Urinary Tract Infections
2021 Update

Carol E. Chenoweth, MD

KEYWORDS

• Prevention • Catheter-associated urinary tract infection
• Health care–associated infection • Urinary catheter

KEY POINTS

- Catheter-associated urinary tract infections (CAUTIs) are common and costly.
- CAUTI is often caused by hospital-based pathogens with a propensity toward antimicrobial resistance.
- Duration of urinary catheterization is the predominant risk for CAUTI; preventive measures directed at limiting placement and early removal of urinary catheters can successfully decrease catheter use and CAUTI rates.
- Intervention bundles and collaboratives are powerful tools for implementing preventive measures for health care–associated infections, including CAUTI.

INTRODUCTION

Preventive measures have improved the incidence of health care–associated urinary tract infections (UTIs) in US hospitals, but the Centers for Disease Control and Prevention (CDC) estimated that, in 2011, 93,300 catheter-associated UTIs (CAUTIs) occurred in US hospitals.[1] UTI still accounts for 12.9% of health care–associated infections (HAIs) and 23% of infections in the intensive care unit (ICU).[1–3] Most UTIs are related to indwelling urinary catheters; approximately 70% of UTIs (and 95% of UTIs occurring in ICUs) develop in patients with urinary catheters.[4]

CAUTI has significant impact on clinical outcomes, including mortality, length of hospital stay, and cost.[5,6] It is estimated that 65% to 70% of these infections are preventable,[7,8] thus the Centers for Medicare and Medicaid Services (CMS) has not reimbursed hospitals for the extra costs of managing patients with hospital-acquired CAUTI for more than a decade.[9] As a result, prevention of CAUTI has become a priority for most hospitals. This article reviews the epidemiology and pathogenesis, with a focus on preventing CAUTI.

Division of Infectious Diseases, Department of Internal Medicine, University of Michigan Medical School, F4141 South University Hospital, 1500 E. Medical Center Drive, Ann Arbor, MI 48109-5226, USA
E-mail address: cchenow@umich.edu

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PATHOGENESIS

Humans have innate defense mechanisms, such as length of urethra and micturition, that prevent attachment and migration of pathogens into the bladder; urinary catheters interfere with these natural defenses.[2,10] Biofilms, composed of clusters of microorganisms and extracellular matrix, deposit on all surfaces of urinary catheters and allow bacterial attachment.[11,12] Biofilms also provide a protective environment from immune cells and antimicrobials. In addition, microorganisms grow more slowly in biofilms, decreasing the effects of many antimicrobials.[11,12] Despite slow growth, microorganisms within the biofilm may ascend the catheter to the bladder in 1 to 3 days. Typically, the biofilm is composed of 1 type of microorganism, although polymicrobial biofilms are possible.[11,12]

Most microorganisms causing CAUTI are endogenous organisms colonizing the patient's intestinal tract and perineum, entering the bladder by ascending the urethra from the perineum.[13] Approximately 66% of the time, organisms migrate in the biofilm on the external surface of the catheter. A smaller proportion of infections (~34%) are acquired from intraluminal contamination of the collection system from exogenous sources resulting from cross-transmission of organisms from the hands of health care personnel.[12,13] Rarely, organisms such as *Staphylococcus aureus* spread from a hematogenous source and cause upper UTI.

Most CAUTIs are caused by microorganisms from the patient's own gastrointestinal tract; however, approximately 15% of episodes of health care–associated bacteriuria occur in clusters from intrahospital transmission from one patient to another.[2,12] Most of these hospital-based outbreaks have been associated with improper hand hygiene by health care personnel.

EPIDEMIOLOGY OF CATHETER-ASSOCIATED URINARY TRACT INFECTION

Rates of CAUTI in US hospitals have declined significantly since 1990, because of increased emphasis on prevention.[14] Rates of CAUTI in ICUs, reported through the National Healthcare Safety Network (NHSN) in 2013, ranged from to 1.3 UTIs/1000 catheter-days in small medical/surgical ICUs to 5.3 UTIs/1000 catheter-days in neurosurgical ICUs. General care wards had rates of CAUTI similar to the ICU setting, ranging from 0.2 to 3.2/1000 catheter-days; the highest rates occurred in hematology and rehabilitation wards.[15] CAUTIs in pediatric ICUs occur at a rate of 0 to 3.4 UTIs/1000 catheter-days; CAUTI rates in pediatric ICUs in the United States may not be decreasing as in other ICUs.[15,16] In a community hospital consortium, rates of CAUTI were found to be similar in ICU and non-ICU care units, but 72% of CAUTIs occurred in non-ICU patients, suggesting targeted prevention efforts for non-ICU patients may have a significant impact.[17] In non-US settings, rates of CAUTI reported through the International Nosocomial Infection Control Consortium 2010 to 2015, were generally higher than those reported through NHSN, with a range of 1.66 CAUTIs/1000 catheter-days in surgical cardiothoracic ICUs to 17.17 CAUTIs/1000 catheter-days in neurologic ICUs.[18] In addition, NHSN has recently reported CAUTI surveillance data collected between 2013 and 2016, in long-term care facilities in the United States; rates of CAUTI (0.49 CAUTI/1000 catheter-days) were lower than previously reported rates from hospitals discussed earlier.[19]

Microbial Cause of Catheter-associated Urinary Tract Infection

Enterobacteriaceae are the most common pathogens associated with CAUTI,[20] but, in the ICU setting, *Pseudomonas* sp, *Candida* sp, and *Enterococcus* sp become more prevalent.[20,21] Antimicrobial resistance in CAUTI isolates from ICU patients has

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increased in recent decades; in summary reports from the NHSN 2015 to 2017, 31.1% of *Escherichia coli* isolates from patients with CAUTIs were nonsusceptible to fluoroquinolones.[20] In addition, 16.6% of *Klebsiella* sp and 16% of *E coli* isolates from patients with CAUTIs produced extended-spectrum beta-lactamases (ESBLs).[20] Resistance to antibiotics in CAUTI isolates was even greater in long-term acute care hospitals, where 48.2% of *Klebsiella* sp showed ESBL-mediated (48%) or carbapenem resistance (23.1%).[20]

Risk Factors for Catheter-associated Urinary Tract Infection

Up to 95% of UTIs in the ICU are associated with an indwelling urinary catheter; duration of catheterization is the most important risk factor for CAUTI.[17,22] The precursor of CAUTI is bacteriuria, which develops at an average rate of 3% to 10% per day of catheterization. Virtually all patients catheterized for a month develop bacteriuria, so catheterization for longer than 1 month is generally defined as long-term catheterization.[22]

Table 1 outlines major risk factors for CAUTI. Women have a higher risk of bacteriuria than men, and heavy bacterial colonization of the perineum increases that risk. Other patient factors identified in 1 or more studies include rapidly fatal underlying illness, age greater than 50 years, nonsurgical disease, hospitalization on an orthopedic or urologic service, catheter insertion after the sixth day of hospitalization, catheter inserted outside the operating room, diabetes mellitus, and serum creatinine level greater than 2 mg/dL at the time of catheterization. Nonadherence to aseptic catheter care recommendations has been associated with increased risk of bacteriuria, whereas systemic antimicrobial agents have a protective effect on bacteriuria (relative risk = 2.0–3.9).[22] Additional risk factors for hospitalized children include prematurity, underlying urogenital abnormalities, neurologic disorders, and immune compromised state.[23,24]

Catheter-associated bacteremia occurs in fewer than 4% of CAUTIs[25,26]; therefore, risk factors for UTI-associated bacteremia are incompletely understood. Risk factors for bloodstream infections from a urinary source from early studies included infections caused by *Serratia marcescens*, male sex, immunosuppressant therapy, history of malignancy, cigarette use in the past 5 years, and number of hospital days before bacteriuria.[26,27] In more recent studies, independent predictors of bloodstream infection included neutropenia, diabetes mellitus, malignancy, renal disease, and male sex[26,28]; prevention strategies for those patients at highest risk of bacteremia should be considered in an overall CAUTI prevention program.

Table 1
Risk factors for catheter-associated urinary tract infection

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	Age>50 y
Catheter insertion after sixth day of hospitalization	Diabetes mellitus
—	Serum creatinine >2 mg/dL

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SURVEILLANCE FOR CATHETER-ASSOCIATED URINARY TRACT INFECTIONS

An essential element of any improvement initiative is to measure the prevalence of the condition or surrogate marker, with feedback of the results of interventions to clinical care providers. The NHSN surveillance definition for health care–associated UTI has been the standard for interhospital comparison of CAUTI rates.[29]

Clinical diagnosis of CAUTI remains challenging, because bacteriuria is not a reliable indicator of symptomatic UTI in the setting of catheterization.[30,31] However, results of cultures may be affected by collection technique; improperly handled cultures may grow significant numbers of bacteria.[32,33]

Urine cultures are often collected for inappropriate reasons or as part of a generic fever evaluation, without symptoms referable to the urinary tract.[34,35] In such cases, asymptomatic bacteriuria may result in designation of CAUTI in surveillance data, even when another source of fever has been identified.[2] Interventions promoting the stewardship of cultures, as part of a multifaceted approach, have resulted in improvement in CAUTI rates in ICUs.[36] In addition to lack of specificity, the culture-based definitions of CAUTI may lack sensitivity.[37]

Positive urine cultures often lead to inappropriate treatment of asymptomatic UTI.[38–40] However, the distinction of asymptomatic versus symptomatic UTI is clinically important, because asymptomatic catheter-associated bacteriuria rarely results in adverse outcomes[30,41] and treatment is not recommended.[41]

The NHSN symptomatic CAUTI rate (UTIs per 1000 urinary catheter-days) is the most widely accepted measure for infection surveillance, and is endorsed by the CDC and Society for Healthcare Epidemiology of America/Infectious Diseases Society of America practice recommendation. However, as hospitals decrease their catheterization use, a paradoxic increase in rate of UTI per 1000 catheter-days may be observed.[42] This increase has led some experts to recommend the rate of UTIs per patient-days or device use as a more appropriate outcome measure for CAUTI prevention initiatives.[43–45] A recent study suggests that health care–associated CAUTI may be common within 30 days after hospital discharge, suggesting that surveillance efforts may need to be expanded[46]; more studies will be necessary to confirm the significance of this finding.

Because CMS has included CAUTI as one of the hospital-acquired complications that will not be reimbursed, hospitals have had increased attention on CAUTI rates.[9,47,48] In addition, beginning in 2012, CMS has required, as a condition of participation, that hospitals submit ICU-level CAUTI rates to NHSN. To date, the CMS hospital-acquired conditions policy does seem to have resulted in immediate reductions, followed by possible leveling off, in billing rates for CAUTI from US hospitals.[47,48]

PREVENTING CATHETER-ASSOCIATED URINARY TRACT INFECTION

Several guidelines have been developed for prevention of CAUTI.[49–51] It has been estimated that an intervention resulting in a feasible reduction in urinary catheter use could lead to a ~50% reduction in CAUTI-related costs.[52] General strategies have been formulated for prevention of all HAIs, whereas specific strategies have been targeted at risk factors for CAUTI (**Box 1**).

General Strategies for Prevention

Most outbreaks of urinary pathogens have been linked to inadequate employee hand hygiene; strict adherence to hand hygiene is essential for prevention of all HAIs, including UTI.[53] The urinary tract of hospitalized patients, especially those in an ICU setting, represents a significant reservoir for multidrug-resistant organisms

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Box 1
Key strategies for prevention of catheter-associated urinary tract infection

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 reminder
- Nurse-based or physician-based interventions
- Electronic reminders
- Automatic stop orders

Consider alternatives to indwelling catheterization
- Intermittent catheterization
- Condom catheter
- Portable bladder ultrasonography scanner

Proper techniques for insertion and maintenance of catheters
- Sterile insertion
- Secure catheter to prevent movement
- Maintain closed drainage system
- Maintain unobstructed urine flow
- Avoid routine bladder irrigation

Institutional support for CAUTI prevention program
- Policy development and implementation
- Education
- Surveillance for catheter use, CAUTI

Data from Refs.[49–51]

(MDROs).[20] Indwelling devices, including urinary catheters, increase the risk of colonization with MDROs, and therefore limiting their use is an important strategy for prevention of MDRO transmission in health care settings.[54]

Judicious use of antibiotics, as part of an overall antimicrobial stewardship program, is an important strategy to prevent development of antimicrobial resistance related to urinary catheters.[54,55] Inappropriate antimicrobial treatment of bacteriuria in hospitalized patients, especially those with indwelling catheterization, is a significant risk for colonization with MDROs.[35,39,40,55] Educational sessions and audit and feedback to care providers have been used successfully to decrease overdiagnosis of CAUTI and associated inappropriate antibiotic use.[56,57]

Systemic antimicrobial therapy reduces the risk of CAUTI.[22] However, because of issues of cost, potential adverse effects, and selection for multidrug-resistant organisms, systemic antimicrobial therapy for the purpose of preventing CAUTI is not currently recommended.[50] A recent meta-analysis suggests that antimicrobial treatment at the time of removal of a short-term (<14 days) urinary catheter, reduces the risk of UTI.[58] Studies are needed to further define those patients in whom the benefit of reducing UTI outweigh these risks of antimicrobial therapy at the time of urinary catheter removal.[58]

Specific Strategies for Prevention

Limitation of use of urinary catheters

The dominant risk factor for health care–associated UTI is the presence of an indwelling urinary catheter; therefore, the most important strategy for CAUTI prevention is avoiding or limiting urinary catheterization.[49,50] Regional geographic variations

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in urinary catheter use have been identified, suggesting there is room for improvement of catheter usage.[59]

Decreasing catheter usage requires interventions at several stages of the life cycle of a urinary catheter.[60] A critical first step is avoiding placement of indwelling urinary catheters; catheters should be inserted only for appropriate indications (**Box 2**).[50] Despite these recommendations, urinary catheters are placed for inappropriate indications in 21% to 50% of catheterized patients.[59,62,63] Many institutions, believing they followed national guidelines, allowed indications for urinary catheter use that were not currently recommended in guidelines.[62] In addition, multiple perceptions of risk, some non–evidence based, were used by health care providers to determine whether urinary catheter use was necessary; CAUTI prevention initiatives should be formulated with the awareness of these other perceived risks with strategies to address those that are not evidence based.[64]

In a statewide CAUTI prevention initiative, barriers to reducing catheterization included catheter insertion practices in the emergency department.[65] Therefore, successful interventions may be targeted at hospital locations where initial urinary catheter placement usually occurs, such as emergency departments and operating rooms.[45]

Once placed, strategies for early removal of urinary catheters become essential. Urinary catheter management based on physicians' orders alone may be inadequate because physicians are frequently unaware that a patient has a urinary catheter. In 1 study, 28% of physicians were unaware that their patients had catheters, with lack of awareness increasing with level of training.[63] In addition, surveys of house staff reported that although house staff were aware of CAUTI prevention guidelines,

Box 2
Indications for indwelling urinary catheters

Urinary retention
- Acute urinary retention without bladder outlet obstruction
- Acute urinary obstruction with bladder outlet obstruction caused by noninfectious, nontraumatic diagnosis
- Chronic urinary retention with bladder outlet obstruction

Stage III, IV, or unstageable pressure ulcer or other severe wounds that cannot be kept clean despite other strategies

Urinary incontinence that cannot be addressed by noncatheter methods

Accurate monitoring of urine output or urine collection
- Hourly measurement of urine volume required for treatment
- Daily measurement of urine volume that is required and cannot be assessed by other urine collection strategies
- Single 24-hour urine sample collection for a diagnostic test that cannot be collected through other means

Management of gross hematuria with blood clots in urine

Improvement of patient comfort
- Address patient and family goals for dying patients
- Reduce acute, severe pain with movement when other urine management strategies are difficult
- Clinical condition for which intermittent catheterization or external catheter placement was difficult or bladder emptying was inadequate

Data from Refs.[49,50,61]

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application of catheter prevention practices generally fell short of national goals.[66,67] Nurse- or computer-generated reminders or automatic stop orders are important tools for early removal of urinary catheters; a systematic review and meta-analysis reported that urinary catheter reminder systems and stop orders seemed to reduce mean duration of catheterization by 37% and CAUTI by 52%.[68]

Nurse-driven interventions have shown effectiveness in reducing duration of catheterization.[69,70] Such interventions are easy to implement and may consist of either a written notice or a verbal contact with the physician regarding the presence of a urinary catheter and alternative options. A statewide CAUTI initiative, using this strategy, resulted in a significant decrease in catheter use and increase in appropriate indications of catheters.[69] Physician-initiated reminders may be more effective than nurse-initiated reminders for decreasing duration of urinary catheterization.[71] Barriers to implementation of nurse-driven intervention included difficulty with physician and nurse engagement[45]; strategies for health care worker engagement are discussed later.

Computerized physician order entry systems may offer a more cost-effective and efficient system to reduce both placement of catheters and duration of catheterization.[68,72,73] Cornia and colleagues[73] found that a computerized reminder reduced the duration of catheterization by 3 days. A more recent study of a computerized clinical decision support system decreased urinary catheter use from 0.22 to 0.19 ($P<.001$) and CAUTI from 0.84 CAUTI/1000 patient-days to 0.51 CAUTI/1000 patient-days ($P<.001$).[72]

Perioperative management of urinary catheters

Most patients undergoing major surgical procedures have a perioperative indwelling urinary catheter.[74,75] Those catheterized longer than 2 days are much more likely to develop UTIs and are less likely to be discharged to home. Older surgical patients are at highest risk for prolonged catheterization; 23% of surgical patients older than 65 years of age were discharged to skilled nursing facilities with an indwelling catheter in place and had more rehospitalization or death within 30 days.[2]

Postoperative urinary retention developed in 2.1% of patients undergoing one of the Surgical Care Improvement Project (SCIP) surgeries.[75] Patients who developed postoperative retention were more likely to be older men undergoing knee, hip, or colon surgery. This group has significance because they are at risk of requiring recatheterization. Combining the use of a portable bladder ultrasonography scanner with intermittent catheterization may reduce the need for indwelling catheterization in postsurgical patients with urinary retention.[50]

Alternatives to indwelling urinary catheters

Avoiding urinary catheter placement with use of alternative urinary drainage systems has been used successfully in some situations. Patients with neurogenic bladder and long-term urinary catheters, in particular, may benefit from intermittent catheterization instead of indwelling urinary catheterization.[49,50] Combining the use of a portable bladder ultrasonography scanner with intermittent catheterization has been recommended to reduce the need for indwelling urinary catheterization.[50]

Condom catheters may also be considered in place of indwelling catheters in male patients without urinary retention or bladder outlet obstruction. A randomized trial showed a decrease in bacteriuria, symptomatic UTI, or death in patients with condom catheters, compared with those with indwelling catheters; the benefit was primarily seen in men without dementia.[76] In addition, condom catheters may cause less discomfort than indwelling catheters in some men.[76]

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Aseptic techniques for insertion and maintenance of urinary catheters

If indwelling urinary catheterization is deemed necessary, proper aseptic technique during catheter insertion and catheter care is essential for prevention of CAUTI. During 81 catheter insertions observed in a busy emergency department, 59% of the insertions were associated with major breeches of aseptic technique.[77] It is also important that urinary catheters be inserted by a trained health care professional using aseptic technique.[49,50] Cleaning the urethral meatus at the time of catheter insertion is recommended, but daily meatal cleaning thereafter with an antiseptic may increase rates of bacteriuria compared with routine care with soap and water.[49,50]

Closed urinary catheter collection systems reduce the risk of CAUTI; sampling urine may be performed aseptically from a port or from the drainage bag when large, nonsterile samples are required.[49,50] Prophylactic instillation of antiseptic agents or irrigation of the bladder with antimicrobial or antiseptic agents leads to increased infections and is not recommended.[49,50]

Bacteriuria may be reduced with exchange of catheters, but this reduction is transient. Therefore, routine exchange of urinary catheters is not recommended, except for mechanical reasons.[49,50] However, exchange of long-term catheters with treatment of symptomatic UTI is likely beneficial.[78]

Use of anti-infective catheters

Antimicrobial-impregnated catheters, typically coated with nitrofurazone, minocycline, or rifampin, and antiseptic catheters have been studied extensively as an adjunctive measure for CAUTI prevention, with variable results.[79,80] A multicenter, randomized controlled trial that used symptomatic CAUTI as the end point reported no significant clinical benefit with use of silver alloy–coated or nitrofural-impregnated catheters during short-term (<14 days) catheterization.[80] A Cochrane Review similarly found that silver alloy catheters did not significantly reduce the incidence of symptomatic UTI in adult patients.[79] Therefore, current guidelines do not recommend routine use of anti-infective urinary catheters to prevent CAUTI.[50]

Other preventive measures

Body surface decolonization with a short course of intranasal mupirocin and chlorhexidine bathing was found to decrease candiduria and bacteriuria in men, but not in women.[81] Another study of chlorhexidine bathing in ICUs found no benefit in the prevention of CAUTI. More studies are needed to describe whether targeted chlorhexidine bathing could benefit high-risk patients.[82]

Implementation: the role of bundles and collaboratives

Despite CAUTI prevention guidelines having been published for several decades, prevention measures have been inconsistently applied in US hospitals. A national survey of US hospitals from 2005 to 2013 showed that use of catheter reminder systems increased from 9% in 2005 to 53.3% in 2013. Surveillance for CAUTI increased from 46.9% of hospitals to 85.1% during the same time period.[83] There still remains much room for improvement in implementation of CAUTI prevention measures.

Recently, bundles of interventions, often in association with hospital collaborations, have been used with success for prevention of HAIs, including CAUTI.[84,85] A multifaceted approach was used successfully in 2 Veterans' Affairs hospitals with good success.[86,87] Similar improvement projects have been implemented effectively in pediatric hospitals[23,88] and community long-term care facilities.[89] A national collaborative program to prevent CAUTI in Veterans Health Administration nursing homes was less effective, presumably because of a low baseline rate of infection.[90]

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Box 3
The bladder bundle for preventing catheter-associated urinary tract infection

- Adherence to general infection control principles (eg, hand hygiene, surveillance and feedback, aseptic insertion, proper maintenance, education) is important
- Bladder ultrasonography 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 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;35:449-455; with permission

A bladder bundle, outlined in **Box 3**, was successfully adopted by the Michigan Hospital Association Keystone initiative[61,69] and resulted in more Michigan hospitals using key prevention practices and a lower rate of CAUTI compared with hospitals in the rest of the country. This type of collaborative program has been expanded to national initiatives for hospitals[84,85] and nursing homes.[89]

SUMMARY

CAUTIs are common, costly, and cause significant patient morbidity. Despite studies showing benefit of interventions for prevention of CAUTI, adoption of these practices has not occurred consistently in many health care facilities in the United States. Duration of urinary catheterization is the predominant risk for CAUTI; preventive measures directed at limiting placement and early removal of urinary catheters have a significant impact on decreasing CAUTIs. Intervention bundles, collaboratives, and hospital leadership are powerful tools for implementing preventive measures for HAIs, including CAUTIs.

CLINICS CARE POINTS

- The need for indwelling urinary catheters should be assessed daily, with removal of catheters as soon as possible.
- Alternatives to indwelling urinary catheters, such as external catheters and intermittent straight catheterization can decrease risk of CAUTI.
- Institutional initiatives focused on limiting use of indwelling urinary catheters have been successful in decreasing CAUTI in multiple settings.

DISCLOSURE

None.

REFERENCES

1. Magill S, Edward J, Bamberg W, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014;370(13):1198–208.

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2. Chenoweth CE, Saint SS. Urinary tract infections. Infec Dis Clinic N Amer 2016; 30:869–85.
3. Zingg W, Metsini A, Balmelli C, et al. National point prevalence survey on healthcare-associated infections in acute care hospitals, Switzerland, 2017. Euro Surveill 2019;24(32):1–11.
4. Burton D, Edwards J, Srinivasan A, et al. Trends in catheter-associated urinary tract infection in adult intensive care units-United States, 1990–2007. Infect Control Hosp Epidemiol 2011;32:748–56.
5. Mitchell B, Ferguson J, Anderson M, et al. Length of stay and mortality associated with healthcare-associated urinary tract infections: a multistate model. J Hosp Infect 2016;93(1):92–9.
6. Zimlichman E, Henderson D, Tamir O, et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US care system. JAMA Intern Med 2013;173(22):2039–46.
7. Schreiber PW, Sax H, Wolfensberger A, et al. The preventable proportion of healthcare-associated infections 2005-2016: systematic review and meta-analysis. Infect Control Hosp Epidemiol 2018;39:1277–95.
8. Umsheid C, Mitchell M, Doshi J, et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol 2011;32:101–14.
9. Saint S, Meddings J, Calfee D, et al. Catheter-associated urinary tract infection and the Medicare rule changes. Ann Intern Med 2009;150:877–84.
10. Nicolle LE. Catheter-related urinary tract infection. Drugs Aging 2005;22:627–39.
11. Donlan RM, Costertan JW. Biofilms: survival mechanisms of clinically relevant microorganisms. Clin Microbiol Rev 2002;15:167–93.
12. Saint SS, Chenoweth C. Biofilms and catheter-associated urinary tract infections. Infect Dis Clin N Am 2003;17:411–32.
13. Tambyah PA, Halvorson KT, Maki DG. A prospective study of pathogenesis of catheter-associated urinary tract infections. Mayo Clin Proc 1999;74:131–6.
14. Magill SS, O'Leary E, Janelle SJ, et al. Changes in prevalence of health care-associated infections in U.S. hospitals. N Engl J Med 2018;379(18):1732–44.
15. Dudeck M, Edwards J, Allen-Bridson K, et al. National Healthcare Safety Network report, data summary for 2013, device associated module. Am J Infect Control 2015;43(3):206–21.
16. Patrick S, Kawai A, Kleinman K, et al. Health care-associated infection among critically ill children in the US, 2007-2012. Pediatrics 2014;134(4):705–7012.
17. Weber D, Sickbert-Bennett E, Gould C, et al. Incidence of catheter-associated and non-catheter-associated urinary tract infections in a healthcare system. Infect Control Hosp Epidemiol 2011;32:822–3.
18. Rosenthal V, Al-Aabdeli H, El-Kholy A, et al. International nosocomial infection control consortium report, data summary of 50 countries for 2010-2015; device-associated module. Am J Infect Control 2016;44:1495–504.
19. Palms DL, Mungai E, Eure T, et al. The National Healthcare Safety Network long-term care facility component early reporting experience: Jan 2013-December 2015. Am J Infect Control 2018;46:637–42.
20. Weiner-Lastinger LM, Abner S, Edwards JR, et al. Antimicrobial-resistant pathogens associated with adult healthcare-associated infections: Summary of data reported to the National Healthcare Safety Network, 2015-2017. Infect Control Hosp Epidemiol 2020;41(1):1–18.
21. Chitnis A, Edwards J, Ricks P, et al. Device-associated infection rates, device utilization, and antimicrobial resistance in long-term acute care hospitals reporting

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to the National Healthcare Safety Network, 2010. Infect Control Hosp Epidemiol 2012;33:933–1000.
22. Shuman EK, Chenoweth C. Urinary catheter-associated infections. Infec Dis Clinic N Amer 2018;32:886–97.
23. Davis KF, Colebaugh AM, Eithun BL, et al. Reducing catheter-associated urinary tract infections: a quality-improvement initiative. Pediatrics 2014;134:e8557–864.
24. Langley JM, Hanakowski M, LeBlanc JC. Unique epidemiology of nosocomial urinary tract infection in children. Am J Infect Control 2001;29:94–8.
25. Chang R, Greene MT, Chenoweth CE, et al. Epidemiology of hospital-acquired urinary tract-related bloodstream infection at a university hospital. Infect Control Hosp Epidemiol 2011;32:1127–9.
26. Greene MT, Chang R, Kuhn L, et al. Predictors of hospital-acquired urinary tract-related bloodstream infection. Infect Control Hosp Epidemiol 2012;33:1001–7.
27. Krieger JN, Kaiser DL, Wenzel RP. Urinary tract etiology of bloodstream infections in hospitalized patients. J Infect Dis 1983;148:57–62.
28. Patel P, Greene MT, Rogers MAM, et al. The epidemiology of hospital-acquired urinary tract-related bloodstream infection in veterans. Am J Infect Control 2018;46(7):747–50.
29. CDC. Urinary tract infection (Catheter-associated urinary tract infection {CAUTI} and non-catheter-associated urinary tract infection [UTI] Events. 2021. Available at: https://wwwcdcgov/nhsn/pdfs/validation/2020/pcsmanual_2020-508pdf. Accessed June 11, 2021.
30. Tambyah PA, Maki D. Catheter-associated urinary tract infection is rarely symptomatic: a prospective study of 1,497 catheterized patients. Arch Intern Med 2000;160:678–82.
31. Tambyah PA, Maki D. The relationship between pyuria and infection in patients with indwelling urinary catheters: a prospective study of 761 patients. Arch Intern Med 2000;160:673–7.
32. Jones K, Sibaie J, Battjes R, et al. How and why nurses collect urine cultures on catheterized patients: a survey of 5 hospitals. Am J Infect Control 2016;44:173–6.
33. LaRocco M, Franek J, Leibach E, et al. Effectiveness of preanalytic practices on contamination and diagnostic accuracy of urine cultures: a laboratory medicine best practices systematic review and meta-analysis. Clin Micro Rev 2016;29(1):105–46.
34. Advani SD, Gao CA, Sann L, et al. Knowledge and practices of physicians and nurses related to urine cultures in catheterized patients: an assessment of adherence to IDSA guidelines. Open Forum Infect Dis 2019;6(8):ofz305.
35. Hartley S, Valley S, Kuhn L, et al. Inappropriate testing for urinary tract infection in hospitalized patients: an opportunity for improvement. Infect Control Hosp Epidemiol 2013;34(11):1204–7.
36. Mullin KM, Kovacs CS, Fatica C, et al. A multifaceted approach to reduction of catheter-associated urinary tract infections in the intensive care unit with an emphasis on "stewardship of culturing. Infect Control Hosp Epidemiol 2017;38(2):186–8.
37. Greene MT, Ratz D, Meddings J, et al. Potential misclassification of urinary tract-related bacteremia upon applying the 2015 NHSN catheter-associated urinary tract infection surveillance definition. Infect Control Hosp Epidemiol 2016;37(4):469–71.
38. Grein J, Kahn K, Eells S, et al. Treatment of positive urine cultures in hospitalized adults: a survey of prevalence and risk factors. Infect Control Hosp Epidemiol 2016;37(3):319–26.

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39. Hartley S, Valley S, Kuhn L, et al. Overtreatment of asymptomatic bacteriuria: Identifying targets for intervention. Infect Control Hosp Epidemiol 2015;36(4): 470–3.
40. Trautner B, Petersen N, Hysong S, et al. Overtreatment of asymptomatic bacteriuria: identifying barriers to evidence-based care. Am J Infect Control 2014;42: 653–8.
41. Nicolle LE, Gupta K, Bradley SF, et al. Clinical practice guideline for the management of asymptomatic bacteriuria: 2019 update by the Infectious Disease Society of America. Clin Infect Dis 2019;68(10):e83–110.
42. Wright M-O, Kharasch M, Beaumont J, et al. Reporting catheter-associated urinary tract infections: denominator matters. Infect Control Hosp Epidemiol 2011; 32:635–40.
43. Advani SD, Fakih M. The evolution of catheter-associated urinary tract infection (CAUTI): is it time for more inclusive metrics? Infect Control Hosp Epidemiol 2019;40:681–5.
44. Fakih M, Gould C, Trautner B, et al. Beyond infection: device utilization ratio as a performance measure for urinary catheter harm. Infect Control Hosp Epidemiol 2016;37(3):327–33.
45. Fakih M, Pena M, Shemes S, et al. Effect of establishing guidelines on appropriate urinary catheter placement. Acad Emerg Med 2010;17:337–40.
46. Elman MR, Williams CD, Bearden DT, et al. Health-care associated urinary tract infections with onset post hospital discharge. Infect Control Hosp Epidemiol 2019;40:863–71.
47. Kawai A, Calderwood M, Jin R, et al. Impact of the Centers for Medicare and Medicaid Services hospital acquired conditions policy on billing rates of 2 targeted healthcare-associated infections. Infect Control Hosp Epidemiol 2015; 36(2):871–7.
48. Waters T, Daniels M, Bazzoli G, et al. Effect of Medicare's nonpayment for hospital-acquired conditions: lessons for future policy. JAMA Intern Med 2015; 175(3):347–54.
49. Gould C, Umscheid C, Agarwal R, et al. CDC Guideline for prevention of catheter-associated infections 2009. Infect Control Hosp Epidemiol 2010;31:319–26.
50. Lo E, Nicolle L, Coffin S, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35(S2):S32–47.
51. Rebmann T, Greene L. Preventing catheter-associated urinary tract infections: an executive summary of the Association for Professionals in Infection Control and Epidemiology. Am J Infect Control 2010;38:644–6.
52. Kennedy E, Greene M, Saint S. Estimating hospital costs of catheter-associated urinary tract infection. J Hosp Med 2013;2013(8):644–6.
53. Boyce J, Pittet D. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR Recomm Rep 2002;51:1–45.
54. Dellit T, Owens R, McGowan J Jr, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. Clin Infect Dis 2007;44:159–77.
55. Gandhi T, Flanders S, Markovitz E, et al. Importance of urinary tract infection to antibiotic use among hospitalized patients. Infect Control Hosp Epidemiol 2009;30:193–5.

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56. Trautner B, Grigoryan L, Petersen N, et al. Effectiveness of an antimicrobial stewardship approach for urinary catheter-associated asymptomatic bacteriuria. JAMA Intern Med 2015;175(7):1120–7.
57. Trautner B, Kelly P, Petersen N, et al. A hospital-site controlled intervention using audit and feedback to implement guidelines concerning inappropriate treatment of catheter-associated asymptomatic bacteriuria. Implement Sci 2011;6:41.
58. Marshall J, Carpenter C, Fowler S, et al. Antibiotic prophylaxis for urinary tract infections after removal of urinary catheter: metanalysis. BMJ 2013;2013(356): f3147.
59. Greene M, Fakih M, Fowler K, et al. Regional variation in urinary catheter-associated urinary tract infections in acute care hospitals. Infect Control Hosp Epidemiol 2014;35(S3):S99–106.
60. Meddings J, Saint S. Disrupting the life cycle of the urinary catheter. Clin Infect Dis 2011;52:1291–3.
61. 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;35:449–55.
62. Greene MT, Kiyoshi-Teo H, Reichert H, et al. Urinary catheter indications in the United States: results from a national survey of acute care hospitals. Infect Control Hosp Epidemiol 2014;35(S3):S96–8.
63. Saint S, Weise J, Amory JK, et al. Are physicians aware of which of their patients have indwelling catheters? Am J Med 2000;109:476–80.
64. Harrod M, Kowalski C, Saint S, et al. Variation in risk perceptions: a qualitative study of why unnecessary urinary catheter use continues to be problematic. BMC Health Serv Res 2013;13:151.
65. Krein S, Kowalski C, Harrod M, et al. Barriers to reducing urinary catheter use: a qualitative assessment of a statewide initiative. JAMA Intern Med 2013;173(10): 881–6.
66. Apisarnthanarak A, Damronglerd P, Meesing A, et al. Impact on physicians' mindfulness attitudes toward prevention of catheter-associated urinary tract infections. Infect Control Hosp Epidemiol 2014;35(9):1198–9.
67. Paras M, Shenoy E, Hsu H, et al. Housestaff knowledge related to urinary catheter use and catheter-associated urinary tract infections. Infect Control Hosp Epidemiol 2015;36(11):1355–7.
68. Meddings J, Rogers MA, Macy M, et al. Systematic review and meta-analysis: reminder systems to reduce catheter-associated urinary tract infections and urinary catheter use in hospitalized patients. Clin Infect Dis 2010;51:550–60.
69. Fakih M, Watson S, Greene MT, et al. Reducing inappropriate urinary catheter use: a statewide effort. Arch Intern Med 2012;172:255–60.
70. Huang WC, Wann S, Lin SL, et al. Catheter-associated urinary tract infections in intensive care units can be reduced by prompting physicians to remove unnecessary catheters. Infect Control Hosp Epidemiol 2004;25:974–8.
71. Felix L, Smith B, Santos E, et al. Physician-initiated daily verbal reminders decrease the duration of indwelling urinary catheter use compared to nurse-initiated reminders. Am J Infect Control 2016;44:346–8.
72. Baillie C, Epps M, Hanish A, et al. Usability and impact of a computerized clinical decision support intervention designed to reduce urinary catheter utilization and catheter-associated urinary tract infections. Infect Control Hosp Epidemiol 2014; 35(1):1147–55.

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73. Cornia PB, Amory JK, Fraser S, et al. Computer-based order entry decreases duration of indwelling urinary catheterization in hospitalized patients. Am J Med 2003;114:404–7.
74. Stephan F, Sax H, Wachsmuth M, et al. Reduction of urinary tract infection and antibiotic use after surgery: a controlled, prospective, before-after intervention study. Clin Infect Dis 2006;42:1544–51.
75. Wu A, Aurback A, Aaronson D. National incidence and outcomes of postoperative urinary retention in the Surgical Care Improvement Project. Am J Surg 2012;204:167–71.
76. Saint S, Kaufman SR, Rogers MA, et al. Condom versus indwelling urinary catheters: a randomized trial. J Am Geriatr Soc 2006;54:1055–61.
77. Manojlovich M, Saint S, Meddings J, et al. Indwelling urinary catheterization insertion practices in the emergency department: an observational study. Infect Control Hosp Epidemiol 2016;37(1):117–9.
78. Raz R, Schiller D, Nicolle LE. Chronic indwelling catheter replacement before antimicrobial therapy for symptomatic urinary tract infection. J Urol 2000;164:1254–8.
79. Lam T, Omar M, Fisher E, et al. Types of indwelling urethral catheters for short-term catherisation in hospitalized patients. Cochrane Database Syst Rev 2014;9:CD004013.
80. Pickard R, Lam T, MacLennon G, et al. Antimicrobial catheters for reduction of symptomatic urinary tract infection in adults requiring short-term catheterisation in hospital: a multicentre randomised controlled trial. Lancet 2012;380:1927–35.
81. Noto M, Domenico H, Byrne D, et al. Chlorhexidine bathing and healthcare-associated infections: a randomized clinical trial. JAMA 2015;313(4):369–78.
82. Huang S, Hayden M, Kleinman K, et al. Effect of body surface decolonisation on bacteriuria and candiduria in intensive care units: an analysis of a cluster-controlled trial. Lancet Infect Dis 2016;15:70–9.
83. Krein S, Fowler K, Ratz D, et al. Preventing device-associated infection in US hospitals from 2005-2013. BMJ Qual Saf 2015;24:385–92.
84. Fakih M, George C, Edson B, et al. Implementing a national program to reduce catheter-associated urinary tract infection: a quality improvement collaboration of state hospital associations, academic medical centers, professional societies, and government agencies. Infect Control Hosp Epidemiol 2013;34(10):1048–54.
85. Saint S, Greene MT, Krein S, et al. A program to prevent catheter-associated urinary tract infection in acute care. N Engl J Med 2016;374(22):2111–9.
86. Knoll B, Wright D, Ellingson L, et al. Reduction of inappropriate urinary catheter use at a Veterans Affairs hospital through a multifaceted quality improvement project. Clin Infect Dis 2011;52:1283–90.
87. Miller B, Krein S, Fowler K, et al. A multimodal intervention to reduce urinary catheter use and associated infection at a Veterans Affairs Medical Center. Infect Control Hosp Epidemiol 2013;34(6):631–3.
88. Foster CB, Ackerman K, Hupertz V, et al. Catheter-associated urinary tract infection reduction in pediatric safety engagement network. Pediatrics 2020;146(4):e20192057.
89. Mody L, Greene M, Meddings J. A national implementation project to prevent catheter-associated urinary tract infection in nursing home residents. JAMA Intern Med 2017;177(8):1154–62.
90. Krein S, Greene MT, King B, et al. Assessing a national collaborative program to prevent catheter-associated urinary tract infection in Veterans Health Administration nursing home cohort. Infect Control Hosp Epidemiol 2018;39:820–5.

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