.
- Prep skin using an appropriate antiseptic agent and proper technique. Do not remove hair at the operative site unless it will interfere with the operation. If hair must be removed, razors should not be used. Clip hair or use a depilatory agent.
- For colorectal surgery patients, mechanically prepare the colon (enemas, cathartic agents) and administer nonabsorbable antimicrobial agents given in divided doses on the day prior to surgery.
- If your patient is undergoing elective cardiac and other procedures (i.e., orthopedic, neurosurgery procedures with implants), perform a nasal screen and decolonize only *S. aureus* carriers with preoperative mupirocin therapy.
- Screen preoperative blood glucose levels and maintain tight glucose control postoperative day 1 and day 2 in patients undergoing elective procedures (e.g., bypass surgeries, arthroplasties, spinal fusions).

**During Surgery**

- Keep operating room doors closed during surgery except as needed for passage of equipment, personnel, and the patient.
- Consider redosing antibiotics at the 3-hour interval in procedures lasting longer than 3 hours and adjust the antimicrobial prophylaxis dose for patients with a body mass index greater than 30.
- Consider using at least 50% fraction of inspired oxygen intraoperatively and immediately postoperatively in select procedures.

**After Surgery**

- Protect the primary closure incision with a sterile dressing for 24–48 hours postop.
- Maintain immediate postoperative normothermia.
- For cardiac surgeries, control blood glucose levels during the immediate postoperative period. Glucose level should be measured at 6:00 a.m. on postop day 1 and day 2 (procedure day is postop day 0). Postop glucose level should be maintained at < 200mg/dL.
- Discontinue antibiotics according to evidence-based standards and guidelines (within 24 hours after surgery end time, or 48 hours for cardiac surgeries).

**Ventilator-Associated Pneumonia**

Ventilator-associated pneumonia (VAP) is an infection of the lungs that develops after a person has been on a ventilator for longer than 48 hours. The most common type of HAI contracted in the ICU, VAP occurs in as many as 28% of patients who have had mechanical ventilation. Infection occurs because the endotracheal or tracheostomy tube allows passage of microbes into the lungs. These organisms may originate from the patient’s aspirate, from the oropharynx and digestive tract, or from external sources, such as contaminated equipment and medications.

Although any microbe can be the causative agent, certain microbes are most often implicated due to increasing drug resistance. *Pseudomonas aeruginosa* is the most common multidrug-resistant organism responsible for VAP. Other microbes that cause VAP include *Staphylococcus aureus*, *Klebsiella* spp., *Escherichia coli*, *Enterobacter* spp., *Actinobacter* spp., MRSA, and *Serratia marcescens*. Pneumonia is considered early in onset if it occurs within the first 4 days after hospital admission. Multidrug resistant organisms are more likely to be the cause of late-onset pneumonia, defined as 5 or more days postadmission.

In addition to recent ventilation, other risk factors increase a patient’s chance of acquiring VAP, such as hospitalization or antibiotic use within the past 90 days, hospital stay greater than 5 days, hemodialysis within the past 30 days, and known circulation of multidrug-resistant organisms in the facility. Immuno-compromised residents and those who reside in a nursing home or long-term care facility are also at greater risk for VAP.

Symptoms of VAP include fever, a decline in oxygenation, leukocytosis, and purulent sputum. Diagnosis of VAP is made based on comprehensive medical history, presence of infiltrates on x-ray, and positive culture of lower
respiratory tract secretions (colonization of the trachea is common; thus a positive culture may not distinguish a pathogen from a colonizing organism). Symptoms of ventilator associated tracheobronchitis (VAT) with purulent secretions can mimic symptoms of VAP. VAT is a condition midway between colonization and VAP and requires antibiotic treatment.

Treatment should not be delayed while diagnostic tests are pending. Empiric treatment is vital in patients with suspected VAP and can be based on patient risk factors for multidrug-resistant organisms, known local prevalence of resistant organisms, severity of infection, and total number of days the patient was hospitalized before the onset of pneumonia. Criteria for empiric treatment include a new or progressive infiltrate on x-ray and at least two of the following conditions: fever greater than 38°C, leukocytosis or leukopenia, and purulent respiratory secretions.

If the patient has received recent doses of antibiotics, a different class of antibiotics should be used for treatment. Therapy should later be adjusted based on culture results. Unless diagnostic testing shows otherwise, initial empiric therapy should not be changed in the first 48 to 72 hours because clinical response to antibiotic therapy is not likely during this time frame. Patients should be treated with antibiotic therapy for at least 72 hours after a clinical response is attained. (For specific antibiotics and dosages, see the Infectious Disease Society of America practice guidelines for patient care at www.idsociety.org.)

To prevent VAP, the CDC recommends the following strategies:

**Strategies to Prevent Aspiration**
- Maintain patients in a semirecumbent position.
- Avoid gastric overdistention.
- Avoid unplanned extubation and reintubation.
- Use a cuffed endotracheal tube with inline or subglottic suctioning.
- Maintain an endotracheal cuff pressure of at least 20 cm water.

**Strategies to Reduce Colonization of the Aerodigestive Tract**
- When possible, use orotracheal intubation rather than nasotracheal intubation.
- Avoid histamine receptor 2 (H2)—blocking agents and proton pump inhibitors for patients who are not at high risk for developing a stress ulcer or stress gastritis.
- Perform regular oral care with an antiseptic solution.

**Strategies to Minimize Contamination of Equipment**
- Use sterile water to rinse reusable respiratory equipment.
- Remove condensate from ventilatory circuits, keeping the ventilatory circuit closed while you do so.
- Change the ventilatory circuit only when visibly soiled or malfunctioning.
- Store and disinfect respiratory therapy equipment properly.

In addition to these strategies, healthcare professionals should perform daily assessments of readiness to wean to minimize the duration of ventilation. Whenever possible, use noninvasive ventilation methods.

### Clostridium difficile Infection

_Clostridium difficile_ infection (CDI), or _Clostridium difficile_-associated disease (CDAD), is an infection of the intestines caused by the anaerobic, spore-forming, gram-positive bacillus _C. difficile_. (Figure 2)This microbe was first identified in 1935 when it was isolated from the stools of neonates. _C. difficile_ produces heat-resistant spores that can remain viable on fomites in the environment for years, becoming a source of outbreaks in healthcare facilities. This bacillus also produces two types of toxins: Toxin A (an enterotoxin) and Toxin B (a cytotoxin). These toxins are responsible for the inflammatory responses of the colon, which results in loss of epithelial integrity and the production of watery diarrhea. _C. difficile_ is the most common cause of antibiotic-associated diarrhea and pseudomembranous colitis and has proved extremely difficult to control due to new, more resistant strains.

![Figure 2. _C. difficile_ taken from a stool sample culture. Source: CDC Public Health Image Library PHIL #9999, photo credit Janice Haney Carr, CDC.](image)

_C. difficile_ is found in the intestinal tract of up to 70% of healthy infants, 1–3% of healthy adults, and in higher rates (up to 20%) in persons on antibiotic therapy. Prevalence, severity, colectomy rates, and mortality rates due to _C. difficile_ have all risen in the past two decades, proving that this microbe has become an extremely virulent superbug that is both persistent and difficult to treat. Surveillance data from the CDC show that between 2000 and 2007 mortality from _C. difficile_ increased by 400% due to a more virulent strain of this organism.

Studies of hospital-acquired CDI have shown that the infection is independently associated with increased risk of in-hospital death: For every 10 hospital patients who acquire a CDI, 1 patient died. Data from the CDC show that _C. difficile_ is responsible for 337,000 infections and 14,000 deaths in the United States each year.

The greatest risk factor for CDI is the use of antibiotics, such as cephalosporins, clindamycin, or the penicillins, because these antibiotics kill the normal flora of the colon, causing overgrowth of _C. difficile_. Risk is increased for those taking multiple antimicrobials and those who take antimicrobials for longer time periods. Other risk factors for CDI include advanced age. Although almost half of the infections occur in persons younger than 65, most CDI-related deaths occur in the elderly. People with HIV infection, compromised immune systems, and compromised physical status are also at increased risk for CDI. Hospital admission increases one’s chance of acquiring CDI, as does gastrointestinal surgery.

Transmission of CDI occurs by the fecal-oral route. Figure 3 portrays an example of how CDI is spread among healthcare facilities.

The time between exposure to _C. difficile_ and infection is 2 to 3 days. Symptoms of CDI vary greatly, ranging from asymptomatic to mild (fever, malaise, and gastrointestinal symptoms, including abdominal pain and cramps, and mild to moderate foul-smelling diarrhea that is rarely bloody) to extremely severe toxic megacolon, septic shock, and even death. Complications of _C. difficile_ include pseudomembranous colitis or fulminant colitis.

Diagnosis is based on clinical history (antibiotic use in the previous 2 months, diarrhea after 72 or more hours of hospitalization), and presence of _C. difficile_ in the stool. Stool culture is the most sensitive test and is often used for diagnosis in the hospital setting. Colonoscopy revealing histopathology with pseudomembranous colitis is also diagnostic but not necessary in most cases.

Treatment for CDI begins with discontinuation of the antibiotic causing the infection. In many cases, this step is the only necessary treatment since normal flora can reestablish in the colon. If mild to moderate diarrhea
George, a 68-year-old man, goes to the doctor’s office and is diagnosed with pneumonia. He is prescribed antibiotics, drugs that put him at risk for C. difficile infection for several months.

1 Month Later
George breaks his leg and goes to a hospital. A healthcare worker spreads C. difficile to him after forgetting to wear gloves when treating a C. difficile–infected patient in the next room.

2 Days Later
George transfers to a rehabilitation facility for his leg and gets diarrhea. He is not tested for C. difficile. The healthcare worker doesn’t wear gloves and infects other patients.

3 Days Later
George goes back to the hospital for treatment of diarrhea and tests positive for C. difficile. He is started on specific antibiotics to treat it. Healthcare workers wear gloves and do not spread C. difficile. George recovers.

Figure 3. How C. difficile spreads. Source: CDC Vital Signs, March 2012, http://www.cdc.gov/vitalsigns/hai/?s_cid=bb-vitalsigns-115#.

C. difficile persists, patients can be treated with either metronidazole or vancomycin. In cases of severe diarrhea, vancomycin is the drug of choice for treatment due to its history of rapid symptom resolution and overall fewer treatment failures. Although antibiotic treatment will clear the infection, it will not kill the bacterial spores. In 27% of cases, relapse occurs within 3 weeks of antibiotic termination. In extreme cases, colectomy with end ileostomy may be necessary. Treatment for asymptomatic cases is not recommended.

An innovative CDI treatment may be on the horizon. Researchers have shown that C. difficile infection arises as the result of the disruption of natural flora in the intestines, a condition known as dysbiosis. New research in the treatment of CDI involves isolating specific gut bacteria in the fecal matter of healthy individuals and incorporating it into the gut of a person with CDI to restore normal flora and cure the infection.

CDI can be catastrophic to patients and indeed to entire healthcare facilities if an outbreak occurs. To prevent CDI, follow these guidelines from the CDC:

- Immediately isolate patients with confirmed C. difficile infection and use contact precautions for the duration of diarrhea. Consider extending precautions beyond the duration of diarrhea and using presumptive contact precautions for patients with diarrhea pending confirmed C. difficile diagnosis.
- Educate healthcare personnel, patients, their families, and any visitors about C. difficile and help them maintain contact precautions.
- Follow proper handwashing techniques. Hand hygiene for C. difficile must include vigorous washing of hands with soap and water to mechanically remove spores. Alcohol-based hand rubs are not effective against C. difficile.
- Because C. difficile spores can survive on objects for long periods of time, it is important to thoroughly clean and disinfect equipment and objects in the environment. Consider use of sodium hypochlorite (bleach)–containing agents or EPA-registered disinfectants with sporicidal claim for environmental cleaning.
- Enact a laboratory-based alert system for immediate notification of positive test results.

MRSA Infection

Methicillin-resistant Staphylococcus aureus (MRSA), also known as multidrug resistant S. aureus, includes any strain of S. aureus that has become resistant to the group of antibiotics known as beta-lactam antibiotics (see Figure 4). Included in this group are the penicillins (methicillin, amoxicillin, oxacillin) and cephalosporins. Staphylococcus aureus includes gram-positive, nonmotile, non-spor-forming cocci that can be found alone, in pairs, or in grapelike clusters.

When penicillin was first introduced in the early 1940s, it was considered to be a wonder drug because it reduced the death rate from Staphylococcus infection from 70% to 25%. Unfortunately, by 1944, drug resistance was beginning to occur, so methicillin was synthesized, and, in 1959, it became the world’s first semisynthetic penicillin. Shortly thereafter in 1961, staphylococcal resistance to methicillin began as well, and the name “methicillin-resistant S. aureus” and the acronym MRSA were coined. Although methicillin was discontinued in 1993, the name and acronym have remained because of MRSA history.

MRSA is now the most common drug-resistant infection acquired in healthcare facilities. In addition to becoming more problematic as a top HAI in recent years, transmission of MRSA has also become more common in children, prison inmates, and sports participants. Community-associated MRSA (CA-MRSA) most often presents in the form of skin infections (see Figure 5). Hospital-acquired MRSA (HA-MRSA) infections manifest in various forms, including bloodstream infections, surgical site infections, and pneumonia. Although approximately 25–30% of persons are colonized in the nasal passages with Staphylococcus, less than
becoming resistant to rifampin; therefore, this drug should not be used alone in the treatment of MRSA infections. Consultation with an infectious disease specialist is recommended for treatment of severe MRSA infections.

The CDC recommends healthcare personnel follow these guidelines to help prevent MRSA infections:
- Follow procedures to recognize previously colonized and infected patients.
- Follow appropriate hand hygiene practices and isolation precautions (see discussion on hand hygiene and isolation precautions later in this course). The CDC has not made a recommendation on when to discontinue contact precautions. Healthcare workers should check with their individual institution’s infection control policies.
- Place patients in single rooms, or, if a single room is not available, cohort patients with the same MRSA in the same room or in the same patient care area. If cohorting patients with the same MRSA is not possible, place MRSA patients in rooms with patients who are at low risk for acquisition of MRSA and are likely to have short lengths of stay.
- Keep skin wounds of MRSA patients clean and covered until healed.
- Handle equipment and instruments/devices used for MRSA patients appropriately, with care and attention to disinfection according to institution infection control policy. Ensure that equipment is properly cleaned and disinfected before being used with another patient.

**Vancomycin-Resistant Enterococci Infection (VRE)**

Enterococci (formerly known as Group D streptococci) are non-spore-forming, gram-positive cocci that exist in either pairs or short chains. They are commonly found in the human intestine or the female genital tract. The most common organism associated with vancomycin-resistant enterococci (VRE) infection in hospitals is *Enterococcus faecium*. *Enterococcus faecalis* is also a cause of human disease. VRE infections can occur in the urinary tract, in wounds associated with catheters, in the bloodstream, and in surgical sites. Enterococci are a common cause of endocarditis, intra-abdominal infections, and pelvic infections.

VRE was first reported in Europe in 1986, followed in 1989 by the first report in the United States. Since then it has spread rapidly. Between 1990 and 1997, the prevalence of VRE in hospital patients increased from less than 1% to 15%.

VRE, which is found predominantly in hospitalized or recently hospitalized patients, are difficult to eliminate because they are able to withstand extreme temperatures, can survive for long periods on environmental surfaces, and are resistant to vancomycin. Transmission of VRE occurs most commonly in the form of person-to-person contact by the hands of healthcare workers after contact with the blood, urine, or feces of an infected individual. VRE is also spread from contact with environmental surfaces, or through contact with the open wound of an infected person.

People most at risk for infection with VRE include the elderly and those with diabetes, those with compromised immune systems, and those who are already colonized with the bacteria. Prolonged hospitalization, catheterization (urinary and intravenous), and long-term use of vancomycin or other antibiotics also increase a person’s risk of infection.

Symptoms of VRE infection vary depending on the site of infection and may include erythema, warmth, edema, fever, abdominal pain, pelvic pain, and organ pain. Definitive diagnosis is made by culture and susceptibility testing with specimens obtained from suspected sites of infection. Treatment of VRE infection may include drainage of abscesses; removal of prosthetic devices, IV lines, or catheters; and antibiotic therapy with one or more appropriate antibiotics that show activity against VRE. Consultation with an infectious disease specialist is recommended for treatment of patients with serious infections or VRE that is resistant to other antibiotics.

To prevent infection from VRE, the CDC recommends healthcare professionals use vancomycin prudently and promptly detect and report VRE infections. Healthcare providers in direct contact with patients should follow steps for proper hand hygiene and contact precautions (see the discussion on these topics later in this course).

**Norovirus Infection**

Norovirus (previously known as Norwalk virus) infections are highly contagious gastrointestinal infections caused by a group of single-stranded RNA viruses. Statistics from the CDC show that Norovirus spp. cause 23 million gastroenteritis infections each year in the United States, equaling 60% of all acute gastroenteritis cases.

Risk factors for norovirus infection include improper or unsanitary food handling and improper hand hygiene practices. Those living in close quarters, such as a nursing home, and
those with compromised immune systems are at increased risk of infection.

Norovirus spp. is transmitted primarily by the fecal-oral route, but they can also be transmitted by the droplet route from vomitus. In healthcare facilities, transmission occurs when people touch contaminated objects and surfaces and then touch their mouth. These viruses can spread rapidly because they require a low infectious dose, are easily transmitted, are highly resistant on environmental surfaces, are resistant to chlorine, and can survive freezing and temperatures up to 140°F. The lack of lasting immunity after infection also increases the resistance of the organism.

The incubation period for norovirus infection ranges from 12–48 hours, with the greatest amount of the virus being shed during the first 48 hours of illness. Up to 30% of cases are asymptomatic. When symptoms are present, they can include low-grade fever (50% of cases), fatigue, chills, headache, muscle aches, nausea, vomiting, abdominal cramping, and watery diarrhea (diarrhea is most commonly seen in children; vomiting is most commonly seen in adults). Mild to severe dehydration may also occur. Symptom onset may be very sudden and may last 24–72 hours.

Kaplan’s Criteria

When diagnostic testing is delayed or unavailable, the CDC recommends using Kaplan’s clinical and diagnostic criteria for identifying Norovirus outbreaks:

* Vomiting in more than 50% of symptomatic cases, AND
* Mean or median incubation period of 24–48 hours, AND
* Mean or median duration of illness of 12–60 hours, AND
* No bacterial pathogen isolated from stool culture.

There is no available vaccine against Norovirus. Treatment consists of oral or IV maintenance and replacement of electrolytes and fluid volume. To prevent norovirus infection, the CDC recommends healthcare professionals take the following actions:

* Avoid exposure to vomitus or diarrhea.
* Place patients on contact precautions in single rooms if symptoms are consistent with norovirus infection and keep patients on contact precautions for minimum of 48 hours after symptoms resolve. Patients who cannot be placed in single rooms should be separated from asymptomatic patients (see later discussion of contact precautions).
* Use soap and water for hand hygiene after caring for a patient with known or suspected Norovirus. Research evidence shows that alcohol-based hand sanitizers have little effect in reducing Norovirus and that overreliance on hand sanitizers may put certain institutions at a greater risk for Norovirus outbreaks.
* Suspend group activities (e.g., eating and recreation activities that take place in a common area) for the duration of the outbreak.
* Increase the frequency of cleaning and disinfection in high-touch patient areas (bed rails, door handles, telephones) with an EPA-approved product labeled for disinfection of Norovirus.
* Remove and wash contaminated linens and clothing using appropriate standard precautions.
* If a healthcare employee is infected, exclude the employee from work while symptoms are present and for a minimum of 48 hours after symptoms resolve.
* Ensure that staff care for only one patient cohort and that staff do not move between patient cohorts. Nonessential staff and volunteers should not work in areas with known or suspected Norovirus.

Long-Term Care Facilities

Long-term care facilities (LTCFs), including rehabilitation centers, psychiatric hospitals, and residences for the disabled, differ from acute care hospitals in many ways. They are essentially a home for their residents, but many residents are often transferred between the LTCF and acute treatment hospitals as health needs arise. Because of their nature, LTCFs pose some unique risks for HAIs.

Nursing homes and skilled nursing facilities for the care of the elderly are the most common type of LTCF. In the United States, about 1.5 million people reside in 16,100 nursing homes. It is estimated that 765,000 to 2.8 million of these residents suffer from infections each year. Risk factors for infection are specific in this vulnerable population and include advanced age, incontinence, immobility, lower immunity, dysphagia, age-related skin changes, frequent hospitalizations, malnutrition, and underlying chronic illness.

Because of the compromised nature of these patients, they suffer from a number of HAIs. Urinary tract infections are the most common type of infection reported in LTCFs and can arise due to patient illness or incontinence. Pneumonia, influenza, and lower respiratory tract infections account for significant morbidity and mortality in residents of LTCFs. C. difficile infection is of particular importance in this population as it is the primary cause of diarrhea in nursing homes. Skin, soft tissue, and wound infections are the third most common type of infection in LTCF residents and include infected pressure ulcers and cellulitis, often with group A Streptococci and MRSA. Other infections include viral hepatitis, tuberculosis (TB), and conjunctivitis.

LTCFs face a variety of challenges associated with HAIs. Compared to acute care facilities, nursing homes frequently lack properly trained infection control personnel, and many of these staff members work only part-time on infection control regardless of the size of the facility. Few have a certification in infection control. LTCFs may also have a limited staff, a high staff turnover, problems with funding, and limited information technology (IT) resources, including a computer system that is integrated with diagnostic labs and radiology centers. Nurses in LTCFs must be particularly vigilant in protecting their patients from HAIs.

Enlisting the Help of the Patient and Family

Don’t underestimate the importance of patients and their family members and visitors. With a little education, they can help facilities decrease the spread of infection:

* Educate patients and families on the type of infection diagnosed in the patient, proper hand hygiene, and appropriate precautions, such as contact, droplet, or airborne.
* Keep materials for precautions readily available to visitors, such as gowns, gloves, and masks.
* Encourage all visitors to wash their hands properly before and after visiting with the patient.
* Post instructions on proper handwashing where visitors can see them.
* Keep adequate supplies of hand sanitizer in hallways, near doors, and by elevators and encourage visitors to use them.

Prevention Is Key

The Joint Commission includes infection prevention as one of its National Patient Safety Goals in hospitals, behavioral care facilities, and ambulatory care facilities, as well as home health care. Specifically, the Joint Commission emphasizes handwashing as key to infection prevention. Although hand hygiene and transmission precautions are routine in healthcare facilities, a review of evidence-based practice can remind healthcare professionals of the process of and rationale for these procedures.
Proper Hand Hygiene

Handwashing is the single most effective way to prevent the transmission of infection. To understand the effects of handwashing, it is important to consider the environment on human skin. Microorganisms found on the skin are classified as either resident flora, colonizing flora (normal flora), or transient flora. Colonization is the presence of microorganisms in or on a host with growth and multiplication. A person who carries an organism with no clinical signs or symptoms of disease is said to be colonized with that organism. Resident organisms rarely cause infections unless they are introduced into deep tissues through invasive procedures or if the patient is severely immunocompromised. These organisms are usually aerobic, gram positive, and not easily removed by handwashing. Examples include *Staphylococcus epidermidis* and *Corynebacterium* spp.

Transient flora are organisms that are recent contaminants that survive only a short time, generally fewer than 24 hours on the skin. They readily cause infection and are most frequently associated with HAIIs. These organisms are usually anaerobic, gram negative, and easily removed by handwashing. Examples include streptococci, *E. coli*, *Candida* spp., and *Klebsiella pneumonia*

An overwhelming amount of literature cites inadequate handwashing in the transfer of organisms such as *Staphylococcus, Enterobacteriaceae, Pseudomonas*, and *Klebsiella* in healthcare facilities. Inadequate handwashing also places healthcare workers at risk for viral diseases, such as hepatitis and HIV, and multiple bacterial infections, such as those caused by staphylococci and streptococci.

Various organizations are at work to promote consistent and effective hand hygiene in the healthcare workplace. One agency, the World Health Organization (WHO), created the Five Moments for Hand Hygiene to simplify the timing of handwashing. This handwashing protocol dictates times for hand hygiene within the sequence of patient care to yield the maximum opportunity for patient safety. According to the WHO, the healthcare workers should wash their hands at the following “moments”:

1. Before touching a patient
2. Before a clean or aseptic procedure is begun
3. After exposure to a body fluid
4. After touching a patient
5. After touching patient surroundings

The theory behind this approach is that if handwashing occurs at the precise time it is needed, transmission of microbes will be halted and patient harm will be prevented. Proponents of the WHO approach hope that the methods taught will stick with healthcare workers and handwashing compliance will increase enough to become an unconscious habit.

The CDC recommends appropriate timing and effective materials for handwashing in the following guidelines for hand hygiene during the delivery of healthcare:

- Hands should be washed with either a nonmicrobial soap and water or, in the following situations, with an *antimicrobial soap* and water:
  1. When hands are visibly dirty
  2. When hands are contaminated with blood or body fluids
  3. When hands are contaminated with protein-based substances

4. When there has been contact with spore-forming bacteria, such as *Clostridium difficile* (The physical action of handwashing using friction and running water is more likely to remove the spores. Alcohols, chlorhexidine, and other antimicrobial agents used in antiseptic hand rubs have virtually no activity against spores. It should also be noted that alcohol-based hand sanitizers have virtually no effect on reducing the number of genomic copies of *Norovirus* spp. Hands should be vigorously washed with soap and water when outbreaks of infectious diarrhea or gastrointestinal illness have occurred and *Norovirus* is the known or suspected agent.)

   - When hands are not visibly soiled, or after soil is removed with soap and water, the preferred method of handwashing, or more specifically hand decontamination, is with an alcohol-based hand rub. Hand decontamination with antimicrobial agents (hand asepsis) is indicated for removing or destroying transient organisms. Antibacterial soap and water can also be used. Hands should be decontaminated at the following times:

1. Before direct contact with all patients and before donning gloves and performing invasive procedures
2. After contact with blood, body fluids, excretions, mucous membranes, nonintact skin, or wound dressings
3. After contact with patient intact skin (e.g., when taking blood pressure)

4. During patient care, if hands are moving from a contaminated body site to a clean body site
5. After contact with inanimate objects and medical equipment near the patient (e.g., bedrails, IV pumps, computer keyboards)
6. After removing gloves and other personal protective equipment (PPE)
7. Before preparing or eating food
8. After contact with one’s own body fluids (e.g., nose blowing, sneezing, using the bathroom)

The use of antiseptic hand rub has brought into question the effectiveness of soap and water. Studies show that when hands of healthcare workers are heavily contaminated with pathogens, alcohol-based antiseptic hand rub prevents transmission of the pathogen much more effectively than plain soap and water handwashing. In a study of the transfer of gram-negative bacilli from the hands of nurses to a piece of catheter material, transfer of the bacilli occurred 2 out of 12 times (17%) when an alcohol-based hand rub was used for hand hygiene, compared to 11 out of 12 times (92%) when plain soap and water were used for hand hygiene. For standard handwashing or hand asepsis, the CDC recommends healthcare workers use alcohol-based products over plain soap or antimicrobial soap, except in the cases listed in the guidelines outlined earlier.

How you wash your hands also matters. Proper handwashing technique must be used to decrease the transmission of infection-causing organisms. Simply rinsing one’s hands with cool water and briefly wiping them dry will not reduce the rate of transmission. To reduce the number of transient organisms, hands must be washed with a sufficient amount of product, with the correct technique, and for a sufficient length of time. The following steps should be taken to ensure proper handwashing:

- When using soap and water:
  1. Wet hands and apply a sufficient amount of soap (3 ml).
  2. Rub hands vigorously to create a lather, scrubbing all surfaces of both hands, including backs of hands, wrists, between fingers, and, especially, thumbs and under fingernails. Continue for at least 20 to 30 seconds.
  3. Rinse hands well under running water.
  4. Dry hands with a paper towel, and if possible use the paper towel to turn off the faucet on sinks that do not have foot controls or automatic shut-off sensors.

- When using an alcohol-based hand rub:
  1. Apply the rub to the palm of one hand.
  2. Rub hands together, wetting all surfaces and focusing on fingernails and fingertips.
3. Continue until hands are dry. Drying time should take a minimum of 15–20 seconds if a sufficient amount of rub was applied. If hands are dry in less than 15 seconds, an insufficient amount of product was used. In addition to maintaining, monitoring, and promoting correct hand hygiene, it is also important for healthcare facilities to perform self-assessments on hand hygiene. The Joint Commission (the accrediting agency for more than 19,000 healthcare organizations) in collaboration with the CDC and other organizations outlined the rationale for self-assessment of handwashing in healthcare facilities:

- To assess the performance of staff members and educate them in real time
- To assess an institution’s level and quality of practice for regulatory or accreditation purposes
- To measure an institution’s performance within high-risk patient populations or units
- To assess the impact of a quality improvement program that increases adherence to hand hygiene guidelines
- To compare the performance of an institution to that of other healthcare facilities
- To investigate an outbreak of infection
- To conduct a research project
- To improve patient and family perception of quality of care

Facilities that assess their effectiveness at prevention can analyze their strengths and weaknesses in prevention efforts and revise their practice to reduce infection rates and thus keep patients safe.

**Personal Protective Equipment**

Healthcare professionals are both barriers to and carriers of infection. To avoid distributing infection among patients, healthcare professionals must remain diligent in the use of personal protective equipment, or PPE. Gloves, gowns, shoe covers, caps, masks, respirators, hair covers, face protection, and eye protection are all vital in preventing the spread of infection. Nurses who use PPE effectively help prevent the spread of infection through the touch of a hand, through contact with their uniform, and through air and droplets from their respiratory tract. In turn, they are personally protected against any organisms the patient may carry.

Gloves are the most frequently worn item of PPE. Gloves reduce the opportunity for microbes on healthcare workers’ hands to be spread to patients during care or invasive procedures. Removing gloves between patients prevents the transmission of bacteria from patient to patient. It is important for healthcare professionals to understand that gloves should not be used in place of handwashing. After removing gloves, healthcare professionals should always follow handwashing guidelines.

Gowns and masks also help prevent HAI. Gowns worn in patient rooms and in operating rooms prevent infectious microbes from being carried from patient to patient on healthcare workers’ clothing. Masks are used to prevent microbes from being transmitted via the respiratory tract. In 2011, the Food and Drug Administration (FDA) approved a new type of N95 respirator for single-use that kills methicillin-resistant *Staphylococcus aureus* (MRSA), *Streptococcus pyogenes*, and *Haemophilus influenzae*. This specialty mask incorporates an antimicrobial agent into the fiber of the mask. The mask eliminates 99.99% of bacteria on its surface within 1 hour and traps and kills additional microbes in the mask’s middle filtration layers.

**Transmission-Based Precautions**

The topic of PPE is not complete without a review of contact, droplet, and airborne precautions. Most nurses are familiar with the types of precautions used to prevent infection transmission. Even so, nurses, as well as other healthcare professionals, can become lax in their use of precautions, increasing the incidence of HAI.

Contact precautions are designed to reduce the risk of transmission of infectious organisms by direct or indirect contact with the patient or the patient’s environment. Transmission can occur through direct skin-to-skin contact from an infected person or host or through indirect contact of a susceptible host with a contaminated intermediate object or fomite in the environment. To comply with contact precautions, healthcare professionals should follow these guidelines:

- Wear gowns and gloves for all patient contact or contact with potentially contaminated areas of the patient’s environment (e.g., bedrails, furniture, medical equipment).
- Put on PPE before entering the patient’s room and remove it before leaving the room to contain any potential microbes.
- Whenever possible, patients on contact precautions should be admitted to private rooms. Infection control personnel should be consulted before cohorting patients if a private room is not available.
- Transport patients only when necessary for diagnosis or treatment and weigh the risk of infection against the need for transport.

When transporting a patient, place the patient in a clean gown and cover the patient with linen per facility policy.

Transmission of microbes by droplet involves contact of conjunctivae of the mucous membranes of the nose or mouth of a susceptible person with large particle droplets. Droplets are generated from the source patient primarily during coughing, sneezing, or talking or during certain procedures, such as suctioning and bronchoscopy. Transmission of infection by large particle droplets requires close contact between the source patient and the susceptible host. Droplets do not remain suspended in the air and generally travel only short distances—up to 3 feet. For this reason, special ventilation systems and air handling are not required for droplet precautions. To properly follow droplet precautions, healthcare professionals should follow these guidelines:

- Wear a surgical mask for close contact (within 3 feet) with patients on droplet precautions; respirators are not necessary.
- Admit the patient to a private room, if possible. Infection control personnel should be consulted before cohorting patients if a private room is not available.
- When transporting patients on droplet precautions, place a mask on them and instruct them in proper cough etiquette.

Airborne precautions are designed to prevent transmission of infectious organisms that remain infectious over long distances if they become suspended in the air. Airborne transmission occurs when there is dissemination of either airborne droplet nuclei (small particle residue of evaporated droplets) or dust particles containing the infectious agent. Airborne organisms are transmitted by air currents and may be inhaled or deposited on a susceptible host within the same room as a source patient or even a long distance away from the source patient. To prevent airborne transmission, healthcare professionals should follow proper airborne precautions:

- Admit the patient to a room with special air handling and ventilation systems. These airborne infection isolation rooms (AIIRs) use negative airflow relative to hallways or surrounding areas to prevent air from escaping the room. The rooms complete 12 air exchanges per hour in buildings with new construction and renovation or 6 air exchanges per hour in existing facilities. Air exhausted from AIIRs must be directly exhausted to the outside or put through a HEPA filtration system before returning to the building.
• Don the proper PPE when entering an isolation room, including an N95 mask—a mask approved to filter 95% of airborne particles. Healthcare professionals must not confuse N95 respirators with surgical masks. They are not the same. Surgical masks cannot filter small particles and do not prevent leakage around the edges when the user inhales. To identify an N95 mask, look for the manufacturer’s name, part number (P/N), the protection provided by the filter, and the letters NIOSH or the NIOSH logo written on either the outside front, the exhalation valve, or the straps of the mask.
• Be sure to be fit-tested for an N95 mask before you care for anyone requiring airborne precautions. Facilities that have AII RS must have a facility-wide respiratory protection program that includes education of workers on respirator use with appropriate fit testing and user seal checks.
• Limit patient transport to medically necessary procedures only. If the patient must be transported, skin lesions must be covered and the patient must wear a surgical mask and observe respiratory hygiene/cough etiquette.

**Environmental Decontamination**

Some bacteria do not need a living host to survive. Microbes such as MRSA, vancomycin-resistant enterococci (VRE), and *C. difficile* can survive for long periods on environmental surfaces, such as bedrails and phones. After being contaminated, these environmental surfaces become the source of infection. A clean healthcare environment is essential for prevention of infection from these organisms.

Cleaning and disinfection of the patient environment includes high touch surfaces, such as bedrails, carts, toilets, and doorknobs, as well as general housekeeping surfaces, such as floors, walls, and blinds. Proper disinfection and sterilization of medical and surgical instruments and devices are also vital in the prevention of HAIs.

Agents used by facilities that are designated by the Environmental Protection Agency (EPA) as hospital-grade detergents/disinfectants must be able to inactivate specific organisms, such as *staphylococci* and streptococci. These agents must be chosen carefully to determine if they are effective in killing pathogens.

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**Nurse Staffing and Burnout and HAI**

A recent study in the *American Journal of Infection Control* showed a correlation between nurse staffing ratios, nurse burnout, and HAIs. According to the researchers, the higher the nurse-patient ratio, the higher the likelihood of occurrence of a HAI due to increased demands on nurses and resulting burnout. The study showed that increasing a nurse’s patient load by one patient increased the incidence of urinary tract infections and SSIs. The authors of this study suggest that healthcare facilities decrease nurse burnout to decrease the incidence of HAIs.

**Surveillance of HAIs**

Infection surveillance helps experts identify infectious disease, spot trends in infections, and create treatment and eradication goals. The federal government provides resources to estimate and track HAIs affecting patients and healthcare personnel. The National Healthcare Safety Network (NHSN), the largest HAI reporting system in the United States collects data from participating institutions, including acute care hospitals, long-term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centers, ambulatory surgery centers, and long-term care facilities. Currently, more than 9,000 institutions participate in the NHSN to share infectious disease data in a timely manner. As the scope of HAI reporting is extended, it is the goal of the NHSN to target prevention, improve patient outcomes, and reduce healthcare costs, with the ultimate goal being elimination of all HAIs.

Another national resource, the Emerging Infections Programs (EIP), consists of a network of state health departments and their academic medical center partners. These agencies collaborate to answer questions regarding emerging HAI threats, advanced infection-tracking methods, and antibiotic resistance in the United States.

**Conclusion**

The medical profession has come a long way in its progress toward elimination of HAIs, but there is still a long way to go. Understanding common pathogens, knowing risk factors of HAIs, and implementing preventative measures are key ways healthcare staff can help keep patients safe. Diligence and attention to proper hand hygiene, environmental disinfection, use of proper transmission-based precautions, and the correct use of PPE will help prevent the spread of these infections. With perseverance, healthcare workers can be instrumental in reaching the ultimate goal of zero HAIs.

**Resources**

For more information on isolation precautions including standard and transmission-based precautions, refer to the NCCE course titled *Science of Infection Control Principles* available at www.nurseece.com.

For general information on common HAIs, visit the CDC’s website at www.cdc.gov.


For more information on infection control in the LTCF, see the *SHEA/APIC Guideline: Infection Control in the Long-Term Care Facility*, available at http://www.jstor.org/stable/10.1086/592416.

For more information on developing strategies for measurement of hand hygiene, refer to the Joint Commission’s monograph titled *Measuring Hand Hygiene Adherence: Overcoming the Challenges*, available at www.jointcommission.org.

For more information on the selection and proper use of disinfection and sterilization materials, see the *Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008*, available on the CDC website at www.cdc.gov.

References and Suggested Readings


