Hospital-Acquired Infections

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Current Trends and Prevention

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KEYWORDS

- Health care–associated infections • Hospital-acquired infections
- Ventilator-associated pneumonia • Surgical site infection
- Catheter-associated urinary tract infection
- Central-line–associated bloodstream infection

KEY POINTS

- Health care–associated infections (HAIs) are the primary cause of preventable death and disability among hospitalized patients.
- The Centers for Disease Control and Prevention monitors surgical site infections, central-line–associated bloodstream infection, catheter-associated urinary tract infections, and ventilator-associated pneumonias.
- Evidence-based prevention strategies are critical to decreasing HAIs.
- Nurses can work as a key member of the collaborative team to establish performance measures, test and study the initiatives, and work to decrease HAIs.

Health care–associated infections (HAIs) are the primary cause of preventable death and disability among hospitalized patients.[1] According to the Centers for Disease Control and Prevention (CDC), complications or infections secondary to either device implantation or surgery are referred to as HAIs. Specifically, the CDC monitors surgical site infections (SSIs), central-line–associated bloodstream infection (CLABSI), catheter-associated urinary tract infections (CAUTI), and ventilator-associated pneumonias (VAP). The purpose of this article was to explore HAIs specific to risk factors, epidemiology, and prevention, and how nurses can work together with other health care providers to decrease the incidence of these preventable complications. Table 1 illustrates trends related to HAIs in intensive care units (ICUs). Mortality rates

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Table 1
Health care–associated infections, incidence and prevalence

HAI	Mortality Rate, %	2014 SIR	2014 SIR Versus 2013 SIR, %
CLABSI	18	0.50	8
CAUTI	2.3	1.00	5
VAP	13	Not reported	Not reported
SSI (colon surgery)	3	0.98	5

Abbreviations: CAUTI, catheter-associated urinary tract infection; CLABSI, central-line–associated bloodstream infection; HAI, health care–associated infection; SIR, standardized infection ratio; SSI, surgical site infection; VAP, ventilator-associated pneumonia.
Data from Refs.[1–3]

remain elevated for all HAIs with Standardized Infection Ratios (SIRs) increasing for CAUTI and SSIs, but decreasing for CLABSIs.

CENTRAL-LINE–ASSOCIATED BLOODSTREAM INFECTIONS

Reliable central venous access is necessary to manage and treat critically ill infants, adults, and children. On average in the United States, there are 15 million central venous catheter-days in the ICU alone.[4] There are 4 main types of central venous catheters (CVCs) that are used in the ICU. Table 2 illustrates each catheter type.

Risk Factors

Several risk factors are associated with CLABSIs. See Table 3 for intrinsic risk factors.

Extrinsic Risk Factors Associated with Increased Incidence of Central-Line–Associated Bloodstream Infections

- Increased length of stay before CVC insertion[5]
- Multiple CVCs
- Parenteral nutrition

Table 2
Types of central venous catheters

Catheter Type	Duration of Use	Insertion	CLABSI Risk
Nontunneled	Short-term use	Percutaneous insertion	Accounts for most CLABSIs
Tunneled CVC	Long-term use	Requires surgical insertion	Lower rate of CLABSI compared with nontunneled
Implantable ports	Long-term use	Requires surgical insertion and removal	Lowest risk of CLABSI
Peripherally inserted central catheters	Short to intermediate use	Inserted at bedside	Lower rate of infection than nontunneled CVCs

Abbreviations: CLABSI, central-line–associated bloodstream infection; CVC, central venous catheter.
Data from The Joint Commission. Preventing central line-associated bloodstream infections: a global challenge, a global perspective. Oak Brook (IL): Joint Commission Resources; 2012. Available at: http://www.PreventingCLABSIs.pdf.

Table 3
Intrinsic risk factors associated with CLABSIs

Intrinsic Risk Factor	Findings
Patient age	CLABSI rates are higher among children and neonates compared with adults
Underlying diseases	Hematologic, oncologic, cardiovascular, and gastrointestinal diseases associated with higher incidence of CLABSI
Gender	Males associated with an increased risk of CLABSI

Abbreviation: CLABSI, central-line–associated bloodstream infection.

Data from The Joint Commission. Preventing central line-associated bloodstream infections: a global challenge, a global perspective. Oak Brook (IL): Joint Commission Resources; 2012. Available at: http://www.PreventingCLABSIs.pdf.

- Femoral or internal jugular access site
- Microbial colonization at insertion site
- Multilumen CVCs
- Noncompliance with maximal sterile barriers during insertion
- CVC insertion in an ICU or emergency department

Microorganisms can enter the bloodstream and contaminate CVCs through 2 mechanisms: extraluminally or intraluminally. The most common mechanism of entry is extraluminally, in which the patient's skin organisms at the insertion site migrate into the area surrounding the catheter tip.[6] Intraluminal contamination occurs from direct contamination of the catheter through the intravenous (IV) system (needleless systems, hubs, connections). Prolonged dwell time of the CVC is related to intraluminal contamination.[7] **Table 4** illustrates the microorganisms most commonly associated with CLABSIs.

Epidemiology

The CDC started collecting data on CLABSIs in the 1970s. CLABSI rates peaked in the 1990s and have steadily declined with state-mandated reporting of HAIs with the implementation of evidence-based interventions.[8] According to the CDC, CLABSI rates in the United States decreased 46% between 2008 and 2013.[1] In 2008, the Centers for Medicare and Medicaid Services (CMS) stopped reimbursing hospitals for costs associated with treating CLABSIs.[9] This change forced hospitals to look closely at evidence-based strategies to decrease CLABSIs.

Table 4
Common microorganisms associated with CLABSI

Microorganism	Percentage of All Health Care–Associated Bloodstream Infections
Coagulase-negative *Staphylococcus aureus*	31
S aureus	20
Enterococcus	9
Candida	9

Abbreviation: CLABSI, central-line–associated bloodstream infection.

Data from The Joint Commission. Preventing central line-associated bloodstream infections: a global challenge, a global perspective. Oak Brook (IL): Joint Commission Resources; 2012. Available at: http://www.PreventingCLABSIs.pdf.

The Agency for Healthcare Research and Quality developed toolkits to estimate both costs and mortality associated with CLABSIs. With an average mortality rate of 18% and a CLABSI rate of 5.3 per 1000 catheter-days, each year approximately 28,000 patients die of CLABSIs.[10] One estimate suggests that CLABSIs cost between $960 million and $18.2 billion annually.[11]

Prevention

Evidence-based prevention strategies are critical to decreasing CLABSI rates. Hand hygiene and aseptic technique are strategies known to decrease the risk of CLABSIs.[5,12] **Table 5** illustrates evidence-based strategies shown to decrease CLABSIs.

Each of the practices listed in **Table 4** are part of the Central Line Bundle developed by The Joint Commission on Healthcare Accreditation.[18] Consistent use of the Central Line Bundle has resulted in a 56% reduction in CLABSIs.[19] Other practices not included in the bundle that are associated with lower CLABSI rates include chlorhexidine-impregnated sponges[20] and alcohol-impregnated port protectors.[21]

Ventilator-Associated Pneumonia

Mechanical ventilation is a common treatment modality in the ICU used to treat respiratory failure secondary to a multitude of conditions. VAP is the most common complication of mechanical ventilation.[22] The incidence of VAP ranges from 2 to 16 episodes for 1000 ventilator days.[23] The most common organisms associated with VAP include *Staphylococcus aureus* (50%–80% of methicillin-resistant strains), *Pseudomonas aeruginosa*, and Enterobacteriaceae.[24]

Table 5
Evidence-based strategies that decrease CLABSI

Recommendation	Rationale
Catheter site selection: subclavian vein preferred	Upper extremity site related to decreased incidence of CLABSI compared with lower extremity[13]
Number of lumens	Use minimum number of lumens necessary[5]
Antimicrobial-impregnated catheters[14]	Recommended if comprehensive strategies to reduce CLABSIs is not working. These strategies include 1. Educating health care providers who insert CVCs 2. Use of maximal barrier precautions 3. Use 0.5% chlorhexidine for skin preparation before insertion
Maximal sterile barrier precautions	Includes sterile gown, sterile gloves, cap, and full-body drape[15,16]
2% chlorhexidine gluconate	Daily bathing with 2% chlorhexidine gluconate reduces CLABSI[17]
Advocate for catheter removal	Daily review of continued need for CVC should be done via multidisciplinary rounds; Zingg and colleagues[12] found that 4.8% of CVC days were unnecessary

Abbreviations: CLABSI, central-line–associated bloodstream infection; CVC, central venous catheter.

Data from The Joint Commission. CVC insertion bundles. Available at: http://www.jointcommission.org/assets/1/6/clabsi_toolkit_tool_3-18_cvc_insertion_bundles.pdf. Accessed April 5, 2016.

From a financial perspective, the costs of VAP are tremendous. VAP is the second most costly HAI (second to CLABSI), adding an additional $40,144 per case.[24] More concerning is the estimated mortality of VAP, which is approximately 13%. This estimation is based on a meta-analysis of 6284 patients from 24 trials.[25] To decrease costs and save lives, the Institute for Healthcare Improvement (IHI) created a VAP bundle[26] that consists of specific evidence-based recommendations. These recommendations include the following:

- Elevation of the head of the bed between 30 and 45°
- Daily “sedative interruption” and daily assessment of readiness to extubate
- Peptic ulcer disease prophylaxis
- Deep venous thrombosis prophylaxis
- Daily oral care with chlorhexidine

Daily oral care is a new recommendation of the IHI bundle, and the evidence is conflicting. One meta-analysis of 12 randomized control trials (RCTs) revealed a 24% decrease in VAP rates with the use of 2% chlorhexidine.[27] This evidence is sufficient to support the adoption of this simple and relatively low cost option. Of recent interest is the effect of probiotics on VAP. One RCT with a sample of 146 patients noted a 47% decrease in VAP rates when daily probiotics were administered to ventilated patients.[28] Another intervention that has decreased VAP rates is the use of kinetic beds. Although costly, kinetic beds offer greater mobility of the patient and can also prone a patient with ease. One meta-analysis of 15 RCTs found a 53% decrease in VAP rates compared with traditional ICU beds.[29]

CATHETER-ASSOCIATED URINARY TRACT INFECTIONS

Costs/Mortality

CAUTI has been identified by CMS as a never event, and a condition for which hospitals no longer receive reimbursement for treatment.[30] There were approximately 93,300 urinary tract infections (UTIs) identified in acute care hospitals in 2011. UTIs are the fourth most common type of HAI.[1] Health care–associated urinary tract infections (HAUTIs) associated with indwelling urinary tract catheters account for 80% of UTIs.[30] CAUTIs account for more than 12% of hospital infections.[1] Between 15% and 25% of hospitalized patients may have an indwelling urinary catheter placed during their hospital stay.[31] The highest rates of CAUTI are identified in burn ICUs, followed by inpatient medical units and neurosurgical ICUs. The lowest rates are identified in medical/surgical ICUs. CAUTI can increase length of patients’ stays, cost of patient care, and mortality. It is estimated that CAUTI contributes to more than 13,000 deaths each year with a mortality rate of 2.3%.[1] CAUTI accounts for 17% of hospital-acquired bacteremias, with an associated mortality of approximately 10%.[31]

Risk Factors

Indwelling urinary catheters are drainage tubes that insert into the urethra, sit in the urinary bladder and are connected to a closed collection system to drain urine. Indwelling urinary catheters are often a reservoir for multidrug-resistant bacteria and are often a source for transmission of infection to other patients.[31] The microorganism source can be endogenous from colonization of the meatus, vagina, or rectum. The microorganism source also can be exogenous from contaminated hands of the health care personnel, or contaminated equipment. The routes of transmission can be through the extraluminal route through migration along the outside of the urinary catheter, or by the intraluminal route through backflow of urine from a contaminated collection bag, breaks in the catheter-drainage tube junction, or biofilms of urinary microorganisms colonizing the urinary catheter.[31] In 1960, the closed sterile urinary drainage system was introduced into use. Even with a closed sterile system, breaks in the sterile system, urinary catheter biofilm contaminated with microorganisms, or extraluminal contamination can occur.[31]

The pathogens most often associated with CAUTI are *Escherichia coli* (21.4%), *Candida* (21.0%), *Enterococcus* (14.9%), *P aeruginosa* (10.0%), *Klebsiella pneumoniae* (7.7%), and *Enterobacter* (4.1%).[32] There are a substantial number CAUTI infections with multidrug-resistant organisms, which has made treatment of CAUTI difficult.

For a patient to be classified as having a CAUTI, the patient must meet all 3 of the following criteria, as outlined by the CDC.[1]

1. Patient had an indwelling urinary catheter that had been in place for more than 2 days on the date of event (day of device placement = day 1) AND was either:
   - Present for any portion of the calendar day on the date of event, OR
   - Removed the day before the date of event
2. Patient has at least 1 of the following signs or symptoms:
   - Fever (>38.0°C)
   - Suprapubic tenderness
   - Costovertebral angle pain or tenderness
   - Urinary urgency
   - Urinary frequency
   - Dysuria
3. Patient has a urine culture with no more than 2 species of organisms identified, at least 1 of which is a bacterium of ≥105 colony-forming units per milliliter. All elements of the UTI criteria must occur during the infection window period.

Prevention

Many indwelling urinary catheters are unnecessary. The risk for bacteriuria with catheterization is 3% to 10% daily, with almost 100% risk after 30 days of catheterization. It is estimated that 69% of CAUTIs can be prevented by following recommended infection control measures, which translates to 380,000 infections, and ultimately 9000 deaths each year prevented.[31] In 2010, through systematic reviews of 249 studies, Gould and colleagues[31] expanded on the CDC's current guidelines on prevention of CAUTI with the recommendations listed in **Table 6**.

SURGICAL SITE INFECTIONS

Costs/Mortality

Approximately 27 million surgical procedures are performed in the United States each year. SSIs account for 31% of all HAIs, making them the most prevalent HAI.[3] SSIs increase the patient's length of stay, interventions completed on the patient, readmission rates, the cost of health care, and ultimately place an increased burden on the patient.[3] The CDC's updated 2014 report on SSIs found a 17% decrease in abdominal hysterectomy SSI between 2008 and 2014, and a 2% decrease in colon surgery SSI between 2008 and 2014.[1] The additional cost of managing SSIs ranges from less than $400 for a superficial SSI, to more than $30,000 per patient for a deep organ/space SSI. SSIs were estimated to cost $20,785 annually and in 2009, the incidence of SSI was approximately 158,639.[33] SSIs have a mortality rate of 3%, with a 2 to 11 times higher risk of death directly related to the infection.[3] It is estimated that 40% to 60% of SSIs are preventable.[34]

Risk Factors

SSIs develop after surgery, in the location of the surgical site. The infection can be superficial when the skin is the only organ involved, or it can involve the tissue under the skin, organs surrounding the skin, or implanted material.[1] All surgical wounds have some degree of contamination that takes place at closure of the incision.[33] The pathogenesis of SSIs involves different factors, including the operating room environment, the host, the surgical procedure, and the specific microorganism involved.[3] Risk factors associated with SSIs include intraoperative blood transfusions, diabetes, and steroid use.[35] Bacteria are continually becoming more resistant to antibiotic treatment, making SSI prevention of utmost importance.[34]

Prevention

In 2002, the CDC and CMS collaborated and implemented the Surgical Infection Prevention Project to decrease morbidity and mortality associated with SSIs. What followed was a partnering of CMS, CDC, and other professional organizations nationally in what is known as the Surgical Care Improvement Project (SCIP). The SCIP highlights measurement of quality in 4 areas in which the incidence and cost of surgical complications is high, one of which is SSI.[36]

Evidence-based interventions to reduce SSIs were introduced through surgical care bundles.[33] The interventions include use of surgical attire, hand hygiene, antimicrobial sutures, preadmission showers and cleansing, and weight-based dosing.[33] In 2010, the Association of PeriOperative Registered Nurses (AORN) published recommendations for clinical practice to minimize risks for SSI, which included recommended practices for surgical attire. This brought about a surge of interest and research surrounding surgical attire in the operating room (OR), and the presence of personal items and food in the OR. The AORN recommendations are simple to incorporate into practice, and the Joint Commission uses these as expectations in their evaluations of hospital OR procedures.[33]

Hand hygiene of the anesthesiologists has been an area of needed improvement. Studies have linked anesthesiologists to direct transmission of pathogens to IV and anesthesia equipment. It has been recommended that all nonscrubbed OR personnel have access to alcohol-based hand rub.[33]

On closure of surgical incisions, it is unavoidable to introduce some bacteria into the surgical site. AORN has suggested the use of antimicrobial braided and monofilament sutures to reduce bacterial introduction into the surgical site. Daoud and colleagues[37] conducted a meta-analysis including 4800 surgical patients, which supported the reduction of incidence of SSI with the use of triclosan-coated sutures. In 2014, Singh and colleagues[38] created an economic model that reported that switching to triclosan-coated sutures had monetary benefits to hospitals, third-party payers, and patients, reporting a 10% reduction in SSI.

Preadmission showers with either 4% aqueous or 2% chlorhexidine gluconate (CHG)-impregnated polyester cloths kills 90% of skin staphylococci, including methicillin-resistant *Staphylococcus aureus* (MRSA).[39] Patient compliance with the preadmission showers, and standardization of directions for the preadmission showers has been an area identified for improvement. Edmiston and Spenser[33] developed suggestions for a protocol for standardization of preadmission showers, including electronic alerts for the preadmission showers that has improved patient compliance.

Another area for improvement includes weight-based dosing of preoperative prophylactic antibiotics. Current doses may be inadequate at inhibiting gram-positive

Table 6
CAUTI prevention recommendations

Who Should Receive Urinary Catheters	
When is urinary catheterization necessary?	Use urinary catheters in operative patients only as necessary, rather than routinely. Avoid use of urinary catheters in patients and nursing home residents for management of incontinence. Further research is needed on periodic (eg, nighttime) use of external catheters in incontinent patients or residents and the use of catheters to prevent skin breakdown. Further research is needed on the benefit of using a urethral stent as an alternative to an indwelling catheter in selected patients with bladder outlet obstruction. Consider alternatives to chronic indwelling catheters, such as intermittent catheterization, in spinal cord injury patients. Consider intermittent catheterization in children with myelomeningocele and neurogenic bladder to reduce the risk of urinary tract deterioration.
What are the risk factors for CAUTI?	Following aseptic insertion of the urinary catheter, maintain a closed drainage system. Insert catheters only for appropriate indications, and leave in place only as long as needed. Minimize urinary catheter use and duration of use in all patients, particularly those at higher risk for CAUTI, such as women, the elderly, and patients with impaired immunity. Ensure that only properly trained persons (eg, hospital personnel, family members, or patients themselves) who know the correct technique of aseptic catheter insertion and maintenance are given this responsibility. Maintain unobstructed urine flow.
What populations are at highest risk of mortality related to urinary catheters?	Minimize urinary catheter use and duration in all patients, particularly those who may be at higher risk for mortality due to catheterization, such as the elderly and patients with severe illness.
For those who may require urinary catheters, what are the best practices? Specifically, what are the risks and benefits associated with the following:	

Different approaches to catheterization?	Consider using external catheters as an alternative to indwelling urethral catheters in cooperative male patients without urinary retention or bladder outlet obstruction. Intermittent catheterization is preferable to indwelling urethral or suprapubic catheters in patients with bladder-emptying dysfunction. If intermittent catheterization is used, perform it at regular intervals to prevent bladder overdistension. For operative patients who have an indication for an indwelling catheter, remove the catheter as soon as possible postoperatively, preferably within 24 h, unless there are appropriate indications for continued use. Further research is needed on the risks and benefits of suprapubic catheters as an alternative to indwelling urethral catheters in selected patients requiring short-term or long-term catheterization, particularly with respect to complications related to catheter insertion or the catheter site. In the non–acute care setting, clean (ie, nonsterile) technique for intermittent catheterization is an acceptable and more practical alternative to sterile technique for patients requiring chronic intermittent catheterization.
Different catheters or collecting systems?	If the CAUTI rate is not decreasing after implementing a comprehensive strategy to reduce rates of CAUTI, consider using antimicrobial/antiseptic-impregnated catheters. The comprehensive strategy should include, at a minimum, the high-priority recommendations for urinary catheter use, aseptic insertion, and maintenance. Further research is needed on the effect of antimicrobial/antiseptic-impregnated catheters in reducing the risk of symptomatic UTI, their inclusion among the primary interventions, and the patient populations most likely to benefit from these catheters. Hydrophilic catheters might be preferable to standard catheters for patients requiring intermittent catheterization. Following aseptic insertion of the urinary catheter, maintain a closed drainage system. Complex urinary drainage systems (using mechanisms for reducing bacterial entry, such as antiseptic-release cartridges in the drain port) are not necessary for routine use. Urinary catheter systems with preconnected, sealed catheter-tubing junctions are suggested for use. Further research is needed to clarify the benefit of catheter valves in reducing the risk of CAUTI and other urinary complications.

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Table 6
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Different catheter-management techniques?	Unless clinical indications exist (eg, in patients with bacteriuria on catheter removal post urologic surgery), do not use systemic antimicrobials routinely as prophylaxis for UTI in patients requiring either short-term or long-term catheterization. Further research is needed on the use of urinary antiseptics (eg, methenamine) to prevent UTI in patients requiring short-term catheterization. Further research is needed on the use of methenamine to prevent encrustation in patients requiring chronic indwelling catheters who are at high risk for obstruction. Unless obstruction is anticipated (eg, as might occur with bleeding after prostatic or bladder surgery), bladder irrigation is not recommended. Routine irrigation of the bladder with antimicrobials is not recommended. Routine instillation of antiseptic or antimicrobial solutions into urinary drainage bags is not recommended. Do not clean the periurethral area with antiseptics to prevent CAUTI while the catheter is in place. Routine hygiene (eg, cleansing of the meatal surface during daily bathing) is appropriate. Further research is needed on the use of antiseptic solutions vs sterile water or saline for periurethral cleaning before catheter insertion. Changing indwelling catheters or drainage bags at routine, fixed intervals is not recommended. Rather, catheters and drainage bags should be changed based on clinical indications, such as infection, obstruction, or when the closed system is compromised. Use a sterile, single-use packet of lubricant jelly for catheter insertion. Routine use of antiseptic lubricants is not necessary. Further research is needed on optimal cleaning and storage methods for catheters used for clean intermittent catheterization. Inset catheters only for appropriate indications, and leave in place only as long as needed. For operative patients who have an indication for an indwelling catheter, remove the catheter as soon as possible postoperatively, preferably within 24 h, unless there are appropriate indications for continued use. Consider using a portable ultrasound device to assess urine volume in patients undergoing intermittent catheterization to assess urine volume and reduce unnecessary catheter insertions. Further research is needed on the use of a portable ultrasound device to evaluate for obstruction in patients with indwelling catheters and low urine output. Further research is needed on the use of bacterial interference to prevent UTI in patients requiring chronic urinary catheterization.

Different systems interventions (ie, quality improvement programs)?	Ensure that health care personnel and others who take care of catheters are given periodic in-service training stressing the correct techniques and procedures for urinary catheter insertion, maintenance, and removal. Implement quality improvement programs or strategies to enhance appropriate use of indwelling catheters and to reduce the risk of CAUTI based on a facility risk assessment. Examples of programs that have been demonstrated to be effective include the following: 1. A system of alerts or reminders to identify all patients with urinary catheters and assess the need for continued catheterization 2. Guidelines and protocols for nurse-directed removal of unnecessary urinary catheters 3. Education and performance feedback regarding appropriate use, hand hygiene, and catheter care 4. Guidelines and algorithms for appropriate perioperative catheter management, such as a. Procedure-specific guidelines for catheter placement and postoperative catheter removal b. Protocols for management of postoperative urinary retention, such as nurse-directed use of intermittent catheterization and use of ultrasound bladder scanners Routine screening of catheterized patients for asymptomatic bacteriuria is not recommended. Perform hand hygiene immediately before and after insertion or any manipulation of the catheter site or device. Maintain unobstructed urine flow. Further research is needed on the benefit of spatial separation of patients with urinary catheters to prevent transmission of pathogens colonizing urinary drainage systems. When performing surveillance for CAUTI, consider providing regular (eg, quarterly) feedback of unit-specific CAUTI rates to nursing staff and other appropriate clinical care staff.
What are the best practices for preventing CAUTI associated with obstructed urinary catheters?	Further research is needed on the benefit of irrigating the catheter with acidifying solutions or use of oral urease inhibitors in long-term catheterized patients who have frequent catheter obstruction. Silicone might be preferable to other materials to reduce the risk of encrustation in long-term catheterized patients who have frequent obstruction.

Abbreviations: CAUTI, catheter-associated urinary tract infection; UTI, urinary tract infection.

From Gould CV, Umscheid CA, Agarwal RK, et al. Guideline for prevention of catheter associated urinary tract infections. Infect Control Hosp Epidemiol 2010;31:319–26; with permission.

and gram-negative bacteria associated with SSIs.[40] Historically, 1-g dosing of cefazolin prophylactically was standard protocol. Patients with a body mass index (BMI) of 30 kg/m^2 should receive a 3-g prophylactic dose of cefazolin 30 minutes before the first incision is made, and patients with a BMI of less than 30 kg/m^2 receive a 2-g dose of cefazolin 30 minutes before the first incision is made.[41] Currently not all hospitals in the United States have embraced weight-based dosing of prophylactic antibiotics, which may leave patients vulnerable to SSIs. Further research is needed in this area, to prove efficacy of weight-based dosing.

Surgical attire, hand hygiene, antimicrobial sutures, preadmission showers and cleansing, and weight-based dosing are currently used to prevent SSIs. Other recommendations that have not been fully implemented as part of the SSI bundle include the following:

- Identification of patients who are nasal carriers of MRSA, and decolonization of these patients with mupirocin before surgery.[42]
- Irrigation of surgical wounds with 0.05% CHG.[43]
- AORN, The Society for Healthcare Epidemiology of America, and the National Institute for Health and Care Excellence recommend leaving hair at the surgical site and removing hair only if it is identified as interfering with the procedure.
  - If hair removal is necessary, it should be done outside of the surgical site, with single-use clipper heads, and hair should be cut, not shaved.[44]

Link to Nursing Care

Nurses are primarily responsible for ensuring that evidence-based interventions related to HAIs are implemented. Many of the HAIs are considered “nurse sensitive,” meaning that the quality of nursing care is directly related to the incidence and prevalence of HAIs. The nursing work environment is an important factor to consider when examining HAIs in critical care. Favorable nursing work environments are associated with fewer HAIs.[45,46]

HAIs are complex and multifaceted. It is crucial that the medical and nursing community continue to investigate and implement evidence-based strategies to decrease the incidence and prevalence of HAIs both in the United States and around the globe.

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