Nursing Interventions to Reduce the Risk of Catheter-Associated Urinary Tract Infection

Part 2: Staff Education, Monitoring, and Care Techniques

Margaret Willson ■ Mary Wilde ■ Marilyn-Lu Webb ■ Donna Thompson ■ Diana Parker ■ Judith Harwood ■ Laurie Callan ■ Mikel Gray

BACKGROUND: The US Centers for Medicare & Medicaid Services has enacted 2 policies that have focused considerable attention on the optimal use of indwelling catheters in the acute and long-term care settings and the prevention of complications including catheter-associated urinary tract infection (CAUTI).

OBJECTIVES: This is the second of a 2-part Evidence-Based Report Card reviewing current evidence pertaining to nursing actions for prevention of CAUTI in patients with short- and long-term indwelling catheters. Part 2 reviews multiple interventions for CAUTI prevention including staff education, monitoring of catheter use and CAUTI incidence, insertion technique, urethral meatal care, securement, use of a closed drainage system, bladder irrigation, frequency of catheter change, and antiseptic solutions in the drainage bag.

SEARCH STRATEGY: Nursing actions for prevention of CAUTI were identified based on search of electronic databases and Web-based search engines for national or international clinical practice guidelines focusing on this topic. Evidence related to the above nursing interventions was identified by searching electronic databases MEDLINE, CINAHL, the Cochrane Library, the ancestry of articles identified in these searches and Google scholar.

RESULTS: Limited evidence suggests that the following interventions reduce the incidence of CAUTI in patients managed by short-term indwelling catheterization: (1) staff education about catheter management, combined with regular monitoring of CAUTI incidence, (2) a facility-wide program to ensure catheterization only when indicated and prompt removal of indwelling catheters, (3) daily cleansing of the urethral meatus using soap and water or perineal cleanser, and (4) maintenance of a closed urinary drainage system. Mixed evidence suggests that use of a preconnected system reduces inadvertent interruption of a closed urinary drainage system and may prevent CAUTI. Limited evidence suggests that routine catheter changes every 4 to 6 weeks reduce CAUTI incidence in patients managed by long-term catheterization. Existing evidence suggests that the following interventions are not effective for reducing CAUTI incidence: (1) use of sterile technique for catheter insertion, (2) use of antiseptic solutions or ointments during routine meatal care, (3) use of a 2-chambered urinary drainage bag, (4) use of antiseptic filters incorporated into a urinary drainage bag, (5) bladder or catheter irrigation, (6) frequent changes of the urinary drainage bag, and (7) placement of an antiseptic solution in the urinary drainage bag.

IMPLICATIONS FOR PRACTICE: Evidence from parts 1 and 2 of this Evidence-Based Report Card provides a sound basis for designing an evidence-based program to prevent CAUTI. Essential elements of a CAUTI prevention program include staff education, ongoing monitoring of CAUTI incidence, monitoring catheter insertion and ensuring prompt removal, and careful attention to techniques for catheterization and catheter care.

Questions:

1. Do staff education, regular monitoring of CAUTI incidence or prevalence, and feedback reduce the incidence of CAUTI?
2. Does a program providing standardized indications for catheter insertion and/or prompted catheter removal programs reduce the incidence of CAUTI?
3. Does aseptic (sterile) technique during insertion reduce CAUTI incidence?

Margaret Willson, MSN, RN, CWOCN, Columbia Hospital, Milwaukee, Wisconsin.
Mary Wilde, PhD, RN, Associate Professor, University of Rochester, Rochester, New York.
Marilyn-Lu Webb, PhD, NP-BC, CCCN, CRN, The Center for Continence Care, Inc, Clovis, California.
Donna Thompson, MSN, CRNP, CCCN, Neumann College, Aston, Pennsylvania.
Diana Parker, BSN, MS, CWOCN, St Joseph Hospital, Bellingham, Washington.
Judith Harwood, BS, RN, PHN, CWOCN, Kaiser Permanente Department of Long-Term Care, Downey, California.
Laurie Callan, ARNP, CWOCN, NP Services LLC, Clinton, Iowa.
Mikel Gray, PhD, FNP, PNP, CUNP, CCCN, FAANP, FAAN, Department of Urology, University of Virginia, Charlottesville.
Corresponding author: Mikel Gray, PhD, FNP, PNP, CUNP, CCCN, FAANP, FAAN, Department of Urology, University of Virginia, PO Box 800422, Charlottesville, VA 22908 (mg5k@virginia.edu).
4. Does routine care of the urethral meatus reduce CAUTI incidence?
5. Does use of a catheter securement device reduce the incidence of CAUTI?
6. Does the maintenance of a closed drainage system reduce CAUTI incidence?
7. Do other elements of the drainage system, such as use of a 2-chamber drainage bag, influence CAUTI risk?
8. Does irrigation of the catheter and/or bladder reduce CAUTI incidence?
9. Does the frequency of routine catheter changes influence CAUTI incidence?
10. Does placement of an antiseptic (antibacterial) solution in the urinary drainage bag or more frequent urinary drainage bag changes reduce CAUTI incidence?

Introduction

The urinary system accounts for approximately 40% of all hospital-acquired infections. Infections of the urinary tract are the most common types of healthcare-acquired infection in medical-surgical units, critical care units, and rehabilitation wards, and approximately 80% are associated with the use of an indwelling urinary catheter. Two policies put forth by the US Centers for Medicare & Medicaid Services (CMS) have increased interest in ensuring that acute and long-term care facilities optimally use indwelling catheters and prevent associated complications such as catheter-associated urinary tract infection (CAUTI). In 2005, CMS released new guidance for revised F-Tag 315, which described principles for use of indwelling catheters and urinary incontinence management in the nursing home. This document states that an indwelling urinary catheter should be placed in a resident only when indicated and that it should be removed as soon as possible. More recently, CMS identified CAUTI as 1 of 8 conditions that, when hospital acquired, will no longer qualify for additional reimbursement in the acute care facility.

Taken together, these changes in CMS policy signal a major paradigm shift in reimbursement practices from its traditional focus on early recognition and prompt treatment of complications to one of prevention. WOC nurses have expertise in multiple aspects of continence care, including the management of patients with indwelling urinary catheters. As a result, they are frequently sought out to provide guidance as facilities review and revise policies designed to ensure optimal use of indwelling urinary catheters and prevention of complications such as CAUTI. In October 2008, the WOCN Council charged the Society’s Continence Care Task Force to produce a fact sheet about CAUTI and it charged the journal to update a 2004 Evidence-Based Report Card on the prevention of CAUTI to ensure that WOC nurses have the latest information and current best evidence about this timely topic. This 2-part Evidence-Based Report Card reviews current evidence pertaining to nursing actions for the prevention of CAUTI in patients with short- and long-term indwelling catheters. Part 1 reviewed 2 elements of catheter selection, material of construction, and catheter size to identify evidence pertaining to their influence on CAUTI incidence. Part 2 reviews evidence associated with multiple other strategies intended to reduce CAUTI including staff education, institution of a prompted catheter removal program, insertion technique, meatal cleansing, maintenance of a closed drainage system, irrigation, and isolation of patients with a CAUTI. In addition, this issue of the journal contains the CAUTI fact sheet from the Continence Care Task Force. The fact sheet document provides a cogent summary of the epidemiology, pathophysiology, diagnosis, prevention, and treatment of CAUTI. When combined, the 2-part Evidence-Based Report Card and CAUTI fact sheet provide a detailed and comprehensive review of current best evidence and best practice recommendations that WOC nurses can use when acting as a resource as their facilities review and revise practice and policies pertaining to the use of indwelling urinary catheters and prevention of CAUTI.

Nursing Actions for the Prevention of CAUTI

Part 1 of this Evidence-Based Report Card described the process we used to identify common nursing actions intended to prevent CAUTI. Three guidelines were identified: one was produced by the US Centers for Disease Control and Prevention, the second was produced the Joanna Briggs Institute located in Australia, and the third by the International Consultation on Incontinence, an international group of continence researchers. Evidence for the preventive interventions described in this article was derived from or suggested by these national and international guidelines (Table 1).

Methods

We searched the following electronic databases, MEDLINE, CINAHL, and the Cochrane Database for Systematic Reviews, to identify the studies used to answer each of the questions posed in part 2 of this Evidence-Based Report Card. Studies included in our review were limited to those published between 1980 and November 2008. The ancestry of studies or review articles located during this initial search were reviewed to identify other pertinent studies, and, finally, the Internet-based search engine Google Scholar was searched to discover additional studies. Randomized clinical trials and quasi-experimental studies comparing the intervention in question to another intervention or to traditional practice were included in the review. Time series or before-after studies, such as those comparing results prior to and following institution of facility or unit-wide education programs, policy changes, or catheter-removal–prompting programs were also
included in the review. Observational studies that compared care at various facilities that routinely used different techniques of catheter management were included but case studies or clinical series describing multiple case studies were excluded. Studies are limited to those published in English or foreign articles with an English language abstract. All studies were reviewed by at least 2 of the authors to determine eligibility for inclusion. The key

<table>
<thead>
<tr>
<th>Intervention</th>
<th>International Consultation on Incontinence Recommendations&lt;sup&gt;10a&lt;/sup&gt;</th>
<th>Centers for Disease Control and Prevention Guidelines&lt;sup&gt;11&lt;/sup&gt;</th>
<th>Briggs Best Practice Document&lt;sup&gt;12&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter selection based on material of construction</td>
<td>Silver-alloy catheters should be considered for short-term catheterization to reduce the risk of catheter-associated infection</td>
<td>No specific recommendation</td>
<td>Silver impregnated catheters may reduce urinary tract infection risk, but further research is needed to determine which patients are most likely to benefit and to determine the cost-effectiveness of implementation</td>
</tr>
<tr>
<td>Catheter selection based on French size Insertion technique</td>
<td>No specific recommendation</td>
<td>Insert smallest suitable catheter</td>
<td>No specific recommendation</td>
</tr>
<tr>
<td>Meatal care</td>
<td>Meatal cleansing with soap and water is recommended (antiseptic agents offer no advantage)</td>
<td>Insufficient evidence to recommend daily or twice-daily cleansing with soap and water or povidone-iodine solution</td>
<td>No specific recommendation</td>
</tr>
<tr>
<td>Catheter securing</td>
<td>No specific recommendation</td>
<td>Recommends proper securing to prevent movement and urethral traction</td>
<td>No specific recommendation</td>
</tr>
<tr>
<td>Urinary drainage system</td>
<td>Recommends closed drainage system with short-term catheterization to reduce CAUTI risk</td>
<td>Recommends closed sterile system except when irrigating; inadvertent interruption should be followed by insertion of new catheter</td>
<td>Recommends use of a closed sterile drainage system whenever possible, but choice may be influenced by cost considerations</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Bladder irrigation is not recommended</td>
<td>Recommended only to prevent obstruction from debris in the urinary tract or encrustation of the catheter itself</td>
<td>Insufficient evidence to support the use of any irrigation solution for the prevention of UTI</td>
</tr>
<tr>
<td>Catheter change interval</td>
<td>Identification of a characteristic pattern of “catheter life” can facilitate preemptive catheter changes in patients with recurrent catheter encrustation and blockage</td>
<td>Recommends avoidance of arbitrary and routine intervals for changing catheters</td>
<td>Routine monthly catheter changes recommended in one study; no definite recommendation for change interval provided</td>
</tr>
<tr>
<td>Use of antibacterial solutions in drainage bag</td>
<td>Addition of disinfectants to drainage bags is not recommended as an infection control strategy</td>
<td>No specific recommendation</td>
<td>Avoid addition of antibacterial solutions to drainage bags because it is ineffective for UTI prevention</td>
</tr>
<tr>
<td>Isolation of patients with CAUTI</td>
<td>Separate patients with infected indwelling catheters from those with uninfected lower urinary tracts</td>
<td>No specific recommendation</td>
<td></td>
</tr>
<tr>
<td>Care provider education related to catheter insertion techniques, ongoing care, and duration of catheterization</td>
<td>Educate personnel in insertion and care techniques</td>
<td>Insufficient research base to provide recommendations</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CAUTI, catheter-associated urinary tract infection; UTI, urinary tract infection.
words used for each question; they are described in the individual questions.

**Question 1: Do Staff Education, Regular Monitoring of CAUTI Incidence or Prevalence, and Feedback Reduce the Incidence of CAUTI?**

Both the Centers for Disease Control and Prevention (CDC) and the Joanna Briggs guidelines discuss the importance of staff education and its potential influence on urinary tract infection (UTI) risk. The CDC guideline\(^\text{11}\) recommends staff education concerning insertion technique, management techniques, and prevention of potential complications, but the associated references are not based on studies examining the effectiveness of this strategy in reducing CAUTI incidence. The Joanna Briggs Institute\(^\text{12}\) recommends education of staff, but it goes on to acknowledge that there is insufficient evidence to provide specific recommendations concerning the effectiveness of staff education.

A systematic literature review was completed using key terms “education” and “feedback.” These terms were combined with the key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. Four studies meeting inclusion criteria were identified.

Rosenthal and colleagues\(^\text{13}\) studied the efficacy of a program that combined staff education and performance feedback on CAUTI incidence in 2 intensive care units (ICUs) in a private, 180-bed acute care facility in Buenos Aires, Argentina. One of the units cared for critically ill medical/surgical patients and the other was a coronary care unit. The intervention consisted of an educational program focusing on hand hygiene and the principles of urinary catheter management promulgated by the US CDC\(^\text{11}\). However, the researchers reported that special emphasis was placed on several strategies to reduce CAUTI incidence. They were handwashing using an antiseptic cleanser prior to catheterization and positioning the catheter in a manner that avoided luminal compression by the leg. Feedback concerning CAUTI incidence and adherence to handwashing and catheter positioning was provided to staff in both units. CAUTI incidence was measured over a 3-month period prior to the educational intervention and over a period of 12 months following the intervention. The incidence of CAUTI declined from 21.3 days of infection per 1000 catheterized days at baseline to 12.4 per 1000 after the combined educational/feedback intervention (relative risk 0.58, 95% CI 0.39-0.86, \(P = .006\)), a statistically significant and clinically relevant difference.

Goetz and coworkers\(^\text{14}\) sought to reduce CAUTI incidence in a Veteran’s Affairs Medical Center in the northeastern United States. Staff education consisted of a videotaped review of catheter care provided to all professional and support staff in each participating unit. The researchers measured CAUTI incidence on a quarterly basis and shared those findings with the chief nursing officer of the facility and with each unit manager. The unit manager, in turn, reviewed the incidence with staff and graphic representations of quarterly incidences were posted for staff to view. This process was repeated quarterly over a period of 18 months, and serial incidence rates were calculated. The preintervention incidence of CAUTI was 32 per 1000 catheterized days. Within the first quarter following the intervention, the incidence fell more than 50%. After 18 months, the incidence of CAUTI was 17.4 per 1000 catheterized days (\(P = .002\), a statistically significant and clinically relevant difference.

French and colleagues\(^\text{15}\) evaluated the effectiveness of a program to reduce the incidence of CAUTI that included a revised policy for managing indwelling catheters, the addition of 2 additional infection control nurses to the existing staff of a single nurse, introduction of an “improved” closed drainage catheter, and educational classes for nursing staff focusing on the revised policy for catheter management. The setting was a 1400-bed community-based teaching hospital in Hong Kong. Prevalence rates for CAUTI were compared to rates collected approximately 3 years prior to the intervention. After institution of the program described above, the prevalence of CAUTI was measured every 6 months over a period of 30 months. During this period, the prevalence of CAUTI fell from 3.2% to 2.0% (\(P = .032\), a statistically significant difference. Because the prevalence of patient-associated risk factors for CAUTI differed between survey times varied, results were reexamined, using a logistic regression analysis. The decline in CAUTI rates persisted, falling from 9.9% to 6.0% among the highest-risk group and 2.9% to 2.2% in the lower-risk group.

A final study was identified that focused on bacteriologic monitoring of the urine without a program of staff education or regular formalized feedback. Garibaldi and associates\(^\text{16}\) evaluated the efficacy of “daily bacteriologic monitoring” for prevention of CAUTI. Specifically, the investigators obtained a urine culture to determine the presence of bacteriuria at the time of catheter insertion, and urine cultures were obtained daily during the entire period of catheterization. Urine samples were obtained via a sampling port, and the patient’s urine was diagnosed as “colonized” (ie, evidence of asymptomatic bacteriuria) if the colony count was \(\geq 10^3\) colony forming units per milliliter. A symptomatic CAUTI was diagnosed when evidence of bacterial colonization was accompanied by a fever \(\geq 100^\circ\text{F}\) for 12 hours or more in the absence of other sites of infection or when the patient complained of other symptoms described as “referable” to the urinary system. The incidence of CAUTI among 1140 indwelling catheterizations was 3.2%. Based on the development of bacteriuria within 24 hours of catheter insertion, only 2% of all CAUTI were deemed potentially preventable. The influence of this type of monitoring on CAUTI incidence was not statistically significant.

The results of these studies provide limited evidence suggesting that staff education, combined with monitoring
of CAUTI occurrences and feedback for staff, may reduce the incidence of CAUTI. Successful programs combine staff education about indwelling catheter insertion, prompt removal, and catheter care with principles of CAUTI prevention. Regular feedback to staff concerning CAUTI occurrences, similar to the approach used for prevention of hospital-acquired pressure ulcers, is also essential. In 2 studies, feedback focused exclusively on the incidence or prevalence of CAUTI, and a third also provided feedback concerning adherence to specific components of the prevention. Feedback was provided quarterly or biannually. In each of these studies, statistically significant and clinically relevant reductions in CAUTI rates were achieved and results proved sustainable over periods ranging from 12 to 30 months. In contrast, a single study focused on daily monitoring but lacked any formalized educational or feedback. Based on the limited criterion used to determine a “preventable CAUTI” as compared to the frequency of monitoring, it does not seem surprising that the approach was not deemed a useful strategy for preventing CAUTI on a facility-wide basis.

**Question 2: Does a Program Providing Standardized Indications for Catheter Insertion and/or Prompted Catheter Removal Programs Reduce the Incidence of CAUTI?**

Although the guidelines used to identify common nursing strategies to prevent CAUTI do not specifically mention prompting programs for removing catheters, they do advise clinicians to place an indwelling catheter only when indicated and to remove the catheter as soon as possible (Table 1). Despite this consistent admonition, Saint and coworkers reported on a telephone follow-up survey of 14 hospitals throughout the United States. This report follows up a larger, quantitative survey that involved 719 hospitals reported 3 years earlier. When queried about efforts to reduce the incidence of CAUTI, respondents recognized the prevalence of the condition but stated that early removal of catheters remains a “low priority” because it is less likely to produce mortality than bloodstream or ventilator-associated pneumonia. Nevertheless, they consistently reported that early catheter removal is an important component of any program designed to prevent CAUTI. Based on an ancestry search of articles reviewed while answering question 1, we identified 2 studies that specifically evaluated the effect of a prompted program for catheter removal on CAUTI incidence. We completed a systematic review of the electronic databases specified in the methods section and identified 3 additional studies that evaluated the effectiveness of this intervention.

Apisarnthanarak and colleagues reported a before-after study spanning a 2-year period in a 450 university-based tertiary care hospital in Bangkok, Thailand. After collecting baseline data for a 12-month period, the researchers introduced a facility-wide intervention that comprised a multidisciplinary team that included infection control specialists, medicine, nursing, and hospital administration. Any patient with an indwelling catheter that remained in place for more than 3 days was reviewed by the team. Appropriate and inappropriate indications for catheterization were established based on literature review and the reason for initial catheterization was reviewed. Catheters determined to be inserted for inappropriate reasons were discontinued. Patients deemed to have an indwelling catheter inserted for an appropriate reason were reviewed for possible reasons to discontinue the catheter on a daily basis and nurses monitored the patient for signs and symptoms of a CAUTI on a daily basis. Two thousand four hundred twelve patients participated in the trial; analysis of data revealed no statistically significant difference in demographic or clinical characteristics of the pre- and postintervention groups. The diagnosis of a CAUTI was based on criteria promulgated by the US CDC. The intervention significantly reduced the incidence of CAUTI (21.5 UTI per 1000 catheterized days vs 5.2 UTI per catheterized day, P < .001) as well as the number of inappropriate catheterization and the mean length of a time catheters remained indwelling. The highest magnitude of impact was observed in the critical care areas and monthly costs of antimicrobials used to treat CAUTI declined by 58%, a statistically significant and clinically relevant decline (mean US $366 vs US $154, P < .001).

Crouzet and associates completed a quasi-experimental study in 5 units of a 1205-bed university-affiliated acute care facility in Besancon, France. Neurosurgery, cardiovascular and orthopedic surgery, and neurology and geriatric medical units were selected because of their comparatively high rates of indwelling catheterization. Subjects admitted with indwelling catheters were excluded. The CAUTI rates, incidence of catheterization, and duration of catheter drainage were measured during a 3-month preintervention observation phase followed by a 3-month intervention phase. The intervention comprised a nurse-driven daily reminder to review the presence of all catheters that remained indwelling after 4 days for removal. A CAUTI was diagnosed based on a combination of symptoms (fever, loin pain, suprapubic tenderness) and microbiologic evidence of infection (≥10^5 CFU on culture and pyuria). The investigators found that CAUTI was most likely to occur on days 5 and 6 following catheterization. Therefore, they elected to start their intervention on day 4 as compared to day 3 as advocated by Apisarnthanarak and colleagues. The primary outcome variable, CAUTI incidence, was divided into 2 periods: early CAUTI and late CAUTI. Early CAUTI was defined as a symptomatic infection occurring within 4 days of catheterization and a late CAUTI was defined as a symptomatic infection occurring on day 5 or later. After implementation of the intervention, the incidence of late onset CAUTI declined from 12.3 to 1.8 UTI per catheterized days (P = .03), a statistically significant and clinically relevant difference. In contrast, the incidence of early onset catheterizations was not
different. Of note, the duration of catheterization was 8.4 days during baseline observation versus 6.7 days following the intervention; this difference was not statistically significant. Since group assignment was not randomized, the investigators also completed a logistic regression analysis identifying risk factors for CAUTI and the influence of the variable “intervention” on this risk. Even when other risk factors were considered, the introduction of the intervention (program for prompted catheter removal) was associated with a protective effect (odds ratio 0.12, 95% CI 0.02-0.53, P = .01).

Huang and coinvestigators20 also evaluated the effect of a daily nurse-driven catheter removal program on patients admitted to 5 ICUs (cardiovascular surgery, coronary care, surgical, neurosurgical, and medical) in a 1310-bed tertiary care hospital in southern Taiwan that provides care to veterans. Data about catheterization frequency, duration, and CAUTI were obtained retrospectively over a 12-month period, and prospective data were collected following implementation of the intervention. Nurses reminded physicians to review the necessity of catheterization on a daily basis if the catheter remained indwelling for a period of 5 days. CAUTI was diagnosed based on criteria promulgated by the US CDC and National Nosocomial Infections Surveillance Systems. Following the intervention, the rate of CAUTI diminished from 11.5 ± 3.1 (mean ± SD) to 8.3 ± 2.5 UTI per 1000 catheterized days. The authors also reported statistically significant reductions in the duration of catheterization in the critical care units and average monthly costs for antimicrobials drugs.

Cornia and associates21 evaluated the effect of a computer-based catheter insertion and prompted removal program on CAUTI incidence in a university-affiliated Veteran’s Affairs Hospital in the northwestern United States. The computer system required physician staff to select an indication for catheterization and a default stop date of 72 hours after initial insertion. At this point, the computer prompted the physician to either renew the order for catheterization or discontinue the order. CAUTI was based on 2 possible criteria: (1) bacteriuria and pyuria based on urinalysis and urine culture and (2) clinical diagnosis of a urinary infection. Nurses were educated about the study and the computer-based system. Physicians chose among 3 possible responses to the computer-promPTed system: (1) use the computer system to order insertion of an indwelling catheter or its removal, (2) enter a standard (handwritten) order to insert or remove an indwelling catheter, and (3) not enter an order to remove catheters remaining in place for more than 72 hours. Inpatients units were deemed intervention or control in a nonrandomized manner. Seven hundred forty-two patients were entered into the study and 94 (13%) were excluded primarily because they were transferred to another unit during their hospital course. The primary outcome measure of the study was the duration of the indwelling catheter, and the incidence of CAUTI was measured as a secondary outcome. Patients managed in the intervention ward had a significantly shorter mean duration of indwelling catheterization (5 days vs 8 days, P = .03) but the frequency of CAUTI incidence for the units did not differ (3 vs 5, P = .71). In the subsequent discussion, the researchers questioned whether contamination of results may have occurred because resident physicians cross-covered the control and intervention wards throughout the data collection period.

Dumigan and coworkers22 evaluated the efficacy of a program that outlined criteria for insertion of an indwelling catheter and allowed registered professional nurses to remove the catheter without a physician’s order when it was considered no longer medically indicated based on these criteria. The study setting was 3 ICUs in a 500-bed community-based teaching hospital in New Haven, Connecticut. Criteria for catheter insertion and removal and for diagnosing CAUTI were derived from the US CDC and the National Nosocomial Infection Surveillance System and from literature review. Both physician and nursing staff were educated about indwelling catheter management and prevention of CAUTI. The CAUTI rates were aggregated into 6-month intervals and data collection persisted over a period of 5 years. The incidence of CAUTI was the primary outcome measure used to evaluate the efficacy of the intervention. The CAUTI incidences in the surgical ICU did not change significantly following the intervention (10.3 vs 8.6 UTI per 1000 catheterized days) but those in the medical and coronary care ICU did decline significantly when a 1-tailed analysis was used to measure differences (15.8 vs 11.1 UTI per 1000 catheter days and 15.1 vs 8.3 per 1000 catheter days, respectively).

The results of these 5 studies provide mixed evidence that implementation of a prompted catheter insertion and removal program reduces the incidence of CAUTI. Although further research is needed before definitive conclusions can be drawn, elements of a successful program appear to include active participation by a multidisciplinary team that involves nursing and medicine, involvement of the facility’s infection control team, prompts to remove the catheter beginning 3 to 4 days after insertion, education of staff about the significance of prompt catheter removal, and ongoing feedback about results.

**Question 3: Does Aseptic (Sterile) Technique During Insertion Reduce CAUTI Incidence?**

The 3 clinical practice guidelines used to identify common nursing interventions to prevent CAUTI provide varying recommendations on the issue of aseptic or sterile technique for catheterization (Table 1). Sterile technique is advocated in the CDC guidelines,11 but the Briggs Institute Best Practice document states that the use of sterile technique does not reduce CAUTI risk.12 The ICI guidelines10a offer no specific guidance about this issue. This variability...
Grundy compared 2 techniques for indwelling catheter-specific components of insertion technique. Pickard and catheterized via sterile technique. Results revealed that use of sterile technique did not reduce bacteriuria incidence when compared to subjects catheterized using a chlorhexidine solution or tap water. The main outcome measure of the study was bacteriuria, dichotomized as high bacterial colony counts (≥10⁶ CFU/mL) versus low colony counts (<10⁶ CFU/mL). Urine specimens were obtained within 24 hours of catheterization or immediately before removal if the catheter remained in place for less than 24 hours. Data were analyzed on an intention-to-treat basis. Seventy subjects (14%) did not have complete data because a urine specimen was not obtained when the catheter was removed. No statistically significant differences were found when the frequency of bacteriuria was compared between subjects cleansed with chlorhexidine versus tap water.

The results of these studies provide some degree of evidence suggesting that aseptic technique defined as donning sterile gloves, mask and gown, combined with use of sterile barriers, perineal washing using an antiseptic cleanser, and no-touch insertion technique may not influence the incidence of bacteriuria and CAUTI following insertion of an indwelling catheter. Nevertheless, it is important to evaluate these studies with caution. All used bacteriuria as their main outcome measure and none analyzed differences based on CAUTI incidence. In addition, each of the studies used varying criteria to define aseptic technique, and these criteria subtly differ from those defined in the CDC guideline, which describes aseptic technique as “gloves, drape, sponges, an appropriate antiseptic solution for perirectal cleaning, and a single-use packet of lubricant jelly.” However, even the CDC labels advice about the use of sterile technique as a category II recommendation (defined as “moderately recommended for adoption”) based on results of 2 studies published prior to 1966 and a textbook published in 1979.

**Question 4: Does Routine Care of the Urethral Meatus Reduce CAUTI Incidence?**

Two of the clinical practice guidelines provide specific recommendations related to routine meatal care for patients with indwelling catheters (Table 1). The US CDC states that there is insufficient evidence to recommend daily or twice-daily meatal cleansing with soap and water or a povidone-iodine solution. The Briggs Institute Best Practice document recommends “good personal hygiene.”

is partially attributable to differences in the definition of sterile or aseptic technique. Depending on the clinical context, aseptic or sterile technique may involve use of sterile gloves and a single sterile barrier, or it may involve donning a mask and hair covering and the use of multiple barriers such as those seen in the surgical or endoscopic suite.

We completed a systematic literature using key terms “asepsis,” “aseptic technique,” “sterile technique,” and “clean technique.” These terms were combined using the “OR” Boolean function. The set was then combined with key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. This review revealed only 1 randomized clinical trial that specifically evaluated the efficacy of “sterile” versus “clean” technique for indwelling urinary catheter insertion. Carpeti and coworkers randomly assigned 156 subjects to undergo indwelling catheterization using sterile versus clean insertion technique as part of elective surgery. Sterile technique was described as hand scrubbing for 4 minutes, donning sterile gloves and gowns, and employing “strict sterile technique,” including a catheter insertion kit and perineal cleansing, using a povidone-iodine solution. Clean technique was described as handwashing using soap and water, donning nonsterile gloves, and cleansing the patient’s perineum only if visible soiling or debris were observed; no catheter insertion pack was used, and water alone was used to cleanse the perineum. The main outcome measure was not CAUTI; instead, it was the presence of bacteriuria measured immediately following and 3 days after catheterization. Results revealed that use of sterile technique did not reduce bacteriuria incidence when compared to subjects catheterized via sterile technique.

We identified 2 additional studies that focused on specific components of insertion technique. Pickard and Grundy compared 2 techniques for indwelling catheterization in a group of 46 patients with spinal cord injury. Both techniques were described as “sterile” but the primary differences in the techniques were the length of handwashing and use of a sterile gown. The more rigid technique required a 3-minute handwash from fingers to elbows, followed by donning a sterile gown and gloves. The shorter method required a 30-second handwashing followed by double gloving. Catheterization was completed using a no-touch technique in each group; no other technique for catheterization was varied between the groups. CAUTI was defined as bacteriuria and symptoms “suggesting” urinary infection (suggestive symptoms were not specified). Urine specimens were collected monthly for bacteriologic analysis. Data from 94 subjects were analyzed, but 48 subjects (34%) were excluded for a variety of reasons including 35 subjects who were enrolled even though they were managed by condom rather than indwelling urinary catheters and failure to enroll 10 subjects into the trial upon admission to the rehabilitation center. No statistically significant differences were found in the frequency of bacteriuria when results from the 2 techniques were compared.

Webster and colleagues evaluated 2 techniques for cleansing the perirectal area immediately prior to catheterization in a randomized clinical trial of 436 women undergoing obstetric care. Both groups were catheterized using what the authors described as clean technique. Specifically, nurses washed their hands using a detergent-based hand cleanser, opened a sterile pack for catheterization, donned sterile gloves, and inserted the catheter using a “no-touch” technique. (These techniques qualify as “sterile” based on CDC criteria.) However, subjects were randomly assigned to undergo perirectal cleansing, using a chlorhexidine solution or tap water. The main outcome measure of the study was bacteriuria, dichotomized as high bacterial colony counts (≥10⁶ CFU/mL) versus low colony counts (<10⁶ CFU/mL). Urine specimens were obtained within 24 hours of catheterization or immediately before removal if the catheter remained in place for less than 24 hours. Data were analyzed on an intention-to-treat basis. Seventy subjects (14%) did not have complete data because a urine specimen was not obtained when the catheter was removed. No statistically significant differences were found when the frequency of bacteriuria was compared between subjects cleansed with chlorhexidine versus tap water.
and goes on to assert that existing evidence does not support routine use of antiseptic or antimicrobial solutions, ointments, or creams.

Our systematic review was based on key terms “catheter care,” “meatal care,” or meatal cleansing.” These terms were combined using the Boolean function “OR.” This combined set was combined with the term “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function.

Tsuchida and coinvestigators evaluated the relationship between various techniques of catheter management and CAUTI incidence including routine meatal cleansing. Data were collected by direct observation and questionnaire in 555 adult patients managed by indwelling catheterization ≥3 days. CAUTI was diagnosed using CDC standards. Subjects were inpatients at 5 community-based hospitals in Japan. One of their direct observations, described as “absence of daily cleansing of the perineal area,” was found to be associated with an increased risk for CAUTI (relative risk 2.49, 95% CI 1.32–4.69, \( P = .005 \)). CAUTI was particularly prevalent in subjects with fecal incontinence, suggesting that soiling of the catheter and meatus with fecal material may increase the risk of infection.

Koskoroglu and associates compared 130 patients in an ICU in Eskiehir, Turkey. Subjects were divided into 5 groups: (1) once daily application of a 9% povidone-iodine solution, (2) twice-daily application of a 9% povidone-iodine solution, (3) once daily application of 4% chlorhexidine gluconate, (4) twice-daily application of chlorhexidine gluconate, and (5) no intervention (control group). The article does not specify whether subjects were randomly assigned to treatment group. The main outcome measure was development of bacteriuria, but CAUTI was measured as a secondary outcome. In addition, urethral meatal swabs were obtained on days 2, 3, 4, 5, and 7. Daily or twice-daily cleansing with a povidone-iodine solution or a chlorhexidine solution did not influence the rate of CAUTI in this group of ICU patients.

Matsumoto and associates compared 3 meatal care techniques in a group of 55 patients undergoing elective surgical procedures in a university-based hospital in Japan. Subjects were divided into 3 groups: (1) daily application of povidone-iodine solution, (2) twice-daily application of povidone-iodine solution, and (3) once-daily application of povidone-iodine cream. No randomization procedures pertaining to group assignment were described. The main outcome measure was CAUTI; secondary outcome measures included meatal colonization. A sterile urine specimen was documented in all patients prior to catheterization and data were collected up to 14 days depending on the duration of indwelling catheterization. CAUTI was defined as a culture revealing bacteriuria with \( \geq 10^4 \) CFU/mL. By day 14, bacteriuria occurred in 100% of men managed by daily application of povidone-iodine cream, in 36% of men managed by once daily application of solution, and none of the men managed with twice-daily application. Bacteriuric rates in women were 57% of those managed by once-daily application, 62% of those managed by application of povidone-iodine cream, and 29% in the group undergoing twice-daily application of povidone-iodine.

Burke and colleagues reported 2 studies evaluating meatal care in patients managed by short-term indwelling catheterization. In a randomized controlled trial, published in 1981 trial, 846 subjects were randomized to receive (1) twice-daily meatal care comprising cleansing with a povidone-iodine solution and application of a povidone-iodine ointment, (2) once-daily meatal cleansing with a nonantiseptic solution containing soap and water, or (3) no special meatal care. The main outcome measure was bacteriuria. Subjects randomized to receive meatal cleansing combined with application of an ointment had higher bacteriuria rates when compared to those receiving no special care. This difference was statistically significant, indicating an unexpectedly higher risk of bacteriuria among patients randomized to meatal care with an antimicrobial solution as compared to those managed with no meatal care. Similarly, patients treated with a nonantiseptic solution containing soap and water also experienced higher rates of bacteriuria than did subjects randomized to no special meatal care.

Burke's group reported similar results in a randomized clinical trial of 428 subjects randomly assigned to routine meatal care (cleansing visible debris from the meatus during routine bathing) versus cleansing visible debris plus twice-daily application of a neomycin-polymyxin-B bacitracin ointment in prepackaged 1/32 oz foil packages. Slightly more subjects randomized to twice-daily meatal care experienced a slightly higher incidence of bacteriuria (7.5%) when compared to those receiving no special meatal care (6.5%).

Classen and coworkers compared a combined strategy to prevent CAUTI consisting daily meatal care combined with disinfection of the outflow tube of the drainage bag with a povidone-iodine solution with and use of a sealed catheter drainage system to use of a sealed system alone in a group of 747 patients managed in acute care facilities in the United States. The main outcome measure of this study was bacteriuria. Similar to the results of Burke's group, no statistically significant or clinically relevant difference in bacteriuria incidence was found when the intervention group was compared to the standard treatment group (4.7% vs 4.9%, \( P = NS \)).

Huth and associates reported a randomized clinical trial comparing 69 subjects randomly assigned to twice-daily application of 1% silver sulfadiazine cream to the urethral meatus versus routine meatal care comprising regular cleansing of visible debris from the meatus. The main outcome measure was bacteriuria, although meatal colonization was reported as a secondary outcome. Treatment was continued for variable periods of time until the
catheter was removed or the patient was discharged from hospital. The incidence of bacteriuria in the group receiving twice-daily application of silver sulfadiazine cream was 13.2% and the incidence in the control group was 11.4%, a nonsignificant difference.

Similar to the conclusions of Wilde,33 we found only limited research (6 studies) focusing on meatal care (sometimes called catheter care) for the prevention of CAUTI. Specifically, the evidence we identified strongly suggests that meatal care using antiseptic cleansers, creams, or ointments is no better than providing regular meatal care as a part of routine perineal and genital hygiene. In contrast, 2 studies39,40 provide weak evidence that application of antiseptic ointments or creams may slightly increase the incidence of meatal colonization and bacteriuria, suggesting that their use may paradoxically increase rather than diminish the risk for bacteriuria and CAUTI in the catheterized patient.

**Question 5: Does Use of a Catheter Securement Device Reduce the Incidence of CAUTI?**

Catheter securing is a strongly recommended (category I) in the CDC clinical practice guidelines11 but it is not mentioned in the guidelines produced by the ICI10a or the Briggs Institute.12 A systematic review was undertaken using the methods outline previously. The key term used was “catheter securement” which was combined with key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. A single randomized clinical trial was identified14 that compared an adhesive-backed manufactured securement device to various other securement devices or no device at all in a multicenter trial involving 118 subjects in various rehabilitation units in the United States. The main outcome measure was symptomatic CAUTI; the diagnosis of infection was based on bacteriuria quantified as ≥10^4 CFU/mL, combined with pyuria (>10 white blood cell [WBC] per high power filed on microscopy) and one or more of the following signs or symptoms (fever >100°F, suprapubic or flank discomfort, bladder spasm, exacerbation of autonomic dysreflexia, or increased skeletal muscle spasticity). CAUTI occurred in 13.3% of patients managed with the adhesive-backed device as compared to 24.1% of those managed by a variety of alternative methods. This difference was not statistically significant (relative risk 0.55, 95% CI 0.25-1.22, P = .16).

The results of this trial suggest that use of a securement device does not influence CAUTI risk. However, these findings must be interpreted with considerable caution because the study compares a single manufacturer’s device to a heterogenous group using a variety of alterative devices and no device at all. Further research is clearly needed to provide more robust evidence focusing on the potential of securement devices to reduce urethral trauma and CAUTI risk.

**Question 6: Does the Maintenance of a Closed Drainage System Reduce CAUTI Incidence?**

All 3 guidelines recommend maintenance of a closed drainage system as a strategy to prevent CAUTI (Table 1). In order to identify the latest clinical evidence related to this issue, we completed a systematic review that combined key terms “closed system” and “drainage system” with the key terms “urinary catheterization” and “catheters indwelling” using the “OR” Boolean function. This set was then combined with the key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. Using review parameters described previously, we identified 5 studies that addressed the effect of a sealed drainage system on CAUTI incidence. One study compared closed drainage to a continuously open system and 4 evaluated the effect of intermittent opening of the urinary drainage systems for a variety of purposes such as irrigation, changing urinary drainage systems, while dressing or bathing, or for unknown reasons.

Allepuz-Palau and coworkers35 described data from a national database of hospital infections in Spain, including CAUTI, where open urinary catheter drainage systems were in use in some facilities between the years 1990 and 2000. The database contained information on 70,688 persons who had undergone indwelling catheterization. The researchers used logistic regression to analyze trends in the movement from open drainage to closed urinary drainage systems (defined as ≥90% use of closed systems throughout the facility) between 1990 and 200 and CAUTI rates during this time frame. During the last decade of the 20th century, the use of closed urinary drainage systems rose from 50.6% to 70% (odds ratio 1.1, 95% CI 1.095-1.104). This rise in use of closed urinary drainage systems was associated with a decline in CAUTI incidence (r = −0.65, P = .03), a statistically significant and clinically relevant difference.

Other research focused on the use of prepackaged seals designed to help ensure maintenance of a closed urinary drainage system. Sealed systems use a plastic covering that joins the catheter and drainage system. It is designed to prevent inadvertent opening of the closed drainage system and to act as a physical barrier to the migration of microbes into the lumen of the drainage tubes. However, prepackaged systems are also associated with the potential disadvantage of allowing only the prepackaged catheter to be inserted. In an attempt to overcome this potential limitation of prepackaged systems, Huth and associates23 investigated the efficacy of a junction seal applied within 24 hours of catheterization. They studied 1740 subjects who underwent indwelling catheterization in a 479-bed community-based teaching hospital in Salt Lake City, Utah. The main outcome measure, bacteriuria, was defined as ≥10^5 CFU/mL, significantly less than the more typical 10^6 CFU/mL used in the clinical setting. No statistically significant differences in the incidence of bacteriuria were...
found when patients receiving the connection site seals were compared to those managed by a nonsealed system (13.7% vs 14.9%, odds ratio 0.91, 95% CI 0.69–1.20, \( P = .52 \)). Secondary analysis of these data using the more traditional \(10^5\) CFU/mL as the cut point for bacteriuria revealed similar results (9.0% vs 10.2%, \( P = NS \)).

DeGroot-Koscharoen and colleagues\(^3\) compared a closed preconnected system to a nonsealed system in 202 men in a 330-bed university-affiliated Veteran’s Affairs Hospital in Madison, Wisconsin. The preconnected system was sealed by the manufacturer using a preshrunk plastic shield. The nonsealed system comprised a standard urinary drainage system that the catheter was attached to immediately following catheterization and inflation of the retention balloon. The mean catheterization time was 6.4 and 7.6 days in the sealed and nonsealed systems, respectively. No statistically significant differences were noted in the frequency of bacteriuria (11.3% vs 13.3%, \( P = NS \)). Similarly, the frequency of CAUTI did not significantly differ when the sealed and nonsealed drainage systems were compared (3.1% vs 1.0%, \( P > .3 \)).

Platt and associates\(^5\) also studied the effect of catheter drainage systems with preconnected sealed junctions on CAUTI. In this randomized clinical trial completed at the Brigham and Women’s Hospital in Boston, Massachusetts, the unit of analysis was a catheter course rather than individual patients. They reported that 1494 catheter courses in 1476 patients were evaluable but 48.7% were excluded from their final analysis, primarily owing to catheter course less than 24 hours, bacteriuria at the outset of catheterization, catheterization within 24 hours of study enrollment, or urologic surgery. Results of their study were also influenced by junction disconnections, which occurred in 26% of the evaluable catheter courses. Disconnections occurred in both groups, but the total number of disconnections was 2.7 times higher in the nonsealed group as compared to patients with a preconnected, sealed drainage system, a statistically significant and possibly clinically relevant difference. As anticipated, many patients in both groups also received antimicrobial drugs during the course of catheterization. In order to provide the best analysis of the influence of the preconnected, sealed system versus a nonsealed system, the researchers further limited their analysis to 200 evaluable subjects who did not receive antimicrobials during the course of catheterization. Bacteriuria occurred in 27% of those with unsealed junctions and 10% of those with sealed junctions, indicating a protective effect against bacteriuria when a preconnected, sealed urinary drainage system was used for short-term indwelling catheterization (relative risk 2.7, 95% CI 1.4–5.2, \( P < .01 \)). The incidence of bacteriuria did not differ when sealed versus nonsealed drainage system was compared in subjects receiving systemic antibiotic drugs during the course of indwelling catheterization.

Garibaldi and coworkers\(^6\) evaluated risk factors for bacteriuria in a prospective observation study of 405 hospitalized patients in Salt Lake City, Utah. The main outcome measure of their study was bacteriuria, which was defined using the same cut point as Huth’s group\(^1\) (\(\geq 10^2\) CFU/mL). The influence of a number of factors on bacteriuria rates was measured, including maintenance of a closed urinary drainage system. Two indicators of improper maintenance of system closure were observed and reported; disconnection of the system at the level of the catheter to drainage tubing junction and failure to reclamp the drainage spigot after use. Patients subjected to opening of the catheter to drainage system junction experienced a bacteriuria incidence of 13.3% versus 9.5% when no opening occurred, and those subjected to open drainage ports experienced a bacteriuria rate of 17.9% as compared to 11.8% among those whose ports remained closed except when the urine collection bag was drained.

These studies provide limited evidence that maintenance of a closed urinary drainage system reduces bacteriuria and, possibly, CAUTI incidence. The research supporting use of a closed drainage system in North America and the majority of countries in Western Europe is not included in this Evidence-Based Report Card because those studies were published well before 1980. However, results from the national database of hospital-acquired infection in Spain support these older studies and reinforce this traditional principle of indwelling catheter management. Given the context of indwelling catheter management in the majority of the world, the issue of strict maintenance of a closed urinary drainage system deserves greater scrutiny and additional research. Findings from these studies suggest that disruption of the closed system is common among patients with short-term indwelling urinary catheters, and that violation of the sealed system results in a higher incidence of bacteriuria within a 48-hour period and an increased risk for CAUTI. The evidence for use of preconnected system is mixed, with one study supporting a reduced incidence of bacteriuria in patients using a preconnected, sealed system\(^6\) but no difference in another study.\(^6\) While additional research is needed to reconcile these apparently conflicting findings, review of these studies appears to support the observation that a preconnected sealed system may have been more effective in one study because it deterred clinicians from opening the catheter-drainage system junction. Finally, it is important to note that this intervention applies exclusively to patients managed by short-term indwelling catheters. Maintenance of a closed system is, unfortunately, not realistic in patients managed by long-term catheterization who regularly switch from leg bags or belly bags to bedside bags in order to maximize mobility while awake.

**Question 7: Do Other Elements of the Drainage System, Such as Use of a 2-Chamber Drainage Bag, Influence CAUTI Risk?**

Ancestry search of studies evaluating closed urinary drainage systems also revealed several studies reporting
additional design features of urinary drainage systems intended to reduce the risk of CAUTI. Based on this, we completed a systematic review using the same key terms and techniques identified in Question 6 but focusing on studies reporting the effect of urinary system design features other than a closed system on CAUTI incidence. Four studies were found that evaluated the efficacy of different features of urinary drainage systems on bacteriuria or CAUTI incidence.

Wille and coinvestigators^38 compared incidence of bacteriuria in (1) a closed urinary drainage system incorporating an antireflux valve and (2) a closed system incorporating a preconnected coated catheter, tamper-discouraging seal at the catheter-drainage tubing junction, drip chamber, antireflux valve, hydrophobic drainage vent in the collection bag, and a povidone-iodine-releasing cartridge at the drainage port. One hundred eighty-one subjects with indwelling catheters anticipated to remain in place for at least 48 hours were randomly assigned to one of the systems. The main outcome measure, bacteriuria, was monitored every 24 hours. Despite the multiple features present in the test system, bacteriuria rates did not differ between the groups.

Leone’s group^39,40 evaluated the effect of a multi-chamber drainage system with a preconnected catheter, antireflux valve, drip chamber, povidone-iodine releasing cartridge, and 2-chamber drainage system on the incidence of bacteriuria in a nonrandomized study^39 and a subsequent randomized clinical trial. Both studies were set in ICU in a 550-bed university-affiliated hospital in Marseilles, France. The first study involved 224 consecutive patients undergoing indwelling catheterization. A group of 113 patients were managed with a traditional, closed system urinary drainage system, followed by 111 subjects managed by the test system. The incidence of bacteriuria among patients managed by the test system was 13.5% and the incidence in the standard system was 11.5%, a nonsignificant difference. In the second study, Leone’s group^40 completed a randomized clinical trial comparing the same 2 drainage systems in 311 subjects. In addition to randomization to treatment group, this trial also reported the incidence of CAUTI. Similar to their first quasi-experimental study, the incidence of bacteriuria did not differ between the groups (8.0% vs 8.5%, \(P = NS\)). The incidence of CAUTI was 12.1 versus 12.8 episodes per 1000 catheterized days; this difference was not statistically different.

Wilson and associates^41 compared a catheter valve to a “standard” drainage system in 100 subjects managed by long-term indwelling catheterization in London, England. Subjects were randomly assigned to management by a standard drainage system or one that incorporated a catheter valve, a small device that prevents reflux of urine from drainage tubing or collection bag into the catheter or bladder vesicle. The incidence of catheter-associated UTI was not statistically different among subjects assigned to the catheter valve.

Question 8: Does Irrigation of the Catheter and/or Bladder Reduce CAUTI Incidence?

All 3 guidelines conclude that existing evidence does not support bladder irrigation for prevention of CAUTI (Table 1). Their conclusions are influenced by multiple studies completed prior to 1980 that are not reviewed in this Evidence-Based Report Card. These studies provide some evidence suggesting that bladder irrigation may transiently reduce bacteriuria, but it fails to reduce bacteriuria over a period of weeks or months. They also document adverse side effects associated with the procedure based primarily on the solution used for irrigation.

We systematically reviewed the literature to identify evidence about bladder irrigation using key term “irrigation,” which was combined with “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. We identified a single study that evaluated the effect of bladder irrigation on CAUTI incidence published between 1980 and 2008. Waites and coinvestigators^46 compared the effect of bladder irrigation on bacteriuria in a double blind, randomized clinical trial of 89 persons with neurogenic bladder primarily caused by spinal cord injury. Participants resided in the southeastern United States and were managed with long-term indwelling urethral or suprapubic urinary catheters. Only community-dwelling subjects were enrolled in the study. As expected, all participants had asymptomatic bacteriuria on baseline urine culture. Participants were randomly assigned to complete twice irrigations comprising 30 mL of 1 of 3 solutions: (1) normal saline, (2) 0.25% acetic acid, and (3) neomycin-polymyxin GU irrigant containing 40 mg/mL of neomycin and 200,000 IU/mL polymyxin B. Subjects completed twice-daily irrigations over an 8-week period. The main outcome measure was bacteriuria; CAUTI was measured as secondary outcome. Results were not compared to a control group receiving no bladder irrigations. The dropout rate for the study was 41.6%; significantly more subjects randomized to the acetic acid irrigating solution dropped out before completed 8 weeks when compared to those using normal saline or the antimicrobial solution (70% acetic acid vs 26.7% neomycin/polyoxymyxin solution vs 27.6% normal saline, \(P = .0005\)). Common reasons for dropping out were CAUTI (11 subjects), bladder spasm with irrigation (3 participants), autonomic dysreflexia (9 subjects), and no longer willing to perform twice-daily irrigations (12 subjects). Analysis of results, based on the 52 persons who completed the 8-week trial, revealed that none of the solutions reduced the incidence of bacteriuria or pyuria. The mean urinary pH increased in all 3 groups, including those irrigating with the acetic acid solution. Given the absence of a no treatment group and the prevalence of CAUTI in this patient group, it is not possible to determine whether irrigation increased or decreased the incidence of infections when compared to patients who do not irrigate.
Although evidence about prevention of CAUTI via bladder irrigation is extremely sparse, the results of this trial summarize the multiple limitations associated with bladder irrigation. The most important is the researchers’ primary finding that twice-daily irrigations over an 8-week period do not significantly reduce bacteriuria or pyuria, suggesting that the procedure is unlikely to significantly reduce the risk for CAUTI. Other clinically relevant limitations include the significant patient and care provider burden associated with twice-daily irrigation as well as the occurrence of clinically bothersome adverse side effects such as bladder spasm and autonomic dysreflexia.

**Question 9: Does the Frequency of Routine Catheter Changes Influence CAUTI Incidence?**

The 3 guidelines differ on their recommendations concerning catheter change frequency (Table 1). The Briggs Institute Best Practice document advocates monthly catheter changes, whereas the CDC guidelines advise that arbitrary routine change schedules should be avoided. The ICI guidelines appear to focus on the role of catheter change frequency on catheter blockage. This document notes that, with careful observation, the typical duration of indwelling catheterization can be defined and routine changes can be implemented on a schedule that anticipates and avoids adverse effects associated with blockage.

Our systematic literature review focused on the influence of catheter change frequency on CAUTI incidence. Since short-term indwelling catheters remain in place for 2 weeks or less, this question, by definition, addresses long-term indwelling catheter care. The key terms used to identify studies from electronic databases described in the methods section were “indwelling catheterization,” “urinary catheterization,” and “catheter change.” These terms were combined with the key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. We identified 4 studies that fulfilled the inclusion criteria described previously.

Three studies were identified that focused on bacteriuria or CAUTI associated with routine catheter changes. Ho and coinvestigators evaluated bacteriuria and pyuria in 12 spinal cord injured patients before and after routinely monthly changes of their long-term indwelling catheters. Urine specimens were obtained before and following monthly catheter changes, described as routine for this sample population. Urine specimens were obtained immediately before and 24 hours following catheter change; the main outcome measures were bacteriuria (measured as CFU/mL) and bacterial species and pyuria (measured as WBC density in urine specimen). Bacteriuria and pyuria persisted in all subjects following catheter change. No statistically significant differences were found when colony counts and bacterial species were compared. However, a statistically significant increase in WBC in the urine was observed ($P = .0039$). The CAUTI incidence associated with routine catheter change was not reported.

White and Ragland retrospectively reviewed records of 106 patients managed by long-term indwelling urinary catheterization in a home-care setting. The primary outcome of their study was CAUTI incidence, calculated as procedure-based incidence (number of infections per 100 catheters inserted) and person-based incidence (calculated as number of infections per 10,000 days using an indwelling catheter). CAUTI was defined as symptomatic infection characterized by 2 of the following signs or symptoms: (1) fever $\geq 100^\circ F$; (2) new onset flank or suprapubic tenderness; (3) change in urine character such as hematuria, increased sediment, or foul odor; and (4) worsening of mental or functional status. After 6 weeks of catheterization, 15% of subjects whose catheter was changed every 2 weeks or less remained infection free as compared to 80% of those whose catheter was routinely changed every 4 to 6 weeks. Analysis based on a proportional hazards model revealed a relative risk of 11.94 (95% CI 5.46-26.22) among patients undergoing catheter changes every 2 weeks or more frequently as compared to those undergoing catheter changes every 4 to 6 weeks.

Priefer and associates compared routine catheter changes (monthly changes plus changes in response to catheter blockage and/or CAUTI) versus changes only in response to obstruction (PRN group) in 17 nursing home residents managed by long-term indwelling catheterization. The researchers noted that while bladder irrigation was discouraged, it was performed in some patients at the discretion of the nurse’s judgment. All patients were found to have bacteriuria at the time of enrollment into the study, and the main outcome measure was CAUTI defined as temperature $>101^\circ F$, lethargy, anorexia, nausea, vomiting, personality change, or leukocytosis, in the absence of other identifiable sources of infection. The frequency of CAUTI in patients who underwent routine catheter changes was 30% as compared to 86% among patients undergoing PRN catheter changes for obstruction only. These differences did not reach statistical significance.

These studies provide limited evidence that routine indwelling catheter changes (every 4-6 weeks) may reduce CAUTI incidence when compared to catheter changes only when blockage occurs or to planned catheter changes every 2 weeks or more often. White and Ragland’s study provides evidence supporting a statistically significant and clinically relevant difference showing that changes every 4 to 6 weeks reduce CAUTI frequency. While Priefer and associates’ study failed to demonstrate statistical significance, the magnitude of the reported difference in CAUTI frequency (86% vs 30%) raises the possibility of a type II error indicating clinically relevant differences not detected in this study owing to the small number of subjects in each group.
Question 10: Does Placement of an Antiseptic (Antibacterial) Solution in the Urinary Drainage Bag or More Frequent Urinary Drainage Bag Changes Reduce CAUTI Incidence?

Although seldom considered in the medical literature on this topic, the care of urinary drainage bags rises as an important nursing management issue. A single practice document, The Briggs Institute Best Practice Guideline,13 states that the addition of antiseptic solutions does not reduce CAUTI risk (Table 1). The CDC and the ICI guidelines offer no specific recommendations related to this issue.10a,11

We systematically searched the literature using the parameters specified previously to identify evidence about the influence of frequency of urinary drainage bag changes or placement of antimicrobial solutions in the drainage bag on CAUTI. We used the key terms “drainage bag” and “urinary drainage,” which were combined using the Boolean function “OR.” The resulting set was then combined with key terms “indwelling catheterization” and “urinary catheterization” using the “AND” Boolean function. Finally, this set was combined with key terms “urinary tract infection” and “catheter-associated urinary tract infection” using the “AND” Boolean function. Five studies were identified that addressed the efficacy of adding an antiseptic solution to the urinary drainage bag, and a single study was identified that evaluated the effect of frequency of urinary drainage bag changes.

Keerasuntonpong and colleagues50 evaluated the efficacy of frequent urinary drainage bag changes in a group of 153 patients in a university-based teaching hospital in Bangkok, Thailand. Participants were catheterized for at least 3 days prior to enrollment in the trial. They were randomly assigned to routine urinary drainage bag changes every 3 days (79 subjects) or no bag change (74 subjects). Demographic characteristics of the groups were similar. The researchers reported a slight difference in duration of indwelling catheterization (10.1 days for bag change group vs 9.5 days for no change group, P = .1) but the clinical relevance of this difference is not immediately apparent. The main outcome measure was symptomatic CAUTI, which was diagnosed based on CDC criteria. The incidence of CAUTI did not differ based on the frequency of urinary drainage bag changes (13.8 infections per 1000 catheter days for routine bag change vs 11.4 infections per 1000 catheter days, P = .7).

Three studies51-53 assessed the effect of adding the antiseptic hydrogen peroxide to the urinary drainage bag. Holliman and coinvestigators51 reported a quasi-experimental study comparing bacteriuria rates in patients with standard urinary drainage bags subjected to disinfection with hydrogen peroxide in an orthopedic surgery unit in Harrow, United Kingdom. The treatment cohort comprised 30 consecutive patients treated with a 3% solution of hydrogen peroxide instilled into their urinary drainage bag 3 times daily immediately after the bag was emptied. A second group comprised 27 consecutive patients managed by identical urinary drainage bags without instillation of any antiseptic solution. The main outcome measure was described by the investigators as CAUTI, but the diagnosis was based exclusively on the presence of bacteriuria (≥10⁷ CFU/mL) rather than signs or symptoms of a symptomatic urinary infection. Subjects managed with hydrogen peroxide were less likely to experience bacteriuria than were subjects in the no treatment cohort (11 vs 17 occurrences, P < .05). Subjects treated with regular instillations of hydrogen peroxide also experienced a higher number of bacteriuria-free days than the nontreatment group (6.0 vs 8.5 days, P < .02).

Sweet and associates52 reported a randomized clinical trial comparing instillation of 30 mL syringes of 3% hydrogen peroxide in 238 patients in a university-based teaching hospital in the midwestern United States. Subjects were managed on a combination of regular units and 2 critical care units. A significant number of subjects dropped out prior to study completion, including 41% of control group subjects and 46% of treatment group subjects. The primary reasons for dropouts included use of a urinary drainage bag without a port for specimen collection, discontinuation of indwelling catheter within 24 hours of insertion, transfer from the study units, or death. The main outcome measures of the study were bacteriuria, colonization of the urinary drainage bag, and symptomatic CAUTI (defined as bacteriuria, pyuria, and a fever >101°F developing within 24 hours of a positive urine culture). Neither the incidence of bacteriuria (25% vs 28%) nor the incidence of CAUTI (29% vs 42%) significantly differed when treatment and control groups were compared.

Thompson and coworkers53 evaluated the effect of periodic instillations of 30 mL of 3% hydrogen peroxide to the urinary drainage bag in a randomized clinical trial of 688 patients in a university-based acute care facility in the southeastern United States. Aliquots of hydrogen peroxide were added to the urinary drainage bag after catheterization and every 8 hours until the catheter was removed. An initial urine specimen for bacteriologic analysis was obtained at the time of catheterization, and daily specimens were obtained during the course of catheterization. The main outcome measure was bacteriuria. No statistically significant difference was found when subjects randomized to instillation of hydrogen peroxide in their urinary drainage bags 3 times daily were compared to control subjects (11% vs 9%, P > .3). The mean duration between catheterization and onset of asymptomatic bacteriuria did not differ between the groups (5.3 vs 5.2 days).

Sujka’s group54 compared 2 groups of 33 consecutive patients managed by indwelling catheterization following abdominopelvic resection in the northeastern United States. One group was managed by instillation of 20 mL of a povidone-iodine solution every 8 hours and the second group was managed with the same urinary drainage bags...
without instillation of the povidone-iodine solution. Participants in both groups were also managed by intermittent catheter clamping to determine “readiness to void” defined as by perception of urgency as the bladder filled. Subjects in the 2 cohorts did not differ on any demographic characteristics, including duration of catheterization (mean 11 vs 10 days, \( P = \text{NS} \)). Similar to Holliman’s group,\(^{11}\) the researchers labeled their main outcome measure as CAUTI, but they did not differentiate patients with asymptomatic bacteriuria from those with symptomatic infections. Therefore, we are reporting results as bacteriuria rather than CAUTI. Results are based on findings from a single urine culture obtained when the indwelling urinary catheter was removed. Males managed by instillation of povidone-iodine into their urinary drainage bags were found to have a lower frequency of bacteriuria than did those in the no-instillation group (33% vs 61%). The difference in female subjects was less (86% vs 100%). Inferential statistical analysis of these differences was not reported.

Results of these studies provide limited evidence that instillation of an antiseptic solution does not reduce bacteriuria or CAUTI incidence in patients with indwelling urinary catheters. The findings of a single study provide very limited evidence that increasing the frequency of urinary drainage bag changes does not reduce the frequency of CAUTI.

## Clinical Implications

When combined with the results of part 1 and the Continence Subcommittee’s CAUTI fact sheet, this Evidence-Based Report Card provides a sound basis for designing an evidence-based CAUTI prevention program (Table 2). A CAUTI prevention program begins with staff education about indications for indwelling catheterization, the importance of prompt catheter removal, and techniques for catheter care. Facility policies for indwelling catheter management should be reviewed with staff (and updated as indicated). Monitoring of CAUTI incidence is essential since it provides the basis for measuring and analyzing current indwelling catheter management and the outcomes of prevention efforts. A multidisciplinary team, often involving the facility’s infection control committee, should be formed to assume primary responsibility for determining facility policies related to catheter insertion and management, CAUTI diagnosis, and monitoring incidence rates. While monitoring is essential, analysis of the existing evidence also demonstrates that monitoring alone is not sufficient. Instead, results must be shared with clinical leaders and staff nurses so that successful interventions are perpetuated and ineffective or harmful interventions are eliminated. Bacteriuria may be monitored for research purposes, but feedback provided to staff should be limited to the occurrences of symptomatic catheter-associated urinary infections only.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate staff about indwelling catheter management and provide regular feedback about catheter-associated urinary tract infection incidence</td>
<td>Level 4</td>
</tr>
<tr>
<td>Determine indications for catheter insertion and implement a program to ensure prompt removal of indwelling catheters</td>
<td>Level 2</td>
</tr>
<tr>
<td>Consider routine use of antiseptic catheters (silver alloy or antibiotic coated)</td>
<td>Level 1</td>
</tr>
<tr>
<td>Use modified sterile technique recommended by Centers for Disease Control and Prevention guidelines when inserting an indwelling catheter; existing evidence does not support use of strict aseptic technique including surgical gown, mask, and extensive use of sterile drapes similar to that used in the operating room setting</td>
<td>Level 2</td>
</tr>
<tr>
<td>Routinely cleanse the urethral meatus using soap and water or a perineal or incontinence cleanser; do not apply antiseptic solutions, ointments, or creams when cleansing the meatus</td>
<td>Level 1</td>
</tr>
<tr>
<td>Maintain a closed urinary drainage system</td>
<td>Level 4</td>
</tr>
<tr>
<td>Consider use of preconnected closed systems to reduce interruption of the system by patients, staff, or family</td>
<td>Level 3</td>
</tr>
</tbody>
</table>

An optimal CAUTI prevention program should also include mechanisms for monitoring patients with indwelling catheters. Facility policies, often written by the multidisciplinary team that monitors CAUTI rates, should specify indications for inserting an indwelling catheter and outline procedures to ensure its prompt removal. Every patient with an indwelling catheter should have an explicitly documented reason for its insertion, and facility policies should encourage nurses or other care providers to question patients without a documented indication for indwelling catheterization to determine whether it can be safely removed. Existing evidence also suggests that a review of all indwelling catheters should occur 3 to 4 days after their insertion, and the necessity of continued catheterization should be judged based on individualized considerations. Monitoring should continue until the catheter is removed or the patient is discharged from hospital. Discharge teaching should include the reason for ongoing catheterization and a specific plan for follow-up ongoing monitoring and (if possible) catheter removal.

An optimal CAUTI prevention program should also consider multiple aspects of catheter design. Robust research reviewed in part 1 of this Evidence-Based Report Card supports the use of antimicrobial catheters, either silver alloy hydrogel catheters or antibiotic impregnated silicone catheters for short-term catheterization.\(^{10}\) Expert
opinion suggests that selection of a 14-16 French catheter, in preference to catheter sizes 18 French or larger, may reduce urethral irritation and inflammation, but there is insufficient evidence to confirm or refute this recommendation. A single randomized clinical trial was identified in this review that suggests that catheter securement does not reduce CAUTI risk, but additional evidence is required before drawing a firm conclusion about this issue. Routine catheter securement is strongly recommended based on safety considerations in patients with short-term indwelling catheter and for the prevention of urethral erosion in patients with long-term indwelling catheters.

There is insufficient evidence to identify the optimal technique for catheter insertion, but the “sterile” technique described in the CDC clinical practice guidelines provides a reasonable guide to best practice standards pertaining to catheterization. The CDC guidelines describe optimal technique including appropriate handwashing as well as “gloves, drape, sponges, an appropriate antiseptic solution for periurethral cleaning, and a single-use packet of lubricant jelly.”

Several studies completed prior to 1980 form the basis for current recommendations for maintenance of a closed urinary drainage in patients managed by short-term catheterization, and this historic evidence is supported by more recent data from Spain. Mixed evidence suggests that preconnected, sealed urinary drainage systems may reduce the likelihood that patients, family, or staff will disconnect a closed urinary drainage system, potentially reducing the risk of bacteriuria and CAUTI, but this potential advantage must be carefully weighed against the higher cost associated with use of these products. Sparse evidence suggests that no other drainage system features reduce CAUTI risk.

The interventions reviewed above focus on short-term indwelling catheterization, which accounts for the vast majority of catheterized patients in the acute or critical care setting. Nevertheless, WOC nurses practicing in acute care, and especially those practicing in long-term or home-care settings, will care for many patients managed by long-term indwelling catheters. Available evidence suggests that antimicrobial catheters do not prevent bacteriuria in patients managed by long-term catheterization and very limited evidence suggests that these catheters do not reduce CAUTI incidence. Silicone- or hydrogel-coated catheters are generally recommended for these patients, but this preference is based on considerations of patient comfort and prevention of urethral erosion rather than differences in CAUTI risk. Selection of other elements of catheter design, including catheter size and the importance of using a securement device for safety reasons are similar to those recommended for short-term catheterization. In contrast, maintenance of a closed urinary drainage system is not realistic for long-term catheters since patients are typically required to change from bedside to leg or belly bags as they move from bed to chair. Multiple interventions have been recommended to reduce bacterial loads in urinary drainage bags, including more frequent bag changes and instillation of antiseptic solutions into the bag, but none has proven effective for the prevention of CAUTI in this population.

Limited evidence suggests that routinely changing a long-term indwelling catheter every 4 to 6 weeks is superior to frequent changes (every 2 weeks or more often) or infrequent changes only when the catheter blocks. However, more frequent changes may be necessary among those who experience rapid catheter encrustation and blockage. Existing evidence suggests that bladder and/or catheter irrigation does not reduce CAUTI incidence, but irrigation using a mildly acidic solution is often used to extend catheter life in patients who rapidly form blockages. If irrigations are performed to prevent frequent catheter changes, monitoring for changes in the frequency of the individual’s CAUTI may inform decisions about the value of this practice for that person.

**KEY POINTS**

- Limited evidence suggests that staff education about indwelling urinary catheter management and prevention of catheter-associated urinary tract infection (CAUTI), combined with regular feedback about occurrence rates, reduces the incidence of bacteriuria and CAUTI. (Level of evidence: 4)
- Mixed evidence suggests that implementation of a prompted catheter insertion and removal program reduces the incidence of CAUTI. (Level of evidence: 2)
- Limited evidence suggests that strict aseptic technique, including donning a sterile gown, mask, and hair covering as well as extensive use of sterile drapes, sterile gloves, and no-touch insertion technique does not reduce the incidence of bacteriuria within the first 48 to 72 hours following catheterization. (Level of evidence: 2)
- Further research is needed to establish the optimal technique for inserting an indwelling catheter in the acute, long-term, and home-care settings. (Level of evidence: N/A)
- Sufficient evidence exists to conclude that use of antiseptic or antimicrobial solutions of ointments as part of routine urethral meatal care does not reduce the incidence of bacteriuria or CAUTI. (Level of evidence: 1)
- Sparse evidence suggests that routine meatal care (regular cleansing of the meatus as part of routine perineal hygiene) may reduce the incidence of CAUTI, especially in patients with fecal incontinence. (Level of evidence: 4)
There is insufficient evidence to determine whether routine catheter securement reduces the incidence of CAUTI. Results of a single randomized clinical trial suggest that selection of an adhesive-backed device versus other types of devices or no device does not influence CAUTI risk but limitations with the study design preclude more definitive conclusions. (Level of evidence: N/A)

Existing evidence suggests that use of a closed catheter-drainage system reduces the incidence of CAUTI in patients managed by short-term indwelling catheterization. (Level of evidence: 4)

Existing evidence concerning the efficacy of a preconnected closed urinary catheter-drainage system is mixed. The potential of these devices to reduce bacteriuria and CAUTI incidence in patients managed by short-term indwelling catheterization appears related to its potential to reduce clinician-associated disconnection of the catheter from the drainage tubing rather than the physical barriers incorporated into these systems. (Level of evidence: 3)

Use of a multichamber urinary drainage bag, with or without a povidone-releasing cartridge, does not reduce the incidence of CAUTI when compared to single chamber bags. (Level of evidence: 1)

Evidence from a single randomized clinical trial provides very limited evidence that irrigating the bladder with saline, acetic acid, or a neomycin/polymyxin antimicrobial solution does not reduce bacteriuria or CAUTI incidence in patients with long-term indwelling urinary catheters. The results of this study are supported by findings from multiple studies published between 1950 and 1979. These results are reflected in the clinical practice guidelines from the US Centers for Disease Control and Prevention, but they are not specifically reviewed in this Evidence-Based Report Card. (Level of evidence: 1)

Limited evidence suggests that routinely changing the catheter every 4 to 6 weeks reduces the frequency of CAUTI when compared to changing the catheter every 2 weeks or more often in patients with long-term indwelling catheters. (Level of evidence: 4)

Very sparse evidence suggests that routine catheter changes every 4 to 6 weeks may reduce CAUTI incidence when compared to a regimen of changing the catheter only when it becomes blocked. (Level of evidence: 4)

Limited evidence suggests that routinely adding an antiseptic such as hydrogen peroxide does not reduce the incidence of bacteriuria or CAUTI. (Level of evidence: 1)

References

