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Diagnosis, Management, and Prevention of Catheter-Associated Urinary Tract Infections

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Urinary tract infection (UTI) is one of the most common health care–associated infections (HAIs), representing up to 40% of all HAIs.[1–3] Most health care–associated UTIs (70%) are associated with urinary catheters, but as many as 95% of UTIs in intensive care units (ICUs) are associated with catheters.[4,5] Approximately 20% of patients have a urinary catheter placed at some time during their hospital stay,[6,7] especially in ICUs, in long-term care facilities, and increasingly in home care settings.[3,4,8] The Centers for Disease Control and Prevention (CDC) estimated that up to 139,000 catheter-associated UTIs (CAUTIs) occurred in US hospitals in 2007.[4]

CAUTIs are associated with increased morbidity, mortality, and costs. Hospital-associated bloodstream infection from a urinary source has a case fatality of 32.8%.[9,10] Each episode of CAUTI is estimated to cost $600; if associated with a bloodstream infection, costs increase to $2800.[11] Nationally, CAUTIs result in an estimated $131 million annual excess medical costs.[4]

Moreover, in October 2008, the Centers for Medicare and Medicaid Services (CMS) included hospital-acquired CAUTI under conditions that are no longer reimbursed for the extra costs of managing a patient.[11] To date, there has been no measurable effect of the CMS policy to reduce payments for CAUTIs on CAUTI rates or preventive practices.[12–14]

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Nevertheless, the prevention of CAUTIs has become a priority for most hospitals because 65% to 70% of CAUTIs may be preventable.[15]

EPIDEMIOLOGY OF CAUTIs

Likely as a result of widespread interventions occurring nationwide, rates of CAUTIs in ICUs reporting to the CDC decreased significantly between 1990 and 2007.[4] In 2010, the rates of CAUTIs reported to the CDC's National Healthcare Safety Network (NHSN) ranged from 4.7 per 1000 catheter-days in burn ICUs to 1.3 per 1000 catheter-days in medical/surgical ICUs.[4] Pediatric ICUs reported similar rates of CAUTI, 2.2 to 3.9 per 1000 catheter-days[16]; however, CAUTIs are infrequently identified in neonatal ICUs.[17] Inpatient wards reported rates equivalent to ICU settings, with a range from 0.2 to 3.2 per 1000 catheter-days. Among inpatient wards, rehabilitation units had the highest rates of CAUTIs.[5,16]

Microbial Cause of CAUTIs

Most microorganisms causing CAUTIs are from the endogenous microbiota of the perineum that ascend the urethra to the bladder along the external surface of the catheter.[18] A smaller proportion of microorganisms (34%) are introduced by intraluminal contamination of the collection system from exogenous sources, frequently resulting from cross-transmission of organisms from the hands of health care personnel.[18,19] Approximately 15% of episodes of health care–associated bacteriuria occur in clusters from patient-to-patient transmission within a hospital.[2,19] Rarely, organisms, such as *Staphylococcus aureus*, cause UTI from hematogenous spread.

Enterobacteriaceae, especially *Escherichia coli* and *Klebsiella* spp, are the most common pathogens associated with CAUTI; but in the ICU setting, *Candida* spp (18%), *Enterococcus* spp (10%), and *Pseudomonas aeruginosa* (9%) are more prevalent (Table 1).[16,20,21] European hospitals report a similar spectrum of microorganisms associated with nosocomial UTIs, except for *Pseudomonas* spp, which were isolated in only 7% of urine cultures.[22]

Among *E coli* isolates reported to the NHSN from CAUTIs in ICU and non-ICU settings in 2009 to 2010, 29.1% and 33.5%, respectively, were resistant to fluoroquinolones.[21] Many Enterobacteriaceae produced extended-spectrum beta-lactamases; 26.9% of *K pneumonia/oxytoca* and 12.3% of *E coli* isolates from patients with CAUTIs were resistant to extended-spectrum cephalosporins. Alarmingly, during this same time period, 12.5% of *Klebsiella* spp from patients with CAUTIs were resistant to carbapenems.[21] Although long-term acute care hospitals (LTACHs) had a prevalence of carbapenem-resistant Enterobacteriaceae (CRE) in CAUTI isolates similar to that reported in ICUs, a greater percentage of LTACHs reported a CRE CAUTI compared with ICUs.[20]

Enterococci emerged as a commonly reported cause of health care–associated UTIs between 1975 and 1984. Although the clinical significance of enterococci isolated from urine is questionable, urinary drainage devices serve as a reservoir for emergence and spread of vancomycin-resistant strains in short- and long-term acute care settings.[20,21] Also rarely associated with complications when isolated from the urine,[23] *Candida* spp account for

28% of CAUTIs reported from ICUs.[20] S *aureus* are an infrequent cause of CAUTI but, when identified, should prompt consideration for coinciding bacteremia or endocarditis.[10,24] CAUTI associated with long-term catheters are associated with 2 or more organisms in 77% to 95% of episodes, and 10% have more than 5 species of organisms present.[3]

Biofilms, composed of clusters of microorganisms and extracellular matrix (primarily polysaccharide materials), form on the internal and external surfaces of urinary catheters shortly after insertion.[19,25] Typically, the biofilm is composed of one type of microorganism, although polymicrobial biofilms are possible. Microorganisms within the biofilm ascend the catheter to the bladder in 1 to 3 days. Antimicrobials penetrate into biofilms poorly, and microorganisms grow more slowly in biofilms, decreasing the effects of many antimicrobials.[19,25] The microorganisms, resistance patterns, and biofilm factors mentioned earlier have significant implications for the management of CAUTIs.

Risk Factors for CAUTIs

Table 2 outlines major modifiable and nonmodifiable risk factors for CAUTI, which have importance for the design and implementation of interventions for the prevention of CAUTI. The duration of catheterization is the dominant risk factor for CAUTI.[1,3,26] Women have a higher risk of UTI than men, and heavy bacterial colonization of the perineum increases that risk. Other factors that increase the risk of CAUTI include rapidly fatal underlying illness, more than 50 years of age, nonsurgical disease, hospitalization on an orthopedic or urological service, catheter inserted outside the operating room, diabetes mellitus, and serum creatinine greater than 2 mg/dL at the time of catheterization. Nonadherence to aseptic catheter care recommendations has been associated with an increased risk of bacteriuria; conversely, systemic antibiotics have a protective effect on bacteriuria (relative risk 2.0–3.9).[2,3] Independent risk factors for urinary tract–related bloodstream infections in patients with bacteriuria include neutropenia, renal disease, and male sex.[27]

DIAGNOSIS OF CAUTIS

Clinical diagnosis of a CAUTI is challenging because pyuria and bacteriuria are almost uniformly present, but neither are reliable indicators of symptomatic UTI in the setting of catheterization.[28–31] Symptomatic UTI is defined by the presence of symptoms or signs referable to the urinary tract associated with significant bacteriuria.[28] Fever or other systemic symptoms may be the only clinical indication of UTI in patients who are critically ill or who have spinal cord injuries.[2,3] However, outside these patient populations, additional urinary tract-specific signs and symptoms should be sought for the diagnosis of UTI.[28,30]

Defining significant bacteriuria is difficult because some level of bacterial colonization is universal in urine from catheterized patients. Colony counts in urine as low as 10^2 colony-forming units (CFU)/mL can be associated with symptoms, and colony counts of this level rapidly increase to more than 10^5 CFU/mL within 24 to 48 hours.[28,32,33] Therefore, the National Institute on Disability and Rehabilitative Research defined bacteriuria in catheterized patients as growth of 10^2 CFU/mL or more of a predominant microorganism.[33] Other guidelines have defined 10^3 CFU/mL as a more reasonable threshold for significant

bacteriuria, balancing the sensitivity of detecting CAUTI with the feasibility of the microbiology laboratory to quantify microorganisms.[28]

Asymptomatic bacteriuria is defined as bacteriuria in patients without signs or symptoms referable to the urinary tract.[28] The distinction from symptomatic UTI is clinically important because asymptomatic catheter-associated bacteriuria and funguria rarely result in adverse outcomes (eg, pyelonephritis, perinephric abscess, bacteremia) and generally do not require treatment.[30] Nevertheless, a large proportion of antimicrobials in hospitalized patients are prescribed for the treatment of UTIs, most often asymptomatic bacteriuria.[34–36]

MANAGEMENT OF CAUTIS

The treatment of asymptomatic catheter-associated bacteriuria or candiduria is not indicated except in patients who are at a high risk for the development of complications, such as pyelonephritis or bloodstream infection.[37] Screening and treating pregnant women for asymptomatic bacteriuria to prevent pyelonephritis are recommended. In addition, patients undergoing genitourinary procedures likely to induce mucosal bleeding should be screened and treated in advance for asymptomatic bacteriuria.[28,37] As with asymptomatic bacteriuria, asymptomatic candiduria generally does not require treatment, except in neutropenic patients and other high-risk patients noted earlier.[38] Furthermore, because of poor specificity of fever and frequency of bacteriuria and funguria in hospitalized patients with urinary catheters, a thorough investigation for other sources of fever should be conducted before diagnosing a UTI.

Asymptomatic bacteriuria, persisting for 48 hours after the removal of a urinary catheter, has a high risk of progressing to symptomatic UTI; treatment in hospitalized women has been shown to decrease the risk of subsequent UTIs.[39] Therefore, considering the treatment of women with asymptomatic bacteriuria persisting 48 hours after catheter removal is recommended.[28,37,39] When indicated, 3 to 7 days of appropriate antimicrobial therapy based on culture results should be adequate for the treatment of asymptomatic bacteriuria.[28,37]

Repeated antimicrobial treatment of bacteriuria during long-term catheterization is a significant risk for colonization with multidrug-resistant organisms, and most of this use is inappropriate.[34,35] A recent study reported that a 1-hour educational session reduced inappropriate use of antibiotic therapy for inpatients with positive urine cultures.[40] In addition, audit and feedback to care providers decreased overdiagnosis of CAUTIs and associated inappropriate antibiotic use in another study.[36] Educational efforts aimed at reducing unnecessary urine cultures (eg, pan-culturing for fever without a thorough clinical assessment) would also prevent the inappropriate treatment of bacteriuria and funguria.

Because of the presence of biofilm, leaving the catheter in place during the treatment of CAUTIs makes eradicating bacteriuria or candiduria difficult and can lead to the development of antimicrobial resistance. The management of symptomatic CAUTIs should include removing or replacing the urinary catheter if it has been in place for at least 2 weeks.[28,41] In terms of antimicrobial therapy, symptomatic CAUTIs may be treated with

7 days of appropriate antimicrobials if patients have a prompt resolution of symptoms; therapy should be lengthened to 10 to 14 days for those with a delayed response.[28] Initial empiric therapy should be based on local epidemiologic data regarding causative microorganisms of CAUTIs and antimicrobial resistance patterns. Once culture data become available, antimicrobial therapy should be adjusted as necessary, ideally providing the narrowest spectrum of coverage possible while still providing adequate treatment of the UTI. Symptomatic CAUTIs caused by *Candida* species should be treated with 14 days of antifungal agents.[38]

PREVENTING CAUTIS

General strategies, formulated for the prevention of all HAIs, including strict adherence to hand hygiene, are critical for the prevention of CAUTIs.[42] The urinary tract of hospitalized patients, especially those in an ICU setting, represents a significant reservoir for multidrug-resistant organisms. Therefore, precautions recommended for prevention of transmission of multidrug-resistant organisms should be scrupulously observed in catheterized patients.[43] Limiting unnecessary use of antimicrobials, as part of an overall antimicrobial stewardship program, is another important general strategy to prevent the development of antimicrobial resistance related to urinary catheters.[44]

The measurement and feedback of results of interventions to the clinical care team is an essential component of any improvement program. The CDC NHSN CAUTI rate (symptomatic UTI per 1000 urinary catheter-days) is the most widely accepted measure for CAUTI surveillance and is endorsed by the Infectious Diseases Society of America, the Society of Healthcare Epidemiology of America, and the Association for Professionals in Infection Control and Epidemiology.[28,45,46] In addition, beginning in 2012, the CMS has required as a condition of participation that hospitals, long-term care hospitals, and inpatient rehabilitation facilities submit ICU CAUTI rates to the NHSN. A modified definition of UTI is recommended for surveillance in long-term care facilities.[47] Efforts are currently underway to revise the CDC's NHSN UTI surveillance definitions to improve specificity and clinical relevance of the measure.

However, a population-based measure, using hospital-days as the denominator, has been suggested as an alternative measure to assess improvement interventions at individual hospitals.[48] Other measures, such as rates of asymptomatic bacteriuria, percentage of patients with indwelling catheters, percentage of catheterization with accepted indications, and duration of catheter use, have been used in improvement studies and collaboratives with good success.[49]

Several guidelines with specific recommendations for the prevention of CAUTIs have been developed or recently updated (Box 1).[28,45,46,50] However, in 2005, a nationwide survey identified that one-third of hospitals did not conduct surveillance for UTIs, more than one-half did not monitor urinary catheters, and three-quarters did not monitor the duration of catheterization.[12,51] In a follow-up study, after the enactment of the CMS nonpayment rule, still no CAUTI prevention practices had been adopted in more than half of the hospitals, except for the use of bladder ultrasound.[12] Even in ICUs, only a small proportion of

surveyed sites had policies supporting bladder ultrasound (26%), catheter removal reminders (12%), or nurse-initiated catheter discontinuation (10%).[52] The systematic adoption of prevention practices has begun to be observed through the use of bundles and collaboratives, as detailed later.[49,53]

A qualitative study of 12 hospitals participating in a statewide program identified barriers to adoption of the key interventions to reduce unnecessary use of urinary catheters. Common barriers included difficulty with nurse and physician engagement, patient and family request for indwelling catheters, and catheter insertion practices and customs in emergency departments.[54] In addition, qualitative studies have revealed that staff variations of the perceived risk and perceived strength of evidence supporting preventive practices should be incorporated into implementation plans.[55,56]

Limiting Use of Urinary Catheters

The foremost strategy for CAUTI prevention is avoidance of or decreasing the duration of urinary catheterization. Catheter utilization varies by ICU type, with the lowest rate in pediatric medical ICUs (0.16 urinary catheter-days/patient-days) and the highest rates reported in trauma ICUs (0.80 urinary catheter-days/patient-days).[16] Decreasing catheter utilization requires interventions at several stages of the lifecycle of the urinary catheter.[26]

The first stage in decreasing catheter utilization is limiting the placement of indwelling urinary catheters. Overall, urinary catheters are overused and the documentation surrounding catheterization is inconsistent[7,57–59]; urinary catheters are placed for inappropriate indications in 21% to 50% of catheterized patients.[7,60] Written policies and criteria for indwelling urinary catheterization, based on accepted indications, is a first step in limiting the placement of urinary catheters; but tracking indications for catheters with feedback to the care team is also important (Box 2).[45,50] Some hospitals have had success by targeting interventions for limiting the placement of urinary catheters in emergency departments and operating rooms, locations where the initial placement often takes place.[61]

Once catheters are placed, strategies for early removal become necessary to limit the duration of catheterization. Relying on physicians' orders alone may be inadequate for the management of catheters because, in one study, 28% of physicians were unaware that their patient had a catheter.[7] Nurse-driven interventions have demonstrated effectiveness in reducing the duration of catheterization.[62–64] This type of intervention was implemented in a statewide effort that resulted in a significant decrease in catheter use and an increase in appropriate indications of catheters.[49]

Computerized physician order entry systems may offer a more cost-effective and efficient system to reduce both the placement of catheters and the duration of catheterization.[65] A systematic review and meta-analysis found that urinary catheter reminder systems and stop orders seem to reduce the mean duration of catheterization by 37% and CAUTIs by 52%.[66]

Hospitals have also shown success in decreasing urinary catheter prevalence and CAUTIs through the multimodal interventions noted earlier.[67,68] One institution used a multifaceted intervention, which included education, system redesign, rewards, and feedback managed

by a dedicated nurse, resulting in a marked decrease in the daily prevalence of urinary catheter days.[67] Strategies to address barriers to the implementation of urinary catheterization bundles include incorporating planned toileting into other patient safety programs, discussing the risk of indwelling urinary catheters with patients and their families, and engaging emergency department personnel to ensure appropriate indications for catheter use are followed have been promoted.[54]

Perioperative Management of Urinary Catheters

Approximately 85% of patients admitted for major surgical procedures have perioperative indwelling catheters. Those patients catheterized longer than 2 days are significantly more likely to develop UTIs and are less likely to be discharged to home.[69] Older surgical patients are at the highest risk for prolonged catheterization; 23% of surgical patients older than 65 years are discharged to skilled nursing facilities with an indwelling catheter in place and have substantially more rehospitalization or deaths within 30 days.[70] Therefore, specific protocols for the management of postoperative urinary catheters are important for reducing urinary catheterization utilization and patient outcomes; the Surgical Care Improvement Project has added the removal of urinary catheters as one of their measures.

In a large prospective trial of patients undergoing orthopedic procedures, patients were entered into the following protocol: (1) limiting catheterization to surgeries of more than 5 hours or for total hip and knee replacements and (2) the removal of urinary catheters on postoperative day 1 after total knee arthroplasty and postoperative day 2 after total hip arthroplasty. This intervention resulted in a two-thirds reduction in the incidence of UTIs.[71]

Alternatives to Indwelling Urinary Catheters

A randomized trial demonstrated a decrease in bacteriuria, symptomatic UTI, or death in patients who used condom catheters when compared with those with indwelling catheters; this benefit was seen primarily in men without dementia.[72] Condom catheters have also been reported to be less painful than indwelling catheters in some men.[72,73] Therefore, condom catheters may be considered in place of indwelling catheters in appropriately selected male patients without urinary retention or bladder outlet obstruction.

Patients with neurogenic bladder and long-term urinary catheters, in particular, may benefit from intermittent catheterization.[50] Intermittent catheterization may also be beneficial for short-term urinary retention. A recent meta-analysis reported a reduced risk of bacteriuria with the use of intermittent catheterization in patients following hip or knee surgery compared with indwelling catheterization.[74] Combining the use of a portable bladder ultrasound scanner with intermittent catheterization may reduce the need for indwelling catheterization.[45,75]

Aseptic Techniques for Insertion and Maintenance of Urinary Catheters

When indwelling catheterization is necessary, aseptic catheter insertion and maintenance is recommended for preventing CAUTIs. Urinary catheters should be inserted by a trained health care professional using a sterile technique.[50] Cleaning the meatus before catheter insertion is recommended; but ongoing daily meatal cleaning with an antiseptic has not

shown benefit and may increase rates of bacteriuria compared with routine care with soap and water.[50] Sterile lubricant jelly should be used for insertion, but antiseptic lubricants are not necessary.[50]

Maintaining a closed urinary catheter collection system is important to reduce the risk of CAUTIs. Opening the closed system should be avoided, especially when sampling urine that may be performed aseptically from a port or from the drainage bag.[50] Prophylactic instillation of antiseptic agents or irrigation of the bladder with antimicrobial or antiseptic agents has shown no benefit in preventing bacteriuria and is not recommended.[50] Finally, routine exchange of urinary catheters is not recommended except for mechanical reasons because bacteriuria and biofilms return quickly.[2]

Use of Antiinfective Catheters

Antiseptic or antimicrobial impregnated urinary catheters have been studied extensively as an adjunctive measure for preventing CAUTIs with variable results.[76,77] However, almost all previous studies used bacteriuria as the primary end point rather than symptomatic UTIs, thus limiting their clinical relevance. In a Cochrane review, silver alloy catheters were found to significantly reduce the incidence of asymptomatic bacteriuria in adult patients catheterized less than 7 days, but the effect was diminished in those catheterized for greater than 7 days.[77] A recent multicenter randomized controlled trial that did use symptomatic CAUTIs as the end point reported no significant clinical benefit with the use of silver alloy-coated or nitrofural-impregnated catheters during short-term (<14 days) catheterization.[78] Few studies have evaluated antiseptic and antimicrobial catheters in long-term urinary catheterization.[79] Therefore, there is no recommendation for routine use of antiinfective urinary catheters to prevent CAUTIs.[50] Despite these recommendations, a national study in 2009 revealed that 45% of nonfederal and 22% of Department of Veterans Affairs hospitals used antimicrobial catheters; hospitals using antiinfective catheters often based their decisions on hospital-specific pilot studies.[12]

IMPLEMENTATION: THE ROLE OF BUNDLES, COLLABORATIVES, AND LEADERSHIP

Recently, bundles of interventions have been used with success for the prevention of HAIs, including CAUTIs. The Bladder Bundle outlined using the mnemonic *ABCDE* in Box 3 applied was successfully adopted by the Michigan Hospital Association Keystone initiative.[49,53] After the implementation of this initiative, Michigan hospitals used more key prevention practices and had a lower rate of CAUTIs when compared with hospitals in the rest of the country.[80] Finally, the important role of local hospital leadership and followership for ensuring effective implementation of preventive initiatives has recently been highlighted.[81–83] The Web site www.catheterout.org provides a list of common barriers along with solutions that hospitals may wish to use in their CAUTI prevention programs.

SUMMARY

CAUTIs are common, costly, and cause significant patient morbidity. CAUTIs are associated with hospital pathogens with a high propensity toward antimicrobial resistance. The treatment of asymptomatic CAUTIs accounts for excess antimicrobial use in hospitals and should be avoided. The duration of urinary catheterization is the predominant risk factor for CAUTI; preventive measures directed at limiting the placement and early removal of urinary catheters have a significant impact on decreasing CAUTIs. Bladder bundles, collaboratives, and the support of hospital leaders are powerful tools for implementing appropriate preventive measures against CAUTI.

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Box 1

Strategies for prevention of CAUTIs

Avoid insertion of indwelling urinary catheters

- Placement only for appropriate indications (see Box 2)
- Institutional protocols for placement, including perioperative setting

Early removal of indwelling catheters

- Checklist or daily plan
- Nurse-based interventions
- Electronic reminders

Seek alternatives to indwelling catheterization

- Intermittent catheterization
- Condom catheter
- Portable bladder ultrasound scanner

Aseptic techniques for care of catheters

- Sterile insertion
- Closed drainage system
- Maintain gravity drainage
- Avoid routine bladder irrigation

Data from Refs.[28,45,46,50]

Box 2

Appropriate indications for indwelling urinary catheters

Acute urinary retention or bladder outlet obstruction

Need for accurate measurements of urinary output

Perioperative use for selected surgical procedures

- Surgical procedures of anticipated long duration
- Urologic procedures
- Intraoperatively for patients with urinary incontinence
- Need for intraoperative urinary monitoring or expected large volume of intravenous infusions

Urinary incontinence in the setting of open perineal or sacral wounds

Improve comfort for end-of-life care or patient preference

Modified from Gould C, Umscheid C, Agarwal R, et al. Healthcare Infection Control Practices Advisory Committee. Guideline for prevention of catheter-associated infections 2009. Infect Control Hosp Epidemiol 2010;31:319–26.

Box 3

The ABCDE for preventing CAUTIs

- Adherence to general infection control principles (eg, hand hygiene, surveillance and feedback, aseptic insertion, proper maintenance, education) is important.
- Bladder ultrasound may avoid indwelling catheterization.
- Condom catheters or other alternatives to an indwelling catheter, such as intermittent catheterization, should be considered in appropriate patients.
- Do not use the indwelling catheter unless you must.
- Early removal of the catheter using a reminder or nurse-initiated removal protocol seems to be warranted.

From Saint S, Olmsted RN, Fakih MG, et al. Translating health care-associated urinary tract infection prevention research into practice via the bladder bundle. Jt Comm J Qual Patient Saf 2009;35(9):449–55; with permission.

KEY POINTS

- Catheter-associated urinary tract infection (CAUTI) is often caused by hospital-based pathogens with a propensity toward antimicrobial resistance.
- The diagnosis of CAUTI is problematic because pyuria and bacteriuria are not reliable markers of infection. The treatment of bacteriuria in the absence of symptoms is not indicated, except in patients at risk of developing pyelonephritis or bloodstream infection (ie, pregnancy, urologic procedures with bleeding).
- Indwelling urinary catheters that have been in place for more than 2 weeks should be removed when treating CAUTI.
- The duration of urinary catheterization is the predominant risk for CAUTI; preventive measures directed at limiting the placement and early removal of urinary catheters significantly reduce CAUTI rates.
- Bladder bundles, collaboratives, and certain behaviors of hospital-based leaders are powerful tools for implementing preventive measures for CAUTI.

Table 1

Selected microorganisms associated with CAUTIs

	LTACHs 2009–2010 % (Rank)	NHSN All Units 2009–2010 % (Rank)
Escherichia coli	14 (3)	26.8 (1)
Candida spp[a]	10 (5)	12.7 (3)
Enterococcus spp[a]	14 (3)	15.1 (2)
Pseudomonas aeruginosa	19 (1)	11.3 (4)
Klebsiella (*pneumoniae/oxytoca*)	17 (2)	11.2 (5)

Abbreviation: LTACH, long-term acute care hospitals.

[a]Species reported by Sievert et al[21] combined; therefore, rankings modified.

Data from Chitnis A, Edwards J, Ricks P, et al. Device-associated infection rates, device utilization, and antimicrobial resistance in long-term acute care hospitals reporting to the National Healthcare Safety Network, 2010. Infect Control Hosp Epidemiol 2012;33(10):993–1000; and Sievert D, Ricks P, Edwards J, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2009–2010. Infect Control Hosp Epidemiol 2013;34(1):1–14.

Table 2

Risk factors for CAUTIs

Modifiable Risk Factors	Nonmodifiable Risk Factors
Duration of catheterization	Female sex
Nonadherence to aseptic catheter care (ie, opening closed system)	Severe underlying illness
Lower professional training of inserter	Nonsurgical disease
Catheter insertion outside operating room	Aged >50 y Diabetes mellitus Serum creatinine >2 mg/dL