Diagnosis, Prevention, and Treatment of Catheter-Associated Urinary Tract Infection in Adults: 2009 International Clinical Practice Guidelines from the Infectious Diseases Society of America

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Guidelines for the diagnosis, prevention, and management of persons with catheter-associated urinary tract infection (CA-UTI), both symptomatic and asymptomatic, were prepared by an Expert Panel of the Infectious Diseases Society of America. The evidence-based guidelines encompass diagnostic criteria, strategies to reduce the risk of CA-UTIs, strategies that have not been found to reduce the incidence of urinary infections, and management strategies for patients with catheter-associated asymptomatic bacteriuria or symptomatic urinary tract infection. These guidelines are intended for use by physicians in all medical specialties who perform direct patient care, with an emphasis on the care of patients in hospitals and long-term care facilities.

EXECUTIVE SUMMARY

Catheter-associated (CA) bacteriuria is the most common health care–associated infection worldwide and is a result of the widespread use of urinary catheterization, much of which is inappropriate, in hospitals and long-term care facilities (LTCFs). Considerable personnel time and other costs are expended by health care institutions to reduce the rate of CA infections, especially those that occur in patients with symptoms or signs referable to the urinary tract (CA urinary tract infection [CA-UTI]). In these guidelines, we provide background information on the epidemiology and pathogenesis of CA infections and evidence-based recommendations for their diagnosis, prevention and management. Unfortunately, the catheter literature generally reports on CA asymptomatic bacteriuria (CA-ASB) or CA bacteriuria (used when no distinction is made between CA-ASB and CA-UTI; such cases are predominantly CA-ASB), rather than on CA-UTI. As a result, most recommendations in these guidelines refer to CA-bacteriuria, because this is the only or predominant out-

Received 23 November 2009; accepted 24 November 2009; electronically published 4 February 2010.

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Clinical Infectious Diseases 2010;50:625–663
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1058-4838/2010/5005-0001$15.00
DOI: 10.1086/650482

These guidelines were developed by the Infectious Diseases Society of America in collaboration with the American Geriatrics Society, American Society of Nephrology, American Spinal Injury Association, American Urological Association, Association of Medical Microbiology and Infectious Diseases–Canada, European Association of Urology , European Society of Clinical Microbiology and Infectious Diseases, Society for Healthcare Epidemiology of America, Society of Hospital Medicine, and the Western Pacific Society of Chemotherapy.

It is important to realize that guidelines cannot always account for individual variation among patients. They are not intended to supplant physician judgment with respect to particular patients or special clinical situations. The IDSA considers adherence to these guidelines to be voluntary, with the ultimate determination regarding their application to be made by the physician in the light of each patient's individual circumstances.

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come measure reported in most clinical trials. We refer to CA-ASB and CA-UTI as appropriate on the basis of the published literature.

The most effective way to reduce the incidence of CA-ASB and CA-UTI is to reduce the use of urinary catheterization by restricting its use to patients who have clear indications and by removing the catheter as soon as it is no longer needed. Strategies to reduce the use of catheterization have been shown to be effective and are likely to have more impact on the incidence of CA-ASB and CA-UTI than any of the other strategies addressed in these guidelines. Implementing such strategies should be a priority for all health care facilities.

Method of Diagnosing CA-ASB and CA-UTI

1. CA-UTI in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of symptoms or signs compatible with UTI with no other identified source of infection along with $\geqslant 10^3$ colony-forming units (cfu)/mL of $\geqslant 1$ bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral, suprapubic, or condom catheter has been removed within the previous 48 h (A-III).

i. Data are insufficient to recommend a specific quantitative count for defining CA-UTI in symptomatic men when specimens are collected by condom catheter.

2. CA-ASB should not be screened for except in research studies evaluating interventions designed to reduce the incidence of CA-ASB or CA-UTI (A-III) and in selected clinical situations, such as in pregnant women (A-III).

i. CA-ASB in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of $\geqslant 10^5$ cfu/mL of $\geqslant 1$ bacterial species in a single catheter urine specimen in a patient without symptoms compatible with UTI (A-III).

ii. CA-ASB in a man with a condom catheter is defined by the presence of $\geqslant 10^5$ cfu/mL of $\geqslant 1$ bacterial species in a single urine specimen from a freshly applied condom catheter in a patient without symptoms compatible with UTI (A-II).

3. Signs and symptoms compatible with CA-UTI include new onset or worsening of fever, rigors, altered mental status, malaise, or lethargy with no other identified cause; flank pain; costovertebral angle tenderness; acute hematuria; pelvic discomfort; and in those whose catheters have been removed, dysuria, urgent or frequent urination, or suprapubic pain or tenderness (A-III).

i. In patients with spinal cord injury, increased spasticity, autonomic dysreflexia, or sense of unease are also compatible with CA-UTI (A-III).

4. In the catheterized patient, pyuria is not diagnostic of CA-bacteriuria or CA-UTI (AII).

i. The presence, absence, or degree of pyuria should not be used to differentiate CA-ASB from CA-UTI (A-II).

ii. Pyuria accompanying CA-ASB should not be interpreted as an indication for antimicrobial treatment (A-II).

iii. The absence of pyuria in a symptomatic patient suggests a diagnosis other than CA-UTI (A-III).

5. In the catheterized patient, the presence or absence of odorous or cloudy urine alone should not be used to differentiate CA-ASB from CA-UTI or as an indication for urine culture or antimicrobial therapy (A-III).

Reduction of Inappropriate Urinary Catheter Insertion and Duration

Limiting Unnecessary Catheterization

6. Indwelling catheters should be placed only when they are indicated (A-III).

i. Indwelling urinary catheters should not be used for the management of urinary incontinence (A-III). In exceptional cases, when all other approaches to management of incontinence have not been effective, it may be considered at patient request.

7. Institutions should develop a list of appropriate indications for inserting indwelling urinary catheters, educate staff about such indications, and periodically assess adherence to the institution-specific guidelines (A-III).

8. Institutions should require a physician's order in the chart before an indwelling catheter is placed (A-III).

9. Institutions should consider use of portable bladder scanners to determine whether catheterization is necessary for postoperative patients (B-II).

Discontinuation of Catheter

10. Indwelling catheters should be removed as soon as they are no longer required to reduce the risk of CA-bacteriuria (A-I) and CA-UTI (A-II).

11. Institutions should consider nurse-based or electronic physician reminder systems to reduce inappropriate urinary catheterization (A-II) and CA-UTI (A-II).

12. Institutions should consider automatic stop-orders to reduce inappropriate urinary catheterization (B-I).

Strategies to Consider Prior to Catheter Insertion

Infection Prevention

13. Hospitals and LTCFs should develop, maintain, and promulgate policies and procedures for recommended catheter insertion indications, insertion and maintenance techniques, discontinuation strategies, and replacement indications (A-III).

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i. Strategies should include education and training of staff relevant to these policies and procedures (A-III).

14. Institutions may consider feedback of CA-bacteriuria rates to nurses and physicians on a regular basis to reduce the risk of CA-bacteriuria (C-II).

i. Data are insufficient to make a recommendation as to whether such an intervention might reduce the risk of CA-UTI.

15. Data are insufficient to make a recommendation as to whether institutions should place patients with indwelling urinary catheters in different rooms from other patients who have indwelling urinary catheters or other invasive devices to reduce the risk of CA-bacteriuria or CA-UTI.

Alternatives to Indwelling Urethral Catheterization

16. In men for whom a urinary catheter is indicated and who have minimal postvoid residual urine, condom catheterization should be considered as an alternative to short-term (A-II) and long-term (B-II) indwelling catheterization to reduce CA-bacteriuria in those who are not cognitively impaired.

i. Data are insufficient to make a recommendation as to whether condom catheterization is preferable to short-term or long-term indwelling urethral catheterization for reduction of CA-UTI.

ii. Data are insufficient to make a recommendation as to whether condom catheterization is preferable to short-term or long-term indwelling urethral catheterization for reduction of CA-bacteriuria in those who are cognitively impaired.

17. Intermittent catheterization should be considered as an alternative to short-term (C-I) or long-term (A-III) indwelling urethral catheterization to reduce CA-bacteriuria and an alternative to short-term (C-III) or long-term (A-III) indwelling urethral catheterization to reduce CA-UTI.

18. Suprapubic catheterization may be considered as an alternative to short-term indwelling urethral catheterization to reduce CA-bacteriuria (B-I) and CA-UTI (C-III).

i. Data are insufficient to make a recommendation as to whether suprapubic catheterization is preferable to long-term indwelling urethral catheterization for reduction of CA-bacteriuria or CA-UTI.

ii. Data are insufficient to make a recommendation as to whether intermittent catheterization is preferable to suprapubic catheterization for reduction of CA-bacteriuria or CA-UTI.

Intermittent Catheterization Technique

19. Clean (nonsterile) rather than sterile technique may be considered in outpatient (A-III) and institutional (B-I) settings with no difference in risk of CA-bacteriuria or CA-UTI.

20. Multiple-use catheters may be considered instead of sterile single-use catheters in outpatient (B-III) and institutional (C-I) settings with no difference in risk of CA-bacteriuria or CA-UTI.

21. Data are insufficient to make a recommendation as to whether one method of cleaning multiple-use catheters is superior to another.

22. Hydrophilic catheters are not recommended for routine use to reduce the risk of CA-bacteriuria (B-II) or CA-UTI (B-II).

23. Data are insufficient to make recommendations on whether use of portable bladder scanners or "no-touch" technique reduces the risk of CA-UTI, compared with standard care.

Insertion Technique for Indwelling Urethral Catheter

24. Indwelling urethral catheters should be inserted using aseptic technique and sterile equipment (B-III).

Prevention Strategies to Consider after Catheter Insertion

Closed Catheter System

25. A closed catheter drainage system, with ports in the distal catheter for needle aspiration of urine, should be used to reduce CA-bacteriuria (A-II) and CA-UTI (A-III) in patients with short-term indwelling urethral or suprapubic catheters and to reduce CA-bacteriuria (A-III) and CA-UTI (A-III) in patients with long-term indwelling urethral or suprapubic catheters.

i. Institution-specific strategies should be developed to ensure that disconnection of the catheter junction is minimized (A-III) and that the drainage bag and connecting tube are always kept below the level of the bladder (A-III).

26. Use of a preconnected system (catheter preattached to the tubing of a closed drainage bag) may be considered to reduce CA-bacteriuria (C-II).

i. Data are insufficient to make a recommendation as to whether such a system reduces CA-UTI.

27. Use of a complex closed drainage system or application of tape at the catheter-drainage tubing junction after catheter insertion is not recommended to reduce CA-bacteriuria (A-I) or CA-UTI (A-III).

Antimicrobial Coated Catheters

28. In patients with short-term indwelling urethral catheterization, antimicrobial (silver alloy or antibiotic)–coated urinary catheters may be considered to reduce or delay the onset of CA-bacteriuria (B-II).

i. Data are insufficient to make a recommendation about whether use of such catheters reduces CA-UTI in patients with short-term indwelling urethral catheterization.

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ii. Data are insufficient to make a recommendation as to whether use of such catheters reduces CA-bacteriuria or CA-UTI in patients with long-term catheterization.

Prophylaxis with Systemic Antimicrobials

29. Systemic antimicrobial prophylaxis should not be routinely used in patients with short-term (A-III) or long-term (A-II) catheterization, including patients who undergo surgical procedures, to reduce CA-bacteriuria or CA-UTI because of concern about selection of antimicrobial resistance.

Prophylaxis with Methenamine Salts

30. Methenamine salts should not be used routinely to reduce CA-bacteriuria or CA-UTI in patients with long-term intermittent (A-II) or long-term indwelling urethral or suprapubic (A-III) catheterization.

i. Data are insufficient to make a recommendation about the use of methenamine salts to reduce CA-UTI in patients with condom catheterization.

31. Methenamine salts may be considered for the reduction of CA-bacteriuria and CA-UTI in patients after gynecologic surgery who are catheterized for no more than 1 week (C-I). It is reasonable to assume that a similar effect would be seen after other types of surgical procedures.

i. Data are insufficient to make recommendations about whether one methenamine salt is superior to another.

32. When using a methenamine salt to reduce CA-UTI, the urinary pH should be maintained below 6.0 (B-III).

i. Data are insufficient to recommend how best to achieve a low urinary pH.

Prophylaxis with Cranberry Products

33. Cranberry products should not be used routinely to reduce CA-bacteriuria or CA-UTI in patients with neurogenic bladders managed with intermittent or indwelling catheterization (A-II).

i. Data are insufficient to make a recommendation on the use of cranberry products to reduce CA-bacteriuria or CA-UTI in other groups of catheterized patients, including those using condom catheters.

Enhanced Meatal Care

34. Daily meatal cleansing with povidone-iodine solution, silver sulfadiazine, polyantibiotic ointment or cream, or green soap and water is not recommended for routine use in men or women with indwelling urethral catheters to reduce CA-bacteriuria (A-I).

i. Data are insufficient to make a recommendation as to whether meatal cleansing reduces the risk of CA-UTI.

Catheter Irrigation

35. Catheter irrigation with antimicrobials should not be used routinely to reduce or eradicate CA-bacteriuria (A-I) or CA-UTI (A-II) in patients with indwelling catheters.

36. Catheter irrigation with antimicrobials may be considered in selected patients who undergo surgical procedures and short-term catheterization to reduce CA-bacteriuria (C-I).

i. Data are insufficient to make a recommendation about whether bladder irrigation in such patients reduces CA-UTI.

37. Catheter irrigation with normal saline should not be used routinely to reduce CA-bacteriuria, CA-UTI, or obstruction in patients with long-term indwelling catheterization (B-II).

Antimicrobials in the Drainage Bag

38. Routine addition of antimicrobials or antiseptics to the drainage bag of catheterized patients should not be used to reduce CA-bacteriuria (A-I) or CA-UTI (A-I).

Routine Catheter Change

39. Data are insufficient to make a recommendation as to whether routine catheter change (eg, every 2–4 weeks) in patients with functional long-term indwelling urethral or suprapubic catheters reduces the risk of CA-ASB or CA-UTI, even in patients who experience repeated early catheter blockage from encrustation.

Prophylactic Antimicrobials at Time of Catheter Removal or Replacement

40. Prophylactic antimicrobials, given systemically or by bladder irrigation, should not be administered routinely to patients at the time of catheter placement to reduce CA-UTI (A-I) or at the time of catheter removal (B-I) or replacement (A-III) to reduce CA-bacteriuria.

i. Data are insufficient to make a recommendation as to whether administration of prophylactic antimicrobials to such patients reduces bacteremia.

Screening for and Treatment of CA-ASB in Catheterized Patients to Reduce CA-UTI

41. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI in patients with short-term (A-II) or long-term (A-I) indwelling urethral catheters.

42. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI

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in patients with neurogenic bladders managed with intermittent catheterization (A-II).

43. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI in other catheterized patients (A-III), except in pregnant women (A-III) and patients who undergo urologic procedures for which visible mucosal bleeding is anticipated (A-III).

Screening for and Treatment of CA-ASB at Catheter Removal to Reduce CA-UTI

44. Antimicrobial treatment of CA-ASB that persists 48 h after short-term indwelling catheter removal in women may be considered to reduce the risk of subsequent CA-UTI (C-I).

i. Data are insufficient, however, to make a recommendation as to whether all women should be uniformly screened for CA-ASB at catheter removal.

ii. Data are insufficient to make a recommendation about screening for or treatment of persistent CA-ASB in men.

Urine Culture and Catheter Replacement before Treatment

45. A urine specimen for culture should be obtained prior to initiating antimicrobial therapy for presumed CA-UTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance (A-III).

46. If an indwelling catheter has been in place for >2 weeks at the onset of CA-UTI and is still indicated, the catheter should be replaced to hasten resolution of symptoms and to reduce the risk of subsequent CA-bacteriuria and CA-UTI (A-I).

i. The urine culture should be obtained from the freshly placed catheter prior to the initiation of antimicrobial therapy to help guide treatment (A-II).

ii. If use of the catheter can be discontinued, a culture of a voided midstream urine specimen should be obtained prior to the initiation of antimicrobial therapy to help guide treatment (A-III).

Duration of Treatment

47. Seven days is the recommended duration of antimicrobial treatment for patients with CA-UTI who have prompt resolution of symptoms (A-III), and 10–14 days of treatment is recommended for those with a delayed response (A-III), regardless of whether the patient remains catheterized or not.

i. A 5-day regimen of levofloxacin may be considered in patients with CA-UTI who are not severely ill (B-III). Data are insufficient to make such a recommendation about other fluoroquinolones.

ii. A 3-day antimicrobial regimen may be considered for women aged ≤65 years who develop CA-UTI without upper urinary tract symptoms after an indwelling catheter has been removed (B-II).

DEFINITIONS

In these guidelines, CA infection refers to infection occurring in a person whose urinary tract is currently catheterized or has been catheterized within the previous 48 h. UTI refers to significant bacteriuria in a patient with symptoms or signs attributable to the urinary tract and no alternate source. ASB refers to significant bacteriuria in a patient without symptoms or signs attributable to the urinary tract. Bacteriuria is a nonspecific term that refers to UTI and ASB combined. In the urinary catheter literature, CA-bacteriuria is comprised mostly of CA-ASB. In this document, CA-UTI, CA-ASB, and CA-bacteriuria are each considered to represent infection of the urinary tract, because bacteria are not normal inhabitants of the urinary tract.

Significant bacteriuria is the quantitative level of bacteriuria consistent with true bladder bacteriuria, rather than contamination, based on growth from a urine specimen collected in a manner to minimize contamination and transported to the laboratory in a timely fashion to limit bacterial growth. As noted above, significant bacteriuria can occur without symptoms or signs referable to the urinary tract. The colony count criteria defining significant bacteriuria in different clinical scenarios as recommended for use by the Guideline Panel are described in the section below on diagnosis. Lower colony counts are more likely to represent significant bacteriuria in a symptomatic person, compared with an asymptomatic person. Likewise, because catheter urine specimens are not as likely to be contaminated by periurethral flora as are voided urine specimens, lower colony counts are more likely to represent significant bacteriuria. Unfortunately, studies often use different colony count criteria for defining significant bacteriuria and often do not distinguish between symptomatic and asymptomatic patients in applying the definitions.

The urinary catheter literature is problematic, in that many published studies use the term CA-bacteriuria without providing information on what proportion of infections are CA-ASB, and some studies use the term CA-UTI when referring to CA-ASB or CA-bacteriuria. The recommendations that follow refer to the more specific terms, CA-UTI and/or CA-ASB, when data on these outcomes are reported in clinical studies, but most recommendations refer to CA-bacteriuria, because this is the only or predominant outcome measure reported in most clinical trials. It is our hope that the definitions used in these guidelines might help to standardize the terminology used in the catheter literature and related discussions.

INTRODUCTION

The purpose of these guidelines is to provide recommendations for the diagnosis, prevention, and treatment of CA-UTI in adults ≥18 years of age. The guidelines pertain to patients who

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are managed with indwelling catheterization, including short-term (<30 days) and long-term (⩾30 days) catheterization, intermittent catheterization, and condom catheterization. Issues relevant to persons with neurogenic bladders are addressed. The guidelines do not address patients with single in-and-out catheterization for diagnostic purposes; patients who undergo complicated urologic catheterization procedures, such as those involving ureteral stents or nephrostomy tubes; or patients with fungal UTI. Recommendations for the management of fungal UTI are provided in the Infectious Disease Society of America's (IDSA) treatment guidelines for candidiasis [1]. In using these guidelines, it should be noted that CA-ASB and CA-UTI occur in a very heterogeneous group of patients, ranging from healthy persons catheterized for a surgical procedure to patients with neurogenic bladders to severely ill patients catheterized to relieve an obstructed outflow tract. The currently available literature provides little data on the effect of different prevention and treatment strategies among different types of catheterized patients. Studies to address prevention and treatment strategies in specific groupings of catheterized patients are needed.

Most hospital-acquired UTIs are associated with catheterization, and most occur in patients without signs or symptoms referable to the urinary tract. CA-bacteriuria is the most frequent health care–associated infection worldwide, accounting for up to 40% of hospital-acquired infections in US hospitals each year [2, 3]. In hospitalized patients, CA-bacteriuria accounts for many episodes of nosocomial bacteremia, and one study has found an association with increased mortality [4]. From 5% to 10% of residents in LTCFs have long-term indwelling urinary catheters with associated bacteriuria [5, 6]. In addition, CA-bacteriuria results in considerable antimicrobial use (often inappropriate) in hospitals and LTCFs and comprises a large reservoir of antimicrobial-resistant organisms that contribute to the problem of cross-infection.

CA-bacteriuria has important implications for the patient and others in the environment and should be a high priority for infection prevention programs. Not surprisingly, the most effective way to reduce the risk of CA-bacteriuria is to avoid unnecessary catheterization and to remove the catheter promptly when it is no longer needed. However, despite the strong link between urinary catheterization and subsequent UTI, US hospitals have not widely implemented strategies to reduce hospital-acquired UTI [7]. This may change in the United States with the Centers for Medicare and Medicaid Services recent modification of the hospital reimbursement system to eliminate payments to hospitals for treatment of preventable complications, such as CA-UTI [8]. It is not possible, however, to prevent all CA-UTIs, especially in patients who need long-term bladder drainage, such as those with neurogenic bladders.

Because the relationship between CA-ASB and CA-UTI and other outcomes is unclear, it is challenging to assess an intervention that has been shown to reduce CA-ASB (or CA-bacteriuria) but that has an unknown effect on CA-UTI. Although the presence of CA-ASB is presumably necessary for the development of CA-UTI, the vast majority of patients with CA-ASB do not progress to CA-UTI. Thus, the development of urinary symptoms must require some facilitating event(s) that is yet to be determined. Even if CA-ASB itself is benign, there are several reasons that may justify efforts for prevention. For example, CA-ASB may predispose a patient to CA-UTI through a common pathogenic pathway, in which case interventions that reduce CA-ASB would be expected to reduce CA-UTI. In addition, CA-ASB represents a large reservoir of antimicrobial-resistant urinary pathogens that may be transmitted to other patients and frequently triggers inappropriate antimicrobial use. Therefore, the greatest impact of an intervention may be to reduce the frequent occurrence of CA-ASB, rather than to directly reduce the number of episodes of CA-UTI, which occur much less often. The majority of intervention trials that have been shown to reduce CA-ASB or CA-bacteriuria have not demonstrated effectiveness to reduce CA-UTI, but few trials have been designed and powered to evaluate such outcomes.

The focus of these guidelines is the prevention and management of CA-UTI. The Panel addressed the following clinical questions in these guidelines: "How should CA-UTI be diagnosed?," "How should CA-UTI be prevented?," and "How should CA-UTI be managed?" However, when data were available, the Panel agreed to also provide a ranking with supporting level of evidence for recommendations for or against interventions shown to impact CA-ASB or CA-bacteriuria. This recommendation schema allows users of these guidelines to decide whether to implement an intervention on the basis of evidence that it reduces CA-ASB or CA-bacteriuria with or without evidence of its effect on CA-UTI. Ideally, formal evaluations that incorporate clinical and economic consequences of interventions will help decision-makers decide whether interventions that reduce only CA-ASB or CA-bacteriuria or interventions that reduce CA-UTI should be adopted. Unfortunately, such economic evaluations are rarely available.

PRACTICE GUIDELINES AND METHODOLOGY

"Practice guidelines are systematically developed statements to assist practitioners and patients in making decisions about appropriate health care for specific clinical circumstances" [9, p. 8]. Attributes of high-quality guidelines include validity, reliability, reproducibility, clinical applicability, clinical flexibility, clarity, multidisciplinary process, review of evidence, and documentation [9].

Panel composition. The IDSA Standards and Practice Guidelines Committee (SPGC) convened a multidisciplinary panel of experts in the management of CA-UTI. Panel participants included representatives from the following collaborating

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organizations: American Geriatrics Society, American Society of Nephrology, American Spinal Injury Association, American Urological Association, Association of Medical Microbiology and Infectious Diseases–Canada, European Association of Urology, European Society of Clinical Microbiology and Infectious Diseases, Society for Healthcare Epidemiology of America, Society of Hospital Medicine, and the Western Pacific Society of Chemotherapy.

Literature review and analysis. The recommendations in these guidelines have been developed after a review of studies published in English, although foreign language articles were included in some of the Cochrane reviews summarized in these guidelines. Studies were identified through a PubMed search with no date restrictions using subject headings "urinary" combined with the keyword "catheter," other keywords such as "nosocomial," "neurogenic bladder," "intermittent," "suprapubic," and "methenamine," supplemented by review of references of relevant articles to identify additional reports, particularly early studies not accessed through the PubMed search. In addition, experts in urinary infection were asked to identify any additional trials not accessed through the review. Clinical studies include prospective randomized clinical trials, prospective cohort studies, case-control studies, and other descriptive studies. Studies were excluded if the study population, intervention, or study design were not clearly described; if procedures for patient follow-up or exclusions may have introduced sufficient bias to limit the credibility of observations; or if there were insufficient patients enrolled to support valid statistical analysis. Conclusions from meta-analyses, such as Cochrane reviews, were included.

Process overview. To evaluate evidence, the Panel followed a process consistent with that of other IDSA guidelines. This process included a systematic weighting of the quality of the evidence and the grade of recommendation (Table 1) [10]. Initial findings were discussed by the Panel, and final recommendations were determined by consensus. Each Panel member was assigned 1 or more proposed sections of the guidelines, so that each such section was assigned to 2 or more Panel members, and each Panel member was asked to review the literature for that section and to critique the strength of the recommendation and quality of evidence for each recommendation that had been proposed by 1 or more other Panel members for that section. The full Panel was then asked to review all recommendations, their strength, and the quality of evidence. Discrepancies were discussed and resolved, and all Panel members are in agreement with the final recommendations.

Any combination of Strength of Recommendation and Quality of Evidence is possible. For example, a recommendation can have Strength A even if it is based entirely on expert opinion and no research studies have ever been conducted on the recommendation (Quality of Evidence III). Similarly, a Strength B or C can be assigned a Quality of Evidence I if there are multiple randomized, controlled trials that arrive at divergent conclusions. Assigning a Quality of Evidence II or III should not be construed as implying that the recommendation is weak. Many important clinical questions addressed in guidelines either do not lend themselves to experimentation or have not yet been addressed by high-quality investigations. Even though randomized, controlled trials may not be available, the clinical question may be so relevant that it would be delinquent to not include it in the guidelines. Often the Quality of Evidence will parallel the Strength of Recommendation, but this is not necessarily the case.

Consensus development on the basis of evidence. The Panel met on 2 occasions for face-to-face meetings and on 3 occasions via teleconference to complete the work of the guidelines. The purpose of the teleconferences was to discuss the questions to be addressed, assign topics for review and writing of the initial draft, and discuss recommendations. Much of the work was done with e-mail correspondence. All members of

Table 1. Strength of Recommendation and Quality of Evidence

Category/grade	Definition
Strength of recommendation	
A	Good evidence to support a recommendation for or against use.
B	Moderate evidence to support a recommendation for or against use.
C	Poor evidence to support a recommendation for or against use.
Quality of evidence	
I	Evidence from >1 properly randomized, controlled trial.
II	Evidence from >1 well-designed clinical trial, without randomization; from cohort or case-controlled analytic studies (preferably from >1 center); from multiple time-series; or from dramatic results from uncontrolled experiments.
III	Evidence from opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

NOTE. Adapted from the Canadian Task Force on the Periodic Health Examination [10]. Adapted and reproduced with the permission of the Minister of Public Works and Government Services Canada, 2009. Any combination of strength of recommendation and quality of evidence is possible. See Practice Guidelines and Methodology for further discussion.

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the Panel participated in the preparation and review of the draft guidelines. Feedback from external peer reviewers was also obtained. The guidelines were reviewed and approved by the IDSA SPGC and Board of Directors and all collaborating organizations prior to dissemination.

Guidelines and conflict of interest. All members of the Expert Panel complied with the IDSA policy on conflicts of interest, which requires disclosure of any financial or other interest that might be construed as constituting an actual, potential, or apparent conflict. Members of the Expert Panel were provided IDSA's conflict of interest disclosure statement and were asked to identify ties to companies developing products that might be affected by promulgation of the guidelines. Information was requested regarding employment, consultancies, stock ownership, honoraria, research funding, expert testimony, and membership on company advisory committees. The Panel made decisions on a case-by-case basis as to whether an individual's role should be limited as a result of a conflict. Potential conflicts are listed in the Acknowledgements section.

Revision dates. At annual intervals, the Panel Chair, the SPGC liaison advisor, and the Chair of the SPGC will determine the need for revisions to the guidelines on the basis of an examination of current literature. If necessary, the entire Panel will be reconvened to discuss potential changes. When appropriate, the Panel will recommend revision of the guidelines to the SPGC and IDSA Board and other collaborating organizations for review and approval.

BACKGROUND

Epidemiology. CA-bacteriuria is the most common health care–associated infection worldwide [11]. It accounts for up to 40% of hospital-acquired infections and most of the 900,000 patients with nosocomial bacteriuria in US hospitals each year [2, 3, 12, 13]. From 15% to 25% of patients in general hospitals have a urethral catheter inserted at some time during their stay [3, 14], and the rate of catheter use appears to be increasing [15]. Most hospitalized patients are catheterized for only 2–4 days [16], but many are catheterized for longer durations.

CA-bacteriuria is also among the most common infections in LTCFs [5, 6], although symptomatic UTI is less common than are respiratory and skin and soft-tissue infections [5, 6]. From 5% to 10% of nursing home residents are managed with urethral catheterization, in some cases for years [6, 17, 18]. It is estimated that >100,000 patients in US LTCFs have a urethral catheter in place at any given time [6, 16, 17, 19]. Almost all of those residents with long-term indwelling catheters are bacteriuric [20]. In one study involving a Veterans Affairs hospital and nursing home population, the majority of patients who were managed with intermittent catheterization were also bacteriuric [21].

More than 250,000 people in the United States are estimated to be living with spinal cord injury as a result of trauma, and each year ~12,000 new injuries occur [22]. Modern management of the bladder in spinal cord injury has successfully reduced renal-related mortality among individuals with spinal cord injury from 95% in the first half of the 20th century to 3% at present [23]. CA-bacteriuria and CA-UTI rates in patients with spinal cord injury vary according to what infection definitions are used and according to the method of bladder drainage (indwelling catheterization is associated with the highest rates of infection) [24]. In a prospective, 38-month observational study involving 128 acutely injured patients at an spinal cord injury referral hospital, the overall incidence was 2.72 cases and 0.68 cases per 100 person-days for CA- bacteriuria and CA-UTI, respectively [25].

The incidence of bacteriuria associated with indwelling catheterization is 3%–8% per day [14, 26–29], and the duration of catheterization is the most important risk factor for the development of CA-bacteriuria [30, 31]. Thus, rates will vary in published studies according to how long the patients have been catheterized and how often urine cultures are performed. By 1 month, nearly all patients with an indwelling catheter will be bacteriuric. Other risk factors associated with CA-bacteriuria include not receiving systemic antimicrobial therapy, female sex, positive urethral meatal culture results, microbial colonization of the drainage bag, catheter insertion outside the operating room, catheter care violations, rapidly fatal underlying illness, older age, diabetes mellitus, and elevated serum creatinine at the time of catheterization [14, 31–36]. In a questionnaire and microbiologic study involving patients with clean intermittent catheterization, CA-UTI was associated with less frequent catheterization [37].

Complications of short-term catheterization. Less than one-quarter of hospitalized patients with CA-bacteriuria develop UTI symptoms [27, 38–40]. In one study of 235 new cases of nosocomial CA-bacteriuria, >90% of the infected patients were asymptomatic and afebrile, and moreover, the occurrence of symptoms and signs suggestive of UTI, such as dysuria, fever, or leukocytosis, was similar for patients with and patients without CA-bacteriuria [40]. Likewise, in a retrospective cohort study describing 510 consecutive patients with trauma, neither fever nor leukocytosis was associated with CA-bacteriuria [41]. The authors concluded that there was an unnecessary emphasis on UTI as a source of fever and leukocytosis in patients hospitalized in the intensive care unit (ICU).

Approximately 15% of cases of nosocomial bacteremia are attributable to the urinary tract [42], and bacteriuria is the most common source of gram-negative bacteremia among hospitalized patients [43]. However, bacteremia complicates CA-bacteriuria in only <1% [40] to 4% of cases [42, 44]. UTIs in the ICU account for a smaller proportion of bacteremias [45]. The mortality rate among patients with nosocomial bacteremic

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UTI is ~13%, but <1% of hospital deaths are due to bacteremic UTI [42].

The effect of CA-bacteriuria on mortality remains controversial. Platt et al [4] reported in a prospective study involving 1458 hospitalized patients with indwelling bladder catheterizations that death rates were 19% among patients with CA-bacteriuria, compared with 4% among those without, with an adjusted odds ratio for mortality between those who acquired CA-bacteriuria and those who did not of 2.8 (95% confidence interval [CI], 1.5–5.1). These authors presented more evidence for causality in a randomized trial evaluating sealed urinary catheter junctions, in which it was found that the degree of reduction in CA-bacteriuria with use of the sealed catheters corresponded closely with the degree of mortality reduction [46]. The mechanism accounting for an increased mortality among catheterized patients would presumably be secondary bacteremia and septicemia [47], but this is only speculative. Other investigators, in studies of mostly patients hospitalized in the ICU, have not shown an increased mortality risk associated with CA-bacteriuria [48–52]. The association with mortality is likely explained by confounding, because catheterized patients tend to be sicker and more functionally impaired [52].

Studies performed almost 3 decades ago demonstrated that patients who develop CA-bacteriuria have their hospital stays extended by 2–4 days [53, 54]. Haley et al [55] estimated that the attributable additional length of stay was somewhat shorter, ranging from 0.4 days for CA-ASB to 2.0 days for CA-UTI. In recent studies conducted in the era of managed care, each episode of CA-ASB and CA-UTI has been estimated to cost an additional $589 and $676, respectively, and bacteremia associated with CA-bacteriuria is estimated to cost at least $2836 [38, 56]. Although the costs associated with individual episodes of bacteriuria are modest, the high frequency of catheter use means that these infections may add as much as $500 million to health care costs in the United States each year [57]. However, episodes of CA-ASB that are not detected by surveillance cultures do not add to hospital costs [56], and thus, these costs, which are based on surveillance cultures that are not routinely recommended or performed, may well be overestimated.

CA-ASB comprises a large reservoir of antimicrobial-resistant organisms, particularly on critical care units, and can be the source of cross-infection [31, 58–63]. One study reported that 15% of episodes of hospital-acquired bacteriuria occur in clusters [58], and these often involve highly antimicrobial-resistant organisms. Genetic typing of uropathogens isolated from urine samples of 144 catheterized patients with CA-bacteriuria revealed a high rate of clonal relationship among uropathogens in a single urological ward [63]. In addition, CA-ASB is a ubiquitous infection and a tempting target for physicians who have a low threshold for using antimicrobials (inappropriately, in this case). For example, in a recent prospective study involving inpatients with an indwelling catheter and CA-ASB, 15 (52%) of 29 patients received inappropriate antimicrobial treatment [64].

Although most catheters are latex-based, an increasing number of hospitals are using silicone-based catheters because of the prevalence of latex allergies [65]. Silicone catheters may have advantages over latex catheters, with in vitro and in vivo observations suggesting that latex is associated with more cytotoxicity, inflammation, urethritis, stricture formation, penile discomfort, and obstruction from encrustations [66]. However, there are no convincing data that latex catheters are associated with a higher risk of CA-bacteriuria.

Complications of long-term catheterization. Patients in LTCFs are overrepresented among patients with long-term catheterization. The complications of CA-bacteriuria seen in the acute care setting presumably also apply to patients with CA-bacteriuria in LTCFs. In a study involving catheterized and bacteriuric female nursing home patients, the incidence of febrile episodes of possible urinary origin was 1.1 episodes per 100 catheterized patient-days, and most of these episodes were low grade, lasted for <1 day, and resolved without antimicrobial treatment [28]. However, some episodes, usually associated with higher temperatures, were associated with bacteremia and death. Moreover, long-term urinary catheterization is associated with an increased likelihood of upper urinary tract inflammation at autopsy, presumably because of CA-bacteriuria. A blinded autopsy study of 75 aged nursing home patients reported that acute inflammation of the renal parenchyma was present in 38% of patients with a urinary catheter in place at death versus 5% of noncatheterized patients ($P = .004$) [67]. In another prospective 2-year autopsy study of residents ⩾65 years of age in a LTCF, the duration of catheterization was significantly associated with chronic pyelonephritis and chronic renal inflammation [68]. The prevalence of chronic pyelonephritis at death was 10% (5 of 52 patients) for patients catheterized for >90 days during their last year of life versus 0% (0 of 65 patients) for those catheterized for ⩽90 days ($P < .02$).

Bacteriuria is also a common source of bacteremia in LTCFs, accounting for 45%–55% of bacteremias [69–71], and is often polymicrobic in patients with long-term catheterization. Although bacteremias in LTCFs are uncommon [69, 72], urinary catheterization was associated with a 39-fold increase in the incidence of bacteremia in one study [71]. Transient asymptomatic bacteremia occurs in ~4% of bacteriuric patients with long-term catheterization whose indwelling urethral or suprapubic catheter is removed or replaced [73–75].

Increased mortality has also been reported among residents of LTCFs with long-term indwelling catheters, although the association with CA-bacteriuria was not evaluated [76]. However, as with hospitalized patients, the association between uri-

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nary catheterization and increased mortality is likely explained by confounding [52, 77].

Complications of long-term catheterization (>30 days) include, in addition to almost universal bacteriuria, lower and upper CA-UTI, bacteremia, frequent febrile episodes, catheter obstruction, renal and bladder stone formation associated with urease-producing uropathogens, local genitourinary infections, fistula formation, incontinence, and bladder cancer [16].

Pathogenesis. The most important predisposing factor for nosocomial UTI is urinary catheterization, which perturbs host defense mechanisms and provides easier access of uropathogens to the bladder. The indwelling urethral catheter introduces an inoculum of bacteria (fecal or skin bacteria in a patient's own native or transitory microflora) into the bladder at the time of insertion [78], facilitates ascension of uropathogens from the meatus to the bladder via the catheter-mucosa interface, allows for intraluminal spread of pathogens to the bladder if the collecting tube or drainage bag have become contaminated, compromises complete bladder emptying, and provides a frequently manipulated foreign body on which pathogens are deposited via the hands of personnel. It also appears that uroepithelial cells from catheterized patients are more receptive to binding of bacteria just prior to onset of infection [79].

Approximately two-thirds (79% for gram-positive cocci and 54% for gram-negative bacilli) of the uropathogens that cause CA-bacteriuria in patients with indwelling urethral catheters are extraluminally acquired (by ascension along the catheter-urethral mucosa interface), and one-third are intraluminally acquired [80]. The causative uropathogen can be found in the urethra in up to 67% of women and 29% of men just prior to the development of CA-bacteriuria, which suggests that entry of uropathogens via the urethral route occurs more often in women than it does in men [34, 81], which is a sex difference that is not seen in other studies [80]. Further support for extraluminal ascension as the most common pathway for bacteria to gain entry into the bladder comes from a study that showed only 3 of 29 episodes of bacteriuria with gram-negative bacilli or enterococci occurred in patients with negative meatal cultures for these organisms [29]. In addition, patients remain at increased risk of bacteriuria for at least 24 h even after removal of the catheter [27], which suggests that colonization of the urethra persists after the catheter is removed. The relative importance of the intraluminal pathway is associated with the frequency with which closed drainage systems are breached, which is associated with UTI. Both animal and human studies have demonstrated that bacteria that enter the drainage bag are soon found in the bladder [14, 27, 82, 83].

Indwelling urinary catheters facilitate colonization with uropathogens by providing a surface for the attachment of host cell binding receptors recognized by bacterial adhesins, thus enhancing microbial adhesion. In addition, the uroepithelial mucosa is disrupted, exposing new binding sites for bacterial adhesins, and residual urine in the bladder is increased through pooling below the catheter bulb [84]. Organisms causing nosocomial UTI require fewer recognized virulence factors to colonize and establish infection than do organisms that infect a normal urinary tract [85–87]. Bacterial adhesins initiate attachment by recognizing host cell receptors located on the surfaces of the host cell or catheter. Once attached to the catheter surface, bacteria change phenotypically and produce exopolysaccharides that entrap and protect replicating bacteria, forming microcolonies and, eventually, mature biofilms [84]. Tamm-Horsfall protein and urinary salts are often incorporated into the biofilm [47]. Urinary catheters readily develop biofilms on their inner and outer surfaces after insertion, and these biofilms migrate to the bladder within 1–3 days [32]. A scanning electron microscopy study of 50 urethral catheters indwelling for a mean of 35 days showed 44 catheters with evidence of biofilm formation ranging from 3 through 490 microns in depth with visible bacterial cells up to 400 cells deep [88].

Biofilms are usually initially caused by single species but become polymicrobic, especially with long-term catheters. These organisms are often highly antimicrobial resistant. The rate of genetic material exchanged among organisms within the biofilm is greater than that between planktonic cells, which facilitates the spread of genes for antimicrobial resistance and other traits [84]. Once established, biofilms inherently protect uropathogens from antimicrobials and the host immune response. The shedding of daughter cells from actively growing cells seeds other sections of the catheter and bladder. Planktonic bacteria isolated in urine cultures obtained via a catheter with a biofilm may not accurately reflect the bacterial population growing within the bladder [89–91].

Catheter encrustations can be formed by organisms in biofilms, usually organisms that have the ability to hydrolyze urea in the urine to free ammonia, resulting in an increased local pH. These include *Proteus* species, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Providencia* species. This alkaline pH facilitates precipitation of minerals, thereby creating hydroxyapatite or struvite and encrustations that can obstruct catheter urine flow [32]. Patients with repeated blocking of catheters appear to be metabolically different from other patients, because they excrete more alkaline urine, calcium, protein, and mucin [92]. Patients with blocked catheters are also significantly more often colonized with *Proteus mirabilis* and *Providencia stuartii* than are patients without blocked catheters [93]. None of the currently available types of indwelling urethral catheters are capable of resisting encrustation by *P. mirabilis* biofilms in vitro [94, 95], but studies with anti-adherence agents, such as heparin, are promising [96, 97].

Microbiology. Bacteriuria in patients with short-term catheters is usually caused by a single organism [40]. *Escherichia*

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coli is the most frequent species isolated, although it comprises fewer than one-third of isolates [77]. Other Enterobacteriaceae, such as *Klebsiella* species, *Serratia* species, *Citrobacter* species, and *Enterobacter* species, nonfermenters such as *P. aeruginosa*, and gram-positive cocci, including coagulase-negative staphylococci and *Enterococcus* species, are also isolated [77]. Funguria, mostly candiduria, is reported in 3%–32% of patients catheterized for short periods of time [40, 77]. In contrast to patients with short-term catheterization, UTIs in patients with long-term catheterization are usually polymicrobial. In addition to the pathogens isolated from patients with short-term catheterization, species such as *P. mirabilis*, *Morganella morganii*, and *P. stuartii* are common [77]. In these patients, new episodes of infection often occur periodically in the presence of existing infection with organisms that may persist for months [20]. As noted previously, a urine culture obtained from a patient whose catheter has a biofilm may not accurately reflect the bacteriology of bladder urine [89–91]. Organism concentrations increase the longer an indwelling catheter is in place and then decrease significantly when a new catheter is inserted [91]. In patients with long-term catheterization, urine cultures obtained before and after the catheter was replaced showed that the mean concentrations of *P. mirabilis*, *P. stuartii*, *M. morganii*, *P. aeruginosa,* and enterococci were >10-fold higher in the indwelling catheter than they were in the replacement catheter, whereas concentrations of *E. coli* and *K. pneumoniae* were similar in the 2 specimens [91]. These data suggest that the catheter is more important for persistence in the urinary tract with the former group of uropathogens than with the latter group.

GUIDELINE RECOMMENDATIONS FOR THE DIAGNOSIS, PREVENTION, AND MANAGEMENT OF CA-ASB AND CA-UTI

I. IN A PATIENT WITH CATHETER DRAINAGE OF THE BLADDER, WHAT IS THE APPROPRIATE METHOD OF DIAGNOSING CA-ASB AND CA-UTI?

Recommendations

1. CA-UTI in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of symptoms or signs compatible with UTI with no other identified source along with $\geqslant 10^3$ cfu/mL of $\geqslant 1$ bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral, suprapubic or condom catheter has been removed within the previous 48 h (A-III).

i. Data are insufficient to recommend a specific quantitative count for defining CA-UTI in symptomatic men when specimens are collected by condom catheter.

2. CA-ASB should not be screened for except in research studies evaluating interventions designed to reduce CA-ASB or CA-UTI (A-III) and in selected clinical situations, such as in pregnant women (A-III).

i. CA-ASB in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of $\geqslant 10^5$ cfu/mL of $\geqslant 1$ bacterial species in a single catheter urine specimen in a patient without symptoms compatible with UTI (A-III).

ii. CA-ASB in a man with a condom catheter is defined by the presence of $\geqslant 10^5$ cfu/mL of $\geqslant 1$ bacterial species in a single urine specimen from a freshly applied condom catheter in a patient without symptoms compatible with UTI (A-II).

3. Signs and symptoms compatible with CA-UTI include new onset or worsening of fever, rigors, altered mental status, malaise, or lethargy with no other identified cause; flank pain; costovertebral angle tenderness; acute hematuria; pelvic discomfort; and in those whose catheters have been removed, dysuria, urgent or frequent urination, or suprapubic pain or tenderness (A-III).

i. In patients with spinal cord injury, increased spasticity, autonomic dysreflexia, or sense of unease are also compatible with CA-UTI (A-III).

4. In the catheterized patient, pyuria is not diagnostic of CA-bacteriuria or CA-UTI (AII).

i. The presence, absence, or degree of pyuria should not be used to differentiate CA-ASB from CA-UTI (A-II).

ii. Pyuria accompanying CA-ASB should not be interpreted as an indication for antimicrobial treatment (A-II).

iii. The absence of pyuria in a symptomatic patient suggests a diagnosis other than CA-UTI (A-III).

5. In the catheterized patient, the presence or absence of odorous or cloudy urine alone should not be used to differentiate CA-ASB from CA-UTI or as an indication for urine culture or antimicrobial therapy (A-III).

Evidence Summary

Significant bacteriuria versus contamination. Significant bacteriuria is the quantitative level of bacteriuria consistent with bladder bacteriuria, rather than contamination, determined on the basis of growth from a urine specimen collected in a manner to minimize contamination and transported to the laboratory in a timely fashion to limit bacterial growth. ASB is defined as the presence of significant bacteriuria in a patient without signs or symptoms referable to the urinary tract. Symptomatic UTI is defined as the presence of significant bacteriuria in a patient with signs or symptoms referable to the urinary tract and no alternate source. Because catheter urine specimens are not as likely to be contaminated by periurethral flora as are voided urine specimens, low colony counts in a urine sample from a

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freshly placed catheter are more likely to represent true bladder bacteriuria, compared with low counts in a voided specimen.

There is no standard definition for significant bacteriuria in catheterized patients. The National Institute on Disability and Rehabilitation Research (NIDRR) Consensus Statement, entitled "The Prevention and Management of Urinary Tract Infection among People with Spinal Cord Injuries," has defined significant bacteriuria from indwelling catheter or suprapubic aspirate specimens as any detectable concentration; $\geqslant 10^2$ cfu/mL in a catheter urine specimen from a patient with intermittent catheterization; and $\geqslant 10^4$ cfu/mL in a clean-catch specimen obtained from a catheter-free man with a condom collection device [98]. The NIDRR Consensus Statement has defined UTI as bacteriuria with tissue invasion and resultant tissue response with signs and/or symptoms. If antimicrobial therapy is not given to patients with indwelling catheters who have colony counts $\geqslant 10^2$ cfu/mL (or even lower colony counts), the level of bacteriuria or candiduria uniformly increases to $>10^5$ cfu/mL within 24–48 h in those patients who remain catheterized [99]. Given that colony counts in bladder urine as low as 10^2 cfu/mL are associated with symptomatic UTI in uncatheterized patients [100], that catheter urine specimens are less likely than other specimens to be contaminated by periurethral flora, and that colony counts rapidly increase in untreated catheterized individuals [98], it is reasonable to assume that colony counts $\geqslant 10^2$ cfu/mL are reflective of true bladder bacteriuria in a catheterized person with a freshly placed catheter. Low colony counts in catheter urine specimens are also reflective of significant bacteriuria in patients with intermittent catheterization. One study describing 47 persons with acute spinal cord injury and intermittent catheterization, 70% of whom had symptoms clearly or possibly associated with bacteriuria, found that catheter urine specimens with colony counts $\geqslant 10^2$ cfu/mL had optimal sensitivity and specificity, compared with paired suprapubic aspirates [101]. It should be noted, however, that most persons with CA-UTI have colony counts $\geqslant 10^5$ cfu/mL.

A quantitative count $\geqslant 10^3$ cfu/mL in a catheter urine specimen from a symptomatic person with indwelling urethral or intermittent catheterization is recommended as representing significant bacteriuria, because this threshold is a reasonable compromise between sensitivity in detecting CA-UTI and feasibility for the microbiology laboratory in quantifying organisms (ie, with standard methods, the minimum level of detection is 10^3 cfu/mL). As noted above, even lower colony counts may reflect bladder bacteriuria in a catheterized patient and may be reasonably interpreted as such by a clinician in deciding whether to treat or continue treatment in a symptomatic patient. On the other hand, in those situations in which it is desirable to detect CA-ASB, such as in research studies or in selected populations (eg, pregnant women), $\geqslant 10^5$ cfu/mL is considered indicative of CA-ASB, because increased specificity is desirable to reduce overuse of antimicrobials, even though lower counts may represent bladder bacteriuria. These definitions for significant bacteriuria are also reasonable for specimens taken via a suprapubic catheter, although studies have not been performed to address this.

Urine within condom catheters may develop high concentrations of organisms, and the urethra and skin may be colonized with uropathogens [16], so it is difficult to distinguish bladder bacteriuria from skin or mucosal contamination. Thus, in men with condom catheters, the presence of significant bacteriuria should be assessed by analysis of a clean-catch midstream urine specimen or a urine specimen collected from a freshly applied condom catheter after cleaning of the glans. If urine specimens are collected using a freshly applied condom catheter, $\geqslant 10^5$ cfu/mL is the appropriate quantitative criterion for CA-ASB, with 100% sensitivity, 94% specificity, 86% positive predictive value, and 90% negative predictive value for identifying ASB in the voided specimen, compared with a paired catheterized specimen [102, 103]. Comparable studies involving symptomatic men with condom catheters have not been performed.

In uncatheterized men with urinary symptoms, a quantitative count of $\geqslant 10^3$ cfu/mL of one predominant species in clean-catch midstream-void urine specimens best differentiated uninfected from infected bladder urine (as determined by urethral catheterization or suprapubic aspiration) with 97% sensitivity and 97% specificity [104]. Thus, we recommend a quantitative count $\geqslant 10^3$ cfu/mL in a voided urine specimen as the definition of significant bacteriuria in a man with urinary symptoms who has had a urethral, suprapubic, or condom catheter removed within 48 h as an indicator of CA-UTI. Definitions for significant bacteriuria in asymptomatic men and women who are not currently catheterized have been published previously [105]. The National Healthcare Safety Network definitions for symptomatic and asymptomatic health care–associated UTI are for surveillance purposes [106] and are somewhat different from the definitions used in these guidelines.

The collection of urine specimens. In patients with short-term catheterization, it is recommended that specimens be obtained by sampling through the catheter port using aseptic technique or, if a port is not present, puncturing the catheter tubing with a needle and syringe [77]. In patients with long-term indwelling catheters, the preferred method of obtaining a urine specimen for culture is to replace the catheter and collect a specimen from the freshly placed catheter. In a symptomatic patient, this should be done immediately prior to initiating antimicrobial therapy [89–91, 107]. Culture specimens should not be obtained from the drainage bag.

Other laboratory tests that might be useful to differentiate CA-ASB from CA-UTI. Pyuria is evidence of inflammation

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in the genitourinary tract and is usually present in CA-UTI, as well as in CA-ASB. In 761 newly catheterized patients in a university hospital, the sensitivity of pyuria for CA-bacteriuria (>10^5 cfu/mL; almost all patients were asymptomatic) was 47%, the specificity was 90%, and the positive predictive value was 32% [108]. The sensitivity of pyuria for detecting infections due to enterococci or yeasts appears to be lower than that for gram-negative bacilli [105]. The low sensitivity of pyuria for identification of CA-bacteriuria in patients with short-term catheterization contrasts with that in patients catheterized for longer durations [109]. In 177 sequential quantitative cultures and urinalyses from 14 patients with long-term urinary catheters during a 12-month period, bacteriuria and pyuria were common even during asymptomatic periods, and levels of pyuria and bacteriuria did not change substantially during symptomatic episodes [110]. Studies have shown that pyuria is also not helpful in establishing a diagnosis in patients with neurogenic bladders [111, 112]. Dipstick testing for nitrites and leukocyte esterase was also shown to be unhelpful in establishing a diagnosis in catheterized patients hospitalized in the ICU [113]. Thus, in the catheterized patient, pyuria is not diagnostic of CA-bacteriuria or CA-UTI, and the presence, absence, or degree of pyuria alone does not, by itself, differentiate CA-ASB from CA-UTI. However, the absence of pyuria in a symptomatic catheterized patient suggests a diagnosis other than CA-UTI.

Symptoms and signs suggestive of UTI in a catheterized patient. Catheterized patients with CA-UTI usually do not manifest the classic symptoms of dysuria, frequent urination, and urgent urination, although such symptoms may occur in CA-UTI after the catheter has been removed. In addition, patients with neurogenic bladders frequently have absence of sensation in the pelvis, and ascertainment of potential symptoms of UTI is often difficult. The majority of patients with CA-bacteriuria lack symptoms referable to the urinary tract [40]. When 1497 newly catheterized patients were observed prospectively with daily urine cultures, urine leukocyte counts, and symptom assessment, 224 patients developed 235 episodes of CA-bacteriuria (defined as a colony count >10^3 cfu/mL; 85% of patients had a colony count of >10^5 cfu/mL in at least 1 culture). Of 194 patients with CA-bacteriuria who could respond to symptom assessment, only 15 (8%) reported subjective symptoms referable to the urinary tract, including pain, urgent urination, or dysuria, although bacteriuria and pyuria were present in most patients for many days. In addition, there were no significant differences between catheterized patients with and those without CA-bacteriuria with respect to signs or symptoms commonly associated with UTI (fever, dysuria, urgent urination, or flank pain) or with respect to leukocytosis. Thus, for a hospitalized patient with an indwelling urinary catheter, symptoms referable to the urinary tract, fever, or peripheral leukocytosis have little predictive value for the diagnosis of CA-UTI. The lack of an association between fever and CA-bacteriuria has also been convincingly demonstrated in studies of LTCF residents. A prospective study by Kunin et al [52] involving elderly nursing home patients found that, although 74% of catheterized patients developed CA-bacteriuria, <2% had a temperature >38°C. Likewise, in a LTCF, the incidence of febrile episodes of possible urinary origin was 1.1 cases per 100 patient-days of catheterization, despite a high prevalence of CA-bacteriuria, and most fever episodes resolved spontaneously [28].

The foul smell of urine around patients with urine incontinence is thought to be attributable mainly to the production of ammonia from urea by bacterial ureases [114]. Foul-smelling and/or cloudy urine is often interpreted as warranting antimicrobial treatment in catheterized patients with bacteriuria [115]. However, not all individuals with UTI have an unpleasant odor to their urine, and not all urine with an unpleasant odor is indicative of bacteriuria [116]. No studies have demonstrated that odorous or cloudy urine in a catheterized individual, even if these findings are new, has clinical significance. Thus, odorous or cloudy urine should not be used alone to determine the presence of CA-bacteriuria and, in particular, to distinguish CA-ASB from CA-UTI, and alternate interventions, such as improved continence management or hydration, rather than antimicrobial therapy, should be instituted [116, 117].

Unfortunately, most signs and symptoms in bacteriuric catheterized patients are nonspecific and place a burden on the clinician who wishes to use antimicrobials appropriately. Catheterized patients should be thoroughly evaluated for the source of signs and symptoms before attributing them to the urinary tract. Algorithms have been developed and validated to optimize urine culturing and antimicrobial use for patients hospitalized in LTCFs with suspected UTI [118]. For catheterized patients, symptoms appropriate for obtaining a culture and initiating antimicrobial therapy include new costovertebral tenderness, rigors, or new onset of delirium. Use of these algorithms has been shown to reduce the number of antimicrobial prescriptions with no resulting adverse events in LTCF residents, but few catheterized patients were included in these studies [118, 119]. Algorithms for use in the treatment of hospitalized patients have not been developed. In patients with spinal cord injury, the NIDRR Consensus Statement [98] listed signs and symptoms that are suggestive of CA-UTI, including discomfort or pain over the kidney or bladder or during urination, onset of urinary incontinence, fever, increased spasticity, autonomic hypereflexia, malaise, lethargy, or sense of unease. When no alternate source of symptoms is identified in patients with CA-bacteriuria, it is reasonable to monitor symptoms and treat only if the symptoms do not resolve.

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Table 2. Acceptable Indications for Indwelling Urinary Catheter Use

Indication	Comment(s)
Clinically significant urinary retention	Temporary relief or longer-term drainage if medical therapy is not effective and surgical correction is not indicated.
Urinary incontinence	For comfort in a terminally ill patient; if less invasive measures (eg, behavioral and pharmacological interventions or incontinence pads) fail and external collecting devices are not an acceptable alternative.
Accurate urine output monitoring required	Frequent or urgent monitoring needed, such as with critically ill patients.
Patient unable or unwilling to collect urine	During prolonged surgical procedures with general or spinal anesthesia; selected urological and gynecological procedures in the perioperative period.

NOTE. Adapted from [30, 120 121].

II. WHAT STRATEGIES MAY BE USED TO HELP REDUCE THE RISK OF CA-UTI?

In the recommendations that follow, the focus is the effect of interventions on CA-UTI. When a recommendation is provided without reference to type of infection, CA-UTI is assumed. On the other hand, when data were available, the Panel agreed to also provide a ranking with supporting level of evidence for recommendations for or against interventions shown to impact CA-ASB or CA-bacteriuria. However, we do not know with certainty whether interventions shown to reduce CA-ASB but not CA-UTI (or vice versa) similarly reduce CA-UTI (or vice versa).

As noted previously, any combination of Strength of Recommendation and Quality of Evidence is possible. For example, there are convincing data (Quality of Evidence I) that systemic antimicrobial therapy reduces CA-UTI in studies of patients who undergo surgical procedures and have short-term catheterization. However, the Panel felt strongly that prophylactic antimicrobials should not be given routinely for the prevention of CA-UTI in this setting because of the potential problem of antimicrobial resistance, and we ranked this recommendation A-III. The Quality of Evidence provided after each recommendation below thus pertains to the overall recommendation, which weighs both the pros and cons of a preventive measure.

REDUCTION OF INAPPROPRIATE URINARY CATHETER INSERTION AND DURATION

Limiting Unnecessary Catheterization

Recommendations

6. Indwelling catheters should be placed only when they are indicated (A-III).

i. Indwelling urinary catheters should not be used for the management of urinary incontinence (A-III). In exceptional cases, when all other approaches to management of incontinence have not been effective, it may be considered at patient request.

7. Institutions should develop a list of appropriate indications for inserting indwelling urinary catheters, educate staff about such indications, and periodically assess adherence to the institution-specific guidelines (A-III).

8. Institutions should require a physician's order in the chart before an indwelling catheter is placed (A-III).

9. Institutions should consider use of portable bladder scanners to determine whether catheterization is necessary for postoperative patients (B-II).

Evidence Summary

Interventions that reduce urinary catheterization ultimately reduce CA-ASB and CA-UTI. Studies have repeatedly documented that urinary catheters are often inserted for inappropriate reasons or remain in situ longer than necessary. Generally accepted indications for use of indwelling urinary catheters are shown in Table 2. In a prospective study that described 202 hospitalized patients with urinary catheters, the initial indication for catheter use was judged to be inappropriate in 21%, and continued catheterization was judged to be inappropriate for almost one-half of catheter-days [120]. In the medical ICU, many unjustified catheter-days were attributed to presumed monitoring of urine output when this was no longer clinically relevant. No clear indication was apparent in 26% of the unjustified catheter-days. On medical wards, urinary incontinence was the major reason for unjustified initial and continued urinary catheterization. Other studies report 38%–50% of catheterizations had no justifiable indication [122, 123], and 200 (36%) of 562 catheter-days were judged to be unnecessary [27]. In one community teaching hospital, an inappropriate indication for catheterization was identified for 54% of patients, physician or nurse explicit documentation giving the reason for catheter placement was found for only 13% of catheterizations, and there was no written order for catheterization in 33% of charts [124].

A retrospective cohort study involving 170,791 US Medicare patients who were admitted to skilled nursing facilities after discharge from hospitals after major surgery found that hospitalization in the Northeastern or Southern United States was associated with a lower likelihood of admission to a nursing facility with an indwelling urinary catheter, compared with hos-

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pitalization in the Western United States ($P = .002$ and $P = .03$, respectively) [125]. After adjusting for patient characteristics, the patients with catheters had greater odds of rehospitalization for UTI and death within 30 days than did patients who did not have catheters. The reason for these regional differences is unclear, but the differences are consistent with regional variations in the use of many health care services by the Medicare population [126]. Urinary catheters are not routinely indicated when patients are transferred from LTCFs to other health care facilities.

Clinicians are often unaware that their patients are catheterized. In one study, physicians and medical students responsible for patients who were admitted to the medical services at 4 university-affiliated hospitals were asked to identify which patients on their service had an indwelling urethral catheter [126]. Providers were unaware of catheterization for 88 (28%) of the 319 provider-patient observations: this rate was 21% for students, 22% for interns, 27% for residents, and 38% for attending physicians. Catheter use was considered to be inappropriate in 36 (31%) of the 117 patients with a catheter. Among patients with inappropriate catheterization, health care providers were unaware of catheter use for 44 (41%) of the 108 provider-patient observations. Catheterization was more likely to be appropriate if respondents were aware of the catheter ($P < .001$).

Several strategies appear to be effective in reducing inappropriate insertion of catheters. In a pre-post study in an emergency department, an intervention consisting of education and use of an indication sheet produced a dramatic reduction in the total number of catheters used but had a smaller impact on appropriateness of use and documentation in the medical record [127]. The total number of catheters placed after the intervention (in 2003) decreased from 2029 in 2001 and 2188 in 2002 to 300 in 2004 and 512 in 2005. In 2003, just prior to the intervention, compared with just after the intervention, appropriate use of catheters increased from 37% to 51% ($P = .06$), and physician orders for catheter placement significantly increased from 43% to 63% ($P < .01$) [127]. In a controlled, prospective, pre-post study involving 1328 adult patients scheduled for orthopedic (intervention group) or abdominal (control group) surgery, a multifaceted intervention whereby urinary catheterization in the operating room and postanesthesia care unit was restricted to patients with specified conditions together with prompt catheter removal on the postoperative surgical ward led to a reduction in the frequency (31.5% vs 24.0%; $P = .052$) and duration of catheterization (5.0 vs 3.9 days; $P = .02$) [128]. The rate of UTI, which was not clearly defined, decreased from 10.4 to 3.9 cases per 100 patients (incidence density ratio, 0.41; 95% CI, 0.20–0.79), and antimicrobial use for UTI also decreased ($P < .001$). In a study involving 60 postoperative patients with urinary retention, recatheterization and CA-bacteriuria rates were similar (and very low in each group) for patients randomized to indwelling or intermittent urethral catheterization for 24 h after the operation [129].

Use of a portable ultrasound bladder scanner to assess bladder volumes also has the potential to reduce unnecessary catheterization. Bladder scanning has been shown to be an accurate measure of bladder volume in some [130, 131] but not all [132] studies. In a pre-post study of patients after orthopedic surgery, 1920 patients were evaluated and catheterized if there was no spontaneous diuresis by 8 h after surgery during a 4-month observation period; 31% of the patients were catheterized, and 18 developed CA-UTI. In a subsequent 4-month period, 2196 patients were evaluated and catheterized only if the bladder volume was >800 mL 8 h after surgery; 16% were catheterized, and 5 developed CA-UTI [131]. Use of portable bladder ultrasound devices warrants further study in the care of oliguric patients [133, 134].

Discontinuation of Catheter

Recommendations

10. Indwelling catheters should be removed as soon as they are no longer required to reduce the risk of CA-bacteriuria (A-I) and CA-UTI (A-II).
11. Institutions should consider nurse-based or electronic physician reminder systems to reduce inappropriate urinary catheterization (A-II) and CA-UTI (A-II).
12. Institutions should consider automatic stop-orders to reduce inappropriate urinary catheterization (B-I).

Evidence Summary

The optimal time at which to remove indwelling urethral catheters, once they are no longer required for patient management, has not been determined. A Cochrane review of randomized and quasi-randomized, controlled trials that compared the effects of alternative strategies for removal of short-term indwelling urethral catheters on patient outcomes found 13 trials that investigated the effects of different durations of catheterization after treatment for urethral strictures, acute retention of urine, and various surgical procedures [135]. There was an increasing risk of CA-bacteriuria with later catheter removal irrespective of sex. Another Cochrane review of patients after undergoing urogenital surgical procedures [136], in which there is some overlap with the previously mentioned review in terms of the studies reviewed [135], also reported a lower risk of CA-bacteriuria when the catheter was removed earlier (1 day vs 3 days; relative risk [RR], 0.50; 95% CI, 0.29–0.87). In neither review were recatheterization rates consistently higher in the groups in which catheters were removed earlier.

Several strategies have been shown to be effective in reducing the duration of catheterization and CA-UTI. Using a pre-post

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intervention design in an ICU setting in a large Taiwanese hospital, daily prompts to remove unnecessary catheters by the nursing staff to physicians starting 5 days after hospital admission significantly decreased the duration of catheterization (from 7.0 to 4.6 days; $P < .001$) and the incidence of CA-UTI (from 11.5 to 8.3 patients per 1000 catheter-days; $P = .009$) [137]. Another pre-post intervention study involving 2412 patients in a tertiary hospital in Thailand evaluated nurse-based reminders to physicians to remove unnecessary catheters 3 days after insertion [138]. The intervention reduced the rate of inappropriate urinary catheterization (pre-intervention vs post-intervention rate, 20% vs 11%; $P = .04$), the rate of CA-UTI (21.5 vs 5.2 infections per 1000 catheter-days; $P < .001$), the duration of urinary catheterization (mean duration, 11 vs 3 days; $P < .001$), and the duration of hospitalization (mean duration, 16 vs 5 days; $P < .001$). The monthly hospital costs for antimicrobials to treat CA-UTI were also reduced by 63% and the hospitalization cost for each patient during the intervention was reduced by 58%. Using a pre-post controlled trial design, 2 of 4 wards at an academic medical center were assigned to an intervention group, and 2 wards served as controls [139]. The intervention consisted of a nurse-based written reminder placed on the chart of catheterized patients to remind the physicians that their patients were catheterized. The mean length of time that patients were catheterized increased by 15.1% in the control group but decreased by 7.6% in the intervention group ($P = .007$), with no statistically significant difference in urethral recatheterizations between the 2 groups.

Computer reminders can be effective in improving patient care [140]. Using a before-and-after cross-over design, use of a computer-based order for placing an indwelling urinary catheter was found to decrease the average duration of catheterization from 8 to 5 days ($P = .03$) on a medicine and cardiology service with no impact on recatheterization rates [141]. Of 36 patients who were on the study ward when their catheters were placed, 33 (92%) had the order documented in the medical record, compared with only 10 (29%) of 34 on the control ward ($P < .001$). Another pre-post study used prompts in the computerized order/entry system together with handheld bladder scanners, staff education, and nurse empowerment and reported an 81% reduction in device use (calculated as the percentage of urinary catheter–days per 1000 patient-days) and a 69% reduction in the rate of CA-UTI (36 vs 11 cases per 1000 catheter-days; $P < .001$) [142].

A recent Canadian randomized, controlled trial involving 692 hospitalized patients with indwelling urinary catheters in place for ≤48 h tested whether prewritten orders for the removal of urinary catheters if specified criteria were not met, with follow-up by a research nurse, reduced catheterization days, compared with usual care [36]. Stop-orders listed 6 criteria as acceptable for a urinary catheter: urinary obstruction, neurogenic bladder and urinary retention, urological surgery, fluid challenge for acute renal failure, open sacral wound care for incontinent patients, and comfort care for incontinence in terminal illness. There were fewer days of inappropriate and total urinary catheter use in the intervention group than there were in the usual care group (2.20 vs 3.89 days [difference, −1.69 days; 95% CI, −1.23 to −2.15 days; $P < .001$] and 3.70 vs 5.04 days [difference, −1.34 days; 95% CI, −0.64 to −2.05 days; $P < .001$], respectively). However, there was no significant difference in the CA-bacteriuria rates between the 2 groups (19% vs 20%) or CA-UTI (2.1% in each group), perhaps because of the low overall reduction in duration of catheterization (1.34 days), the exposure of 58% of study participants to antimicrobials, and the lack of urine cultures obtained at study completion in ~25% of patients. Nevertheless, it is unclear whether such an intervention could reduce the duration of catheterization to a degree necessary to reduce the risk of CA-bacteriuria or CA-UTI. Of note, the Panel did not find any evidence that the routine use of urinary catheters in patients with pressure ulcers improved wound healing when compared with other measures to prevent urinary incontinence. Therefore, in contrast with other recent guidelines [143, 144], the Panel did not recommend the presence of sacral ulcers as an appropriate indication for routine urinary catheter placement.

Danish national guidelines issued in 1985 encouraged a restrictive policy for use of urinary catheterization. In a 1995 survey to assess compliance of hospitals and LTCFs with the national recommendations, 84% of hospitals but only 27% of LTCFs reported daily or weekly review of whether to continue indwelling catheterization [145]. There are no national US guidelines similar to the Danish guidelines, and most US hospitals report that they do not have systems to monitor placement of urinary catheters or duration of urinary catheterization [7].

STRATEGIES TO CONSIDER PRIOR TO CATHETER INSERTION

Infection Prevention

Recommendations

13. Hospitals and LTCFs should develop, maintain, and promulgate policies and procedures for recommended catheter insertion indications, insertion and maintenance techniques, discontinuation strategies, and replacement indications (A-III).

i. Strategies should include education and training of staff relevant to these policies and procedures (A-III).

14. Institutions may consider feedback of CA-bacteriuria rates to nurses and physicians on a regular basis to reduce the risk of CA-bacteriuria (C-II).

i. Data are insufficient to make a recommendation as to

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whether such an intervention might reduce the risk of CA-UTI.

15. Data are insufficient to make a recommendation as to whether institutions should place patients with indwelling urinary catheters in different rooms from other patients who have indwelling urinary catheters or other invasive devices to reduce the risk of CA-bacteriuria or CA-UTI.

Evidence Summary

Intensive infection surveillance and prevention programs in US hospitals are strongly associated with reductions in the rates of nosocomial UTI [146]. Updated evidence-based guidelines have been recently published for prevention of CA-UTIs among hospitalized patients [143, 147] and residents of LTCFs [6, 147]. Institutions should incorporate optimal strategies for the prevention of CA-UTI in their infection prevention programs. At a minimum, the program should include appropriate indications for urinary catheterization, recommended insertion and maintenance techniques, discontinuation strategies, and catheter change indications.

Infection prevention programs should also address whether it is beneficial to segregate catheterized patients to reduce the risk of cross-infection, given that cross-infection in hospitals and presumably in LTCFs is common [50, 63, 148]. In a 1-month case-control study involving 40 LTCF residents with indwelling catheters and bacteriuria, 20 of whom were nursed together and 20 of whom were nursed in separate rooms, there was a higher transmission rate of urinary strains between patients within rooms (5 of 9 possible transmissions) than between patients in separate rooms (9 of 53 possible transmissions) ($P = .02$), suggesting that catheterized patients should be segregated in different rooms whenever possible [149]. On the other hand, in a 6-month study of cross-infection in which the drainage bags of 12% of catheterized patients had microbial contamination, there was no cross-infection identified among 87 pairs of catheterized roommates and only 1 possible cross-infection identified among >700 pairs of catheterized patients simultaneously residing on the same nursing unit [150].

Feedback of infection rates and other relevant indices to physicians and other health care workers has been followed by reduced rates of CA-bacteriuria, presumably by drawing attention and improving adherence to good infection prevention techniques. In a pre-post study in which the intervention was the daily recording of hospitalized patients' urine culture information in their charts, CA-bacteriuria rates decreased significantly, from 17.9% to 12.5% [39]. However, the authors concluded that routine daily bacteriologic monitoring of urine specimens from all catheterized patients was not an efficient way to decrease the incidence of CA-UTI. In another pre-post study involving hospitalized patients in which nursing staff members were provided with a quarterly report of CA-bacteriuria rates by unit, the CA-bacteriuria rate decreased from 32 to 17.4 cases per 1000 catheter-days over the 18-month intervention period [151]. A pre-post study in ICUs in a hospital in Argentina that evaluated education and performance feedback regarding catheter care measures and hand washing compliance reported a significant reduction in CA-UTI rates, from 21.3 to 12.4 cases per 1000 catheter-days (RR, 0.58; 95% CI, 0.39–0.86; $P = .006$) [152].

Many hospitals have not implemented infection prevention recommendations relevant to CA-bacteriuria. Saint and colleagues recently reported a national study of US hospitals that described practices used to reduce hospital-acquired UTI [7, 153]. Overall, 56% of hospitals did not have a system for monitoring which patients had urinary catheters placed, and 74% did not monitor duration of catheterization. There was no single strategy that appeared to be widely used to reduce hospital-acquired UTI. For example, 30% of hospitals reported regularly using antimicrobial urinary catheters and portable bladder scanners, 14% used condom catheters, and 9% used catheter reminders [7]. In a companion qualitative study that consisted of semistructured phone interviews and in-person interviews with personnel in 14 diverse hospitals, several key themes emerged [153]. First, although preventing hospital-acquired UTI was a low priority for most hospitals, there was substantial recognition of the value of early removal of a urinary catheter for patients. Second, those hospitals that made UTI prevention a high priority had committed advocates who facilitated prevention activities. Third, hospital-specific pilot studies were important in deciding whether to use devices such as antimicrobial-impregnated catheters. Finally, external forces, such as public reporting, influenced UTI surveillance and infection prevention activities.

CA-bacteriuria is common and has important implications for patient health. Thus, prevention of CA-bacteriuria and/or CA-UTI should receive high priority in infection prevention programs. In this regard, the link between hospital-acquired infection prevention and patient safety promotion has been recently highlighted [139]. Although US hospitals have not widely implemented strategies to reduce hospital-acquired UTI [7], this may change with the Centers for Medicare and Medicaid Services modification of the hospital reimbursement system, which is designed to eliminate payments previously provided to hospitals for the treatment of preventable complications during hospitalization, such as CA-UTI [8, 154].

Alternatives to Indwelling Urethral Catheterization

Recommendations

16. In men for whom a urinary catheter is indicated and who have minimal postvoid residual urine, condom catheterization should be considered as an alternative to short-term (A-II) and long-term (B-II) indwelling catheterization to reduce CA-bacteriuria in those who are not cognitively impaired.

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i. Data are insufficient to make a recommendation as to whether condom catheterization is preferable to short-term or long-term indwelling urethral catheterization for reduction of CA-UTI.

ii. Data are insufficient to make a recommendation as to whether condom catheterization is preferable to short-term or long-term indwelling urethral catheterization for reduction of CA-bacteriuria in those who are cognitively impaired.

17. Intermittent catheterization should be considered as an alternative to short-term (C-I) or long-term (A-III) indwelling urethral catheterization to reduce CA-bacteriuria and an alternative to short-term (C-III) or long-term (A-III) indwelling urethral catheterization to reduce CA-UTI.

18. Suprapubic catheterization may be considered as an alternative to short-term indwelling urethral catheterization to reduce CA-bacteriuria (B-I) and CA-UTI (C-III).

i. Data are insufficient to make a recommendation as to whether suprapubic catheterization is preferable to long-term indwelling urethral catheterization for reduction of CA-bacteriuria or CA-UTI.

ii. Data are insufficient to make a recommendation as to whether intermittent catheterization is preferable to suprapubic catheterization for reduction of CA-bacteriuria or CA-UTI.

Intermittent Catheterization Technique

Recommendations

19. Clean (nonsterile) rather than sterile technique may be considered in outpatient (A-III) and institutional (B-I) settings with no difference in risk of CA-bacteriuria or CA-UTI.

20. Multiple-use catheters may be considered instead of sterile single-use catheters in outpatient (B-III) and institutional (C-I) settings with no difference in risk of CA-bacteriuria or CA-UTI.

21. Data are insufficient to make a recommendation as to whether one method of cleaning multiple-use catheters is superior to another.

22. Hydrophilic catheters are not recommended for routine use to reduce the risk of CA-bacteriuria (B-II) or CA-UTI (B-II).

23. Data are insufficient to make recommendations on whether use of portable bladder scanners or "no-touch" technique reduces the risk of CA-UTI, compared with standard care.

Evidence Summary

Alternatives to indwelling urethral catheterization include intermittent catheterization, suprapubic catheterization, and the use of external collection devices, including condom catheters, diapers or pads.

Indications and limitations of intermittent catheterization. Guttman and Frankel [155] in 1966 described intermittent catheterization using sterile technique in patients with neurogenic bladders. Lapides et al [156] later demonstrated in observational studies that the clean (nonsterile) technique was safe and associated with a low incidence of complications. Intermittent catheterization is widely viewed to be associated with fewer complications, compared with indwelling urethral catheterization, including fewer instances of CA-bacteriuria, pyelonephritis, epididymitis, periurethral abscess, urethral stricture, vesicoureteral reflux, hydronephrosis, bladder and renal calculi, bladder cancer, and autonomic dysreflexia [22, 24, 157, 158]. In a 38-month prospective observational study involving 128 patients with acute spinal cord injuries, the incidence rates per 100 person-days for CA-bacteriuria and CA-UTI, respectively, were 5 and 2.72 cases for men with indwelling urethral catheters (128 patients), 2.95 and 0.41 cases for men with clean intermittent catheterization (124 patients), 2.41 and 0.36 cases for men with condom catheters (41 patients), and 0.96 and 0.34 cases for women with suprapubic catheterization (10 patients), respectively [25]. Although there are no randomized, controlled trials that have compared long-term catheterization methods (intermittent urethral catheterization, indwelling urethral or suprapubic catheterization, and external catheter for men) in managing voiding problems in patients with [159] or without neurogenic bladders, clean intermittent catheterization has become the standard of care for appropriate women and men with spinal cord injuries [16]. In addition, clean intermittent catheterization is a more commonly used alternative in men with bladder atonia and elderly patients who need assistance with voiding [21, 77, 160].

In contrast to patients with long-term catheterization, patients with short-term catheterization have been the subject of randomized trials of catheterization techniques. A recent Cochrane review of randomized or quasi-randomized trials that compared catheterization methods in patients who underwent short-term bladder drainage (≤14 days duration) found 2 trials (both involving patients who underwent surgical procedures) that compared indwelling urethral catheterization with intermittent catheterization [161]. The meta-analysis showed that significantly more cases of CA-bacteriuria occurred in the indwelling urethral catheterization group (RR, 2.90; 95% CI, 1.44–5.84).

Intermittent catheterization is not commonly used for short-term catheterization, however, because of the educational, motivational, and staff-time requirements necessary for its implementation and because of discomfort in sensate patients. Other limitations to intermittent catheterization include the inability or unwillingness of patients to perform frequent catheterization because of comorbid conditions or discomfort, or abnormal urethral anatomy, such as stricture, false passages, or bladder neck obstruction. Upper extremity impairment because of cervical spinal cord injury or other abnormality, obesity, and spas-

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ticity also make intermittent catheterization challenging for both male and female patients.

Techniques used for intermittent catheterization. There are many different techniques used in intermittent catheterization, such as sterile or clean technique, use of sterile or multiple-use catheters with the clean technique, whether a multiple-use catheter is changed daily or weekly, and use of hydrophilic or standard catheters. The main difference between sterile and clean (single-use) technique is that sterile gloves and drapes are used for the former but not for the latter technique. Studies that compared these techniques among patients managed with intermittent catheterization were evaluated in a recent Cochrane review [162]. The authors found studies to be methodologically weak, to have small sample sizes, and, in several trials, to combine use of catheters and of techniques leading to possible confounding. Nevertheless, the Cochrane authors concluded from a meta-analysis of these trials involving inpatients and outpatients with and without neurogenic bladders who received intermittent catheterization that there was no difference in the risk of CA-bacteriuria or CA-UTI with use of sterile or clean technique, with use of sterile catheters (single-use) or multiple-use catheters using the clean technique, or with use of multiple-use catheters changed daily or weekly using the clean technique [160, 163–167]. There are no randomized, controlled studies that compared clean or sterile technique for intermittently catheterized patients in the outpatient setting, although the clean technique is widely used by outpatients. Although there are no data that indicate that reusing urinary catheters when performing intermittent catheterization increases infection risk, it may be inconvenient for many patients who find it difficult to clean their catheters away from home, and some patients find it unaesthetic.

The Cochrane review also evaluated randomized, controlled trials of coated (hydrophilic or prelubricated with water soluble gel) or uncoated (separate lubricant) catheters in adults and children managed with intermittent catheterization [162]. Hydrophilic catheters are characterized by having a layer of polymer coating that is bound to the catheter surface that absorbs and binds water to the catheter, which results in reduced friction on catheter insertion and reduced urethral inflammation [168]. These catheters have been associated with improved patient satisfaction in some [169] but not all [166] studies. A crossover trial involving men with prostate enlargement showed no reduction in CA-bacteriuria or CA-UTI with the hydrophilic catheter [166]. Three parallel group trials compared a hydrophilic catheter with an uncoated catheter and reported data on CA-UTI [170–172]. In the largest of these 3 studies, a randomized study involving 123 male patients with spinal cord injury, there were fewer patients with CA-UTI in the hydrophilic catheter group, compared with the uncoated catheter group (39 [64%] of 61 vs 51 [82%] of 62; RR, 0.78; 95% CI, 0.62–0.97) [162, 170]. However, only 57 (46%) of the 123 subjects completed the 12-month study. The estimates from the smaller trials had wide confidence intervals that straddled the no-difference line [162, 171, 172]. In summary, current evidence does not support the routine use of hydrophilic catheters to reduce CA-bacteriuria, CA-UTI, or sequelae of urethral trauma in patients managed with intermittent catheterization [162, 173], but further studies are warranted.

In patients who undergo intermittent catheterization, ascension of bacteria colonizing the urethra into the bladder is more likely to be the source of CA-bacteriuria than is exogenous bacteria colonizing the catheter. Nevertheless, several procedures have been evaluated and have been shown to reduce bacterial contamination of reusable catheters, including rinsing catheters with running tap water after every use, air-drying, and keeping the catheters dry until reuse [174]; microwaving catheters [175–178]; and soaking catheters in hydrogen peroxide, bleach, or betadine [179]. However, there are no published trials evaluating the effectiveness of any of these cleaning methods in preventing CA-bacteriuria or CA-UTI among patients with intermittent catheterization.

In patients who undergo intermittent catheterization, portable bladder scanners accurately assess bladder volumes [180–183]. In addition, studies that compared volume-dependent and time-dependent intermittent catheterization with these devices have shown the volume-dependent method to reduce incontinence, number of catheterizations, and cost [184–186]. However, the effectiveness of these devices in preventing CA-bacteriuria or CA-UTI in patients who undergo intermittent catheterization has not been reported.

Use of the "no-touch" technique of intermittent catheterization (in which the catheter and preattached collecting system are not touched by the patient) reduces microbial contamination of the catheter [187]. Although studies have not been published that evaluate the effect of this technique on the risk of CA-bacteriuria or CA-UTI among patients with intermittent catheterization, it is unlikely to be superior to the sterile technique, which has not been demonstrated to be superior to the clean technique.

Indications and limitations of suprapubic catheterization. Potential advantages of suprapubic catheters in patients who need bladder drainage, compared with indwelling urethral catheters, include lower risk of CA-bacteriuria, reduced risk of urethral trauma and stricture, ability to attempt normal voiding without the need for recatheterization, and less interference with sexual activity. In the Cochrane review of randomized or quasi-randomized trials involving patients (almost all of whom were postsurgical patients) who underwent short-term bladder drainage (≤14 days duration), 14 trials were found that compared indwelling urethral catheterization with suprapubic catheterization [161]. These trials showed that patients with in-

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dwelling urethral catheterization had more cases of CA-bacteriuria (RR, 2.60; 95% CI, 2.12–3.18), more recatheterization (RR, 4.12; 95% CI, 2.94–7.56), and greater discomfort (RR, 2.98; 95% CI, 2.31–3.85). In the one trial that reported data on CA-UTI, there was no statistically significant difference between the 2 catheterization techniques. A review of randomized, controlled trials that compared indwelling urethral and suprapubic catheters among patients who underwent colorectal surgery had similar conclusions [188]. A more recent prospective randomized trial that compared clean intermittent self-catheterization and suprapubic catheterization in a group of 248 women after urogynecologic surgery showed no statistically significant difference in the risk of CA-ASB (23% vs 31%; $P = .23$), but patients with intermittent catheterization reported more frustration ($P = .01$) and more difficulty ($P = .003$) [189].

Even though suprapubic catheterization appears to have advantages over indwelling urethral catheterization, it is not commonly used, except perhaps in gynecologic and urologic surgical procedures in some centers. The use of suprapubic catheterization is limited, because catheter insertion is an invasive procedure with risks of bleeding and visceral injury, the patient can still leak through the urethra, and—a problem especially for patients with long-term catheterization—specially trained caregivers are often needed to change the catheters. Further comparisons of intermittent urethral catheterization, suprapubic catheterization (both open surgical and percutaneous insertion techniques), and indwelling urethral catheterization are needed for patients who require long-term bladder drainage.

Indications and limitations of condom catheter use. External condom catheters are an effective alternative for bladder management in some men. Parallel studies involving patients at the same institution with condom catheters or indwelling urethral catheters have suggested a lower incidence of CA-bacteriuria among patients with condom catheters in most [25, 190–193] but not all [194] studies. Studies suggest that frequent manipulation of condom catheters increases the risk of CA-bacteriuria [192]. These impressions were confirmed in a recent prospective, randomized trial involving 75 men at a Veterans Affairs hospital with a maximum duration of follow-up of 30 days [195]. Patients without dementia who had an indwelling urethral catheter were ~5 times as likely to develop CA-bacteriuria, to develop CA-UTI, or to die as were those patients with appropriately-sized condom catheters (hazard ratio, 4.84; 95% CI, 1.46–16.02; $P = .01$). There was no statistically significant difference in this outcome variable between the condom and indwelling urethral catheterization groups among patients with dementia. The outcome variable was comprised mostly of CA-bacteriuria, but the differences between the condom and indwelling urethral catheterization groups were not statistically significant when CA-bacteriuria alone was considered. Patients reported that condom catheters were more comfortable ($P = .02$) and less painful ($P = .02$) than were indwelling catheters. There have been no prospective trials that have compared condom catheterization and intermittent catheterization.

Thus, condom catheters appear to be associated with less risk for CA-bacteriuria than short-term indwelling urethral catheters in appropriately selected men with low postvoid residual urine volume. There is no standard definition of abnormal residual urine volume, because the association between residual urine volume and UTI is not well established, although studies often define abnormal retention as the presence of >100 mL of urine on ⩾2 consecutive occasions. Another potential advantage is that condom catheters cause less urethral trauma, compared with that caused by indwelling urethral catheters. However, a condom catheter may not be an option in men whose penis is small or whose skin is ulcerated. In addition, condom catheters can lead to penile skin breakdown and scar formation. Men with neurogenic bladders secondary to spinal cord injury should undergo urodynamic testing to assess the safety of using a condom catheter, because assessment of the postvoid residual may not be a reliable indicator of detrusor-sphincter dyssynergia, and long-term use of condom catheterization in the presence of dyssynergia may adversely affect renal function [196, 197].

There is currently no satisfactory external catheter suitable for use by women.

Insertion Technique for Indwelling Urethral Catheter

Recommendations

24. Indwelling urethral catheters should be inserted using aseptic technique and sterile equipment (B-III).

Evidence Summary

There are few data on the optimal level of sterility required to insert an indwelling urinary catheter. Tambyah et al [80], in a large prospective study involving catheterized patients, found that patients catheterized in the operating room had a lower incidence of early CA-bacteriuria than did those catheterized on the ward or in the emergency department (RR, 0.5; 95% CI, 0.2–1.0; $P = .03$), which suggests that augmented barrier precautions at the time of insertion of a catheter may reduce the risk of early CA-bacteriuria. Other studies have also shown that catheter insertion outside of the operating room is associated with a higher risk of CA-bacteriuria [198]. However, in a prospective trial conducted in the operating room, 156 patients who were undergoing preoperative urethral catheterization were randomly allocated to sterile (strict asepsis) or clean/nonsterile (hands washed with soap and water only, no gowns, nonsterile gloves, no catheter pack, cleansing of external

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genitalia with tap water only if visually unclean, and holding the catheter within its plastic sheath at all times) technique groups [199]. There was no statistically significant difference between the 2 groups with respect to the incidence of CA-bacteriuria, but the sterile method was more than twice as expensive. Further support for the clean technique in inserting catheters comes from observations of patients managed with intermittent catheterization who are catheterized multiple times daily and in whom there appears to be no difference in infection risk with clean versus sterile technique [162]. The Panel concluded, however, given the lack of data on CA-UTI as an outcome measure and the ubiquity of multidrug-resistant flora in health care facilities, that the use of aseptic technique was preferred at insertion of an indwelling urethral catheter, although further study is warranted. A study comparing clean and aseptic techniques might be especially relevant for patients with long-term catheterization in LTCFs.

PREVENTION STRATEGIES TO CONSIDER AFTER CATHETER INSERTION

Closed Catheter System

Recommendations

25. A closed catheter drainage system, with ports in the distal catheter for needle aspiration of urine, should be used to reduce CA-bacteriuria (A-II) and CA-UTI (A-III) in patients with short-term indwelling urethral or suprapubic catheters and to reduce CA-bacteriuria (A-III) and CA-UTI (A-III) in patients with long-term indwelling urethral or suprapubic catheters.

i. Institution-specific strategies should be developed to ensure that disconnection of the catheter junction is minimized (A-III) and that the drainage bag and connecting tube are always kept below the level of the bladder (A-III).

26. Use of a preconnected system (catheter preattached to the tubing of a closed drainage bag) may be considered to reduce CA-bacteriuria (C-II).

i. Data are insufficient to make a recommendation as to whether such a system reduces CA-UTI.

27. Use of a complex closed drainage system or application of tape at the catheter-drainage tubing junction after catheter insertion is not recommended to reduce CA-bacteriuria (A-I) or CA-UTI (A-III).

Evidence Summary

Introduction of the closed catheter drainage system, in which the collecting bag is attached to the distal end of the collecting tube, has been the most important infection prevention advance in CA-bacteriuria [4, 26, 200–202]. In noncomparative trials, use of closed drainage systems reduced the incidence of CA-bacteriuria to ~50% at 14 days of continuous catheterization [26], compared with an incidence of 95% among patients with catheter drainage into an open container for 96 h [203]. On the basis of such historical comparisons, closed systems have become the standard for bladder drainage. However, it is important that closed drainage systems remain closed, because disconnections at the catheter-collecting tube junctions have been shown to significantly increase the risk of CA-bacteriuria [46, 204].

Different methods to achieve closed drainage have been evaluated. In a randomized, controlled trial of 1494 catheter courses in a group of 1476 hospitalized patients, bladder catheters with preconnected drainage bags by sealed junctions were associated with a lower risk of catheter junction disconnection and CA-bacteriuria than were catheters without presealed junctions [46]. The risk of CA-bacteriuria was 2.7 times higher prior to receipt of antimicrobials for patients who were assigned unsealed catheters (95% CI, 1.3–5.4; $P = .007$). Among the 220 patients who received no antimicrobials, there was a significant association between mortality in the hospital and assignment to the unsealed junction group (RR, 3.4; 95% CI, 1.1–10.7; $P = .03$). However, a smaller randomized study involving 202 hospitalized men showed no difference in CA-bacteriuria rates among patients with a preconnected system, compared with patients for whom the catheter and drainage system were attached after insertion of the catheter [205]. Likewise, a randomized trial involving 311 patients in an ICU reported that the use of a complex closed drainage system (preattached catheter, antireflux valve, drip chamber, and povidone-iodine releasing cartridge) did not reduce the risk of CA-bacteriuria, compared with a simple 2-chamber closed system [206]. Finally, a large randomized study found that the use of a tape seal applied to the catheter-drainage tubing junction within 24 h of catheter insertion, compared with no tape seal, was not associated with statistically significantly lower rates of CA-bacteriuria among patients with short-term catheterization [207].

After contamination of the drainage bag, subsequent CA-bacteriuria occurs in almost all patients who remain catheterized [14, 27]. Improper positioning of the drainage tube above the level of the bladder or below the level of the collection bag is a predictor for an increased risk of CA-bacteriuria [31]. Indwelling catheters are usually anchored to minimize movement and urethral trauma, but it is not clear whether anchoring helps to reduce CA-bacteriuria. However, in a prospective, randomized trial involving 118 adults with spinal cord injury, use of a securing device to reduce the motion of indwelling catheters, compared with standard methods for anchoring catheters, was associated with a nonsignificant reduction in the rate of CA-UTI (13% vs 24%; RR, 0.55; 95% CI, 0.25–1.22) [208]. Studies that address the impact of a closed system on the risk of CA-bacteriuria or CA-UTI in patients with long-term indwelling urethral or suprapubic catheters have not been reported.

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Antimicrobial-Coated Catheters

Recommendations

28. In patients with short-term indwelling urethral catheterization, antimicrobial (silver alloy or antibiotic)–coated urinary catheters may be considered to reduce or delay the onset of CA-bacteriuria (B-II).

i. Data are insufficient to make a recommendation about whether use of such catheters reduces CA-UTI in patients with short-term indwelling urethral catheterization.

ii. Data are insufficient to make a recommendation as to whether use of such catheters reduces CA-bacteriuria or CA-UTI in patients with long-term catheterization.

Evidence Summary

In vitro studies have shown that antimicrobial-coated catheters have antimicrobial effects against UTI pathogens [209–211]. Antimicrobial-coated catheters have been developed to reduce the risk of CA-UTI by preventing or delaying the onset of bacteriuria. A recent Cochrane review evaluated 23 randomized and quasi-randomized trials that compared types of indwelling urinary catheters for short-term (≤14 days) catheterization in hospitalized adults [212]. Silver oxide catheters were not associated with a statistically significant reduction in CA-bacteriuria; these catheters are no longer available. Silver alloy catheters were found to significantly reduce the incidence of CA-ASB in hospitalized adults catheterized for <1 week (RR, 0.54; 95% CI, 0.43–0.67) and at >1 week (RR, 0.64; 95% CI, 0.51–0.80). Other meta-analyses of antimicrobial catheter trials have also concluded that silver oxide–coated catheters lack efficacy and that silver alloy–coated catheters are protective against CA-bacteriuria [213–216].

These meta-analyses report consistent but variable evidence that antimicrobial-coated catheters reduce CA-bacteriuria during short-term catheterization. Of note, however, the treatment effect observed with silver alloy–coated catheters is smaller in more-recent studies than it is in earlier studies for reasons that are not entirely clear, although more-recent studies were performed in more institutions, had more-diverse study populations, and had lower background rates of CA-bacteriuria [213, 214]. Moreover, concern has been raised that the purported benefits of silver alloy may be attributable to the different catheters used in trials rather than to the silver alloy, in that silicone catheters may have better properties than latex catheters, as noted previously, and these catheters may be only minimally improved by the addition of silver alloy [66]. In this regard, a recent prospective, cross-over study that compared the efficacy of a silicone-based, silver hydrogel–coated catheter with that of a silicone-based, hydrogel-coated catheter in a group of 3036 adult hospitalized patients found no factors, including silver catheters, that were protective against CA-bacteriuria in a multivariable survival analysis [65]. Potential cost savings with the silver alloy catheters are suggested by a prospective cross-over trial in which it was calculated that use of a silver alloy catheter would lead to a cost reduction of 3.3%–35.5% [57] and by 2 economic modeling studies [217, 218], but it has been questioned whether some of the assumptions used in these analyses are supported by data from more-recent trials [214].

The Cochrane review also evaluated trials performed with antibiotic-impregnated catheters [212]. In the only trial of minocycline and rifampin-impregnated catheters [219], which was conducted in a group of men after radical prostatectomy, coated catheters, compared with standard catheters, were associated with lower rates of CA-bacteriuria at <1 week of catheterization (RR, 0.36; 95% CI, 0.18–0.73) but not at >1 week [212]. Patients who were assigned to the minocycline and rifampin catheter had significantly lower rates of CA gram-positive bacteriuria but did not have lower rates of CA gram-negative bacteria or CA candiduria, compared with the control catheter group [219]. One of 56 men in the minocycline-rifampin group had a CA-UTI, compared with 6 of 68 men in the standard catheter group (RR, 0.20; 95% CI, 0.03–1.63). In the 4 trials that compared nitrofurazone-coated catheters with standard catheters, the nitrofurazone catheters were associated with lower rates of CA-bacteriuria at <1 week of catheterization (RR, 0.52; 95% CI, 0.34–0.78), but the benefit at >1 week was inconclusive [212]. A recent randomized trial showed that use of nitrofurazone catheters led to significantly fewer instances of new or changed antimicrobial therapy and decreased rates of CA-bacteriuria [220]. In vitro studies suggest that nitrofurazone catheters might have a more potent antibacterial effect than that of silver hydrogel catheters [210].

Data on the effectiveness of antimicrobial-coated catheters used in patients with long-term catheterization (>30 days) were assessed in another Cochrane review of randomized trials [221]. Only 1 trial of impregnated catheters was identified, which was a randomized, controlled cross-over study in Japan involving 12 elderly patients and comparing a silver alloy catheter with a silicone catheter that reported a mean duration of intervention of 26 months. All patients developed CA-bacteriuria.

In summary, there is evidence from several trials that silver alloy– and antibiotic-coated catheters, compared with standard catheters, reduce the risk of CA-ASB in patients catheterized for short periods of time. However, the clinical benefit of these catheters, especially regarding CA-UTI, morbidity, secondary bloodstream infection, other health care–associated infections, and cost savings have yet to be demonstrated in a randomized trial with any of these devices and in any patient population [212, 214]. Moreover, the benefit of the silver alloy–coated catheter in reducing CA-bacteriuria has been less impressive in more-recent trials. No trial has yet directly compared antibiotic-coated versus silver alloy–coated catheters or one type of silver alloy–coated catheter versus another. Resistance development

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to catheter antimicrobials has not been demonstrated in published trials [212, 222], and it has been suggested that the likelihood of antimicrobial resistance selection is likely to be considerably less than that with use of systemic antimicrobials [210]. However, possible resistance will remain a concern with the antibiotic-coated catheters until it is appropriately addressed in larger studies with adequate follow-up. Clearly, we need more information on the role that silver-coated and antibiotic-coated catheters have in reducing CA-bacteriuria and clinical events.

Prophylaxis with Systemic Antimicrobials

Recommendations

29. Systemic antimicrobial prophylaxis should not be routinely used in patients with short-term (A-III) or long-term (A-II) catheterization, including patients who undergo surgical procedures, to reduce CA-bacteriuria or CA-UTI because of concern about selection of antimicrobial resistance.

Evidence Summary

Systemic antimicrobial drug therapy has been shown repeatedly to lower the risk or to postpone the development of CA-bacteriuria [14, 35, 198, 223–226]. In one such study of hospitalized patients who underwent short-term catheterization, the beneficial effects of systemic antimicrobials on CA-bacteriuria were noted during each of the first 4 days after catheterization, but thereafter the rates of CA-bacteriuria were similar between those who did and those who did not receive antimicrobials, and antimicrobial use selected for more-resistant flora [14]. Studies involving patients with short-term catheterization have mainly been conducted among postoperative patients, whereas studies involving patients with long-term catheterization have largely been conducted among LTCF residents [30].

In a recent Cochrane review of antimicrobial policies for short-term (≤14 days) catheterization in adult patients, randomized, controlled trials involving patients who did and patients who did not undergo surgical procedures were evaluated [227]. The Cochrane authors concluded that there was (1) weak evidence that antimicrobial prophylaxis reduced the rate of CA-UTI among women with abdominal surgery and a urethral catheter for 24 h, (2) limited evidence that receiving antimicrobial drugs during the first 3 postoperative days or from postoperative day 2 until catheter removal reduced the rate of CA-bacteriuria among patients who underwent surgical procedures with bladder drainage for at least 24 h after undergoing the surgical procedure, and (3) limited evidence that prophylactic antimicrobials reduced CA-bacteriuria among patients who did not undergo surgical procedures. In a randomized placebo-controlled trial, a single dose of trimethoprim-sulfamethoxazole administered intravenously during the 30-min period preceding the surgical procedure in women undergoing elective abdominal hysterectomy who had a urethral catheter in place for 24 h resulted in a significantly reduced rate of CA-UTI 6 days after surgery, compared with placebo (RR, 0.20; 95% CI, 0.06–0.66) [228]. In another randomized, double-blind, placebo-controlled trial of prophylactic ciprofloxacin in patients who underwent surgical procedures who had postoperative bladder drainage scheduled to last for 3–14 days, 75% of patients in the placebo group had CA-bacteriuria at catheter removal, compared with 16% of ciprofloxacin-treated patients (RR, 4.7; 95% CI, 3.0–7.4) [229]. Twenty percent of patients who received placebo had CA-UTI, including 3 patients with septicemia, compared with 5% of the patients who received ciprofloxacin (RR, 4.0; 95% CI, 1.6–10.2) [229]. The Cochrane authors raised concerns that adverse drug reactions and selection for antimicrobial resistance associated with antimicrobial prophylaxis had not been adequately addressed in the trials that they reviewed [227].

Several studies have examined systemic antimicrobials in the prevention of CA-bacteriuria or CA-UTI among patients with long-term catheterization [112, 161, 230, 231]. A recent Cochrane review evaluated all randomized and quasi-randomized trials that compared antimicrobial prophylaxis policies for adults and children catheterized for >14 days [231]. One randomized, double-blind, cross-over trial involving 34 elderly nursing home patients with indwelling catheters compared prophylaxis with norfloxacin versus placebo [232]. Norfloxacin prophylaxis was associated with statistically significant reductions in gram-negative isolates ($P < .005$), CA-UTI (1 in 276 catheterization weeks vs 12 in 259 weeks; $P < .02$), and CA encrustations and blockage ($P < .05$). However, at the end of the prophylaxis period, 25% of strains in patients who received placebo, compared with 90% of strains among patients who received norfloxacin, were resistant to norfloxacin. Four other trials that involved adult patients with neurogenic bladders managed with intermittent catheterization were identified that compared antimicrobial prophylaxis with administration of antimicrobials when microbiologically indicated [231, 233–236]. The antimicrobials studied were nitrofurantoin and trimethoprim-sulfamethoxazole. All 4 trials consistently showed a reduction in the rate of CA-bacteriuria. In 1 trial, at least 1 episode of CA-UTI (bacteriuria and fever and at least 1 classical manifestation of UTI) occurred in 4 of 57 trimethoprim-sulfamethoxazole–treated men, compared with 18 of 52 placebo-treated men ($P < .001$) [236]. Among episodes of CA-bacteriuria that occurred during follow-up, 95% of isolates from the treatment group were resistant to trimethoprim-sulfamethoxazole, compared with 51% of isolates from the placebo group.

An earlier review of controlled trials of antimicrobial prophylaxis (mainly with nitrofurantoin, trimethoprim-sulfamethoxazole, or methenamine) involving adolescents and adults

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with spinal cord injury [230] showed that prophylaxis significantly reduced CA-ASB among patients <90 days after spinal cord injury (pooled difference, −0.27; 95% CI, −0.40 to −0.15; $P < .05$) but that the association was weaker in those who had been injured for >90 days ($P = .06$). There was no statistically significant reduction in CA-UTI. In patients who received antimicrobial drugs other than methenamine, there was a 2-fold increase in the proportion of antimicrobial-resistant bacteria cultured from patients.

Although systemic antimicrobial agents reduce or delay the onset of CA-bacteriuria and CA-UTI, authorities discourage their routine use in catheterized persons because of the cost, the potential for adverse effects, and the potential for the development of antimicrobial resistance [14, 16, 30, 32]. For the same reasons, the Panel's recommendation not to use systemic antimicrobial prophylaxis in catheterized patients applies to patients who undergo surgical procedures and have short-term indwelling catheterization, even though systemic prophylaxis has been shown to reduce CA-bacteriuria and CA-UTI in such patients in randomized, controlled trials. Thus, the quality of evidence supporting the recommendation not to use prophylaxis in patients with short-term catheterization is based on opinion rather than trial data.

Some authorities have suggested a possible role for systemic antimicrobial prophylaxis in patients with short-term catheterization at high risk for serious complications if UTI occurs, such as patients who are granulocytopenic, who undergo urologic or gynecologic surgical procedures, or who undergo a surgical procedure involving a foreign body [16, 31, 47, 83, 237]. However, no studies of prophylactic antimicrobials have been performed that involve catheterized persons in these high-risk groups. Of note, studies have shown that up to 80% of hospitalized patients with an indwelling catheter receive antimicrobial therapy for some indication [26, 226]. Moreover, most patients who undergo surgical procedures receive at least a short duration of antimicrobial prophylaxis.

Prophylaxis with Methenamine Salts

Recommendations

30. Methenamine salts should not be used routinely to reduce CA-bacteriuria or CA-UTI in patients with long-term intermittent (A-II) or long-term indwelling urethral or suprapubic (A-III) catheterization.

i. Data are insufficient to make a recommendation about the use of methenamine salts to reduce CA-UTI in patients with condom catheterization.

31. Methenamine salts may be considered for the reduction of CA-bacteriuria and CA-UTI in patients after a gynecologic surgical procedure who are catheterized for no more than 1 week (C-I). It is reasonable to assume that a similar effect would be seen after other types of surgical procedures.

i. Data are insufficient to make recommendations about whether one methenamine salt is superior to another.

32. When using a methenamine salt to reduce CA-UTI, the urinary pH should be maintained below 6.0 (B-III).

i. Data are insufficient to recommend how best to achieve a low urinary pH.

Evidence Summary

Methenamine salts (methenamine mandelate and methenamine hippurate) have been used for the suppression and prevention of UTI for years, although their use is limited because of doubts about their effectiveness and the availability of many other effective urinary antimicrobials. The main advantage to their use is their lack of selection for resistant organisms. Methenamine salts are hydrolyzed to ammonia and formaldehyde, a denaturant of proteins and nucleic acids responsible for the antibacterial activity of methenamine. Antimicrobial activity in urine is correlated with urinary concentrations of formaldehyde, which has a broad spectrum of activity against urinary pathogens [238], and the urinary concentration of formaldehyde is dependent on the concentration of methenamine in the urine, the urine pH, and the time the drug remains in the bladder [239, 240]. However, the association between formaldehyde concentration and urinary pH has not been confirmed consistently [238, 241], and ascorbic acid may increase urinary formaldehyde concentrations with only slight changes in urinary pH [242]. Maintaining urinary pH below 6 or even below 5.5 is thought to be necessary to achieve bactericidal concentrations of formaldehyde [240]. Studies of ascorbic acid in dosages of up to 4 g per day have shown no significant effect on mean urinary pH [243–245], and dosages as high as 12 g per day or more frequent administration (eg, every 4 h) may be required to adequately acidify the urine [238]. Ammonium chloride might be more effective in acidifying the urine, but the potential for metabolic acidosis is a concern [244].

Methenamine is generally considered to have limited effectiveness in catheterized patients for whom the dwell time, and thus the time for hydrolysis to formaldehyde, is limited [238]. In a double-blind, randomized, controlled trial involving 305 community-dwelling patients with spinal cord injury with neurogenic bladder and stable bladder management (indwelling urethral or suprapubic catheterization [51%], clean intermittent catheterization [30%], or reflex voiding [19%]), methenamine hippurate administered at a dosage of 1 g twice daily did not result in a significantly longer CA-UTI–free period, compared with placebo (hazard ratio, 0.96; 95% CI, 0.68–1.35), irrespective of bladder management [246]. Of note, 73% of patients in the methenamine group and 55% of patients in the placebo group were bacteriuric at enrollment. A randomized study involving men with spinal cord injury who underwent intermittent catheterization and whose urine was rendered ster-

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ile with antimicrobials before enrollment reported that prophylactic use of methenamine was not beneficial in preventing CA-bacteriuria [247]. On the other hand, in a double-blind, randomized, placebo-controlled trial involving 39 nonbacteriuric hospitalized patients with neurogenic bladders who underwent intermittent catheterization and bladder retraining, methenamine mandelate with ammonium chloride (1 g every 6 h for both drugs) reduced the CA-ASB rate over a 3-week period, compared with placebo (9 [53%] of 17 vs 19 [86%] of 22; $P < .02$) [248].

A recent Cochrane review [249] of randomized, controlled studies of methenamine hippurate for prevention of UTI included 4 studies involving patients who underwent short-term catheterization for ≤7 days after a gynecologic surgical procedure (eg, uterovaginal prolapse or vaginal plastic surgery). CA-UTI was significantly reduced in the methenamine group, compared with the control group, in the 3 trials that reported this outcome (RR, 0.14; 95% CI, 0.05–0.38), and CA-bacteriuria was significantly reduced in all 4 trials (RR, 0.48; 95% CI, 0.23–0.99) [250–253]. For example, in a prospective, randomized, double-blind, placebo-controlled trial involving 145 patients who underwent gynecologic surgical procedures, CA-bacteriuria and CA-UTI were less common soon after surgery in the methenamine group, compared with the placebo group (rate of CA-bacteriuria, 30% vs 50%; $P = .02$; rate of CA-UTI, 2.7% vs 13.9%; $P = .03$) [251]. Of note, methenamine was administered for several days after the catheters had been removed, which may help to explain its effectiveness.

In summary, the data are unconvincing that methenamine is effective in reducing the risk of CA-bacteriuria or CA-UTI in patients managed with long-term indwelling urethral catheterization, probably because there is insufficient time in the bladder to achieve adequate concentrations of formaldehyde to be clinically effective [30, 238, 241], and its routine use in such patients should be discouraged. Although the data are mixed, methenamine also does not appear to be effective in patients with intermittent catheterization. On the other hand, methenamine is effective in patients after gynecologic surgical procedures who undergo short-term catheterization, although this group experiences limited morbidity from CA-bacteriuria. There are no published data on the use of methenamine in men who use condom catheters. Methenamine is likely to be most effective in situations in which the urine pH is low and there is time for hydrolysis of methenamine to achieve sufficient concentrations of formaldehyde. It may be reasonable to consider a trial of methenamine involving selected patients with intermittent catheterization who have frequent recurrent episodes of CA-UTI, even though the benefit of methenamine in such patients is unproven. If used, the manufacturers' recommended dosage is 1 g twice daily for methenamine hippurate and 1 g 4 times daily for methenamine mandelate. However, concentrations achieved with methenamine hippurate dosed at 12 h may be suboptimal [254]. It is reasonable to try to reduce the urinary pH below 6.0 when using methenamine, but the optimal method to achieve low urinary pH is not known.

Prophylaxis with Cranberry Products

Recommendations

33. Cranberry products should not be used routinely to reduce CA-bacteriuria or CA-UTI in patients with neurogenic bladders managed with intermittent or indwelling catheterization (A-II).

i. Data are insufficient to make a recommendation on the use of cranberry products to reduce CA-bacteriuria or CA-UTI in other groups of catheterized patients, including those using condom catheters.

Evidence Summary

Cranberry products are used widely in different patient populations to reduce UTI. A recent Cochrane review of randomized, controlled trials concluded that there is some evidence that cranberry may be effective in reducing symptomatic UTIs in young women with recurrent UTIs, but effectiveness for other groups, including elderly men and women or people requiring catheterization, is uncertain [255]. Only 2 double-blinded, placebo-controlled studies of cranberry for the prevention of CA-UTI in adults with spinal cord injury were identified [256, 257]. Both of these small studies enrolled outpatients managed with various bladder drainage methods; subjects in one study were bacteriuric [257], and the other study did not provide data on whether patients were bacteriuric [256]. No beneficial effect of cranberry was found on CA-bacteriuria [256, 257] or CA-UTI [257]. Two trials have been published since this review. In a double-blind, factorial-design, randomized, controlled trial involving 305 community-dwelling spinal cord injury patients with neurogenic bladder and stable bladder management, almost two-thirds of whom were bacteriuric at enrollment, no significant benefit was seen from cranberry (800 mg twice daily) in the CA-UTI–free period, compared with placebo [246]. However, in a more recent randomized, double-blind, placebo-controlled trial with a cross-over design, 47 men with spinal cord injury and neurogenic bladder who used condom catheters (74%), intermittent catheterization (17%), or indwelling catheterization (9%) received 6 months of cranberry extract (a 500-mg tablet) or placebo [258]. During the cranberry period, 6 subjects experienced 7 CA-UTIs, compared with 16 subjects who experienced 21 CA-UTIs in the placebo period ($P < .05$ for both number of subjects and incidence). There was no difference in the CA-ASB rate between the 2 groups, but the authors do not state what proportion of patients were bacteriuric at the start of the trial.

Thus, the data on effectiveness of cranberry in preventing

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CA-bacteriuria or CA-UTI in patients with neurogenic bladders are mostly negative, but the quality of the studies is poor. In the Hess trial [258], which was the only 1 of 4 trials that involved patients with neurogenic bladders to show positive results, most patients were using condom catheterization. Routine use of cranberry should be discouraged in patients with neurogenic bladders who require catheterization because of the lack of clearly demonstrated efficacy in preventing CA-UTI, problems with tolerance associated with long-term use, and cost. However, it may be reasonable to consider a trial use of cranberry in men who use condom catheterization who have recurrent episodes of CA-UTI.

There are no published data on the use of cranberry products for the prevention of CA-bacteriuria or CA-UTI in catheterized adults without neurogenic bladder.

Enhanced Meatal Care

Recommendations

34. Daily meatal cleansing with povidone-iodine solution, silver sulfadiazine, polyantibiotic ointment or cream, or green soap and water is not recommended for routine use in men or women with indwelling urethral catheters to reduce CA-bacteriuria (A-I).

i. Data are insufficient to make a recommendation as to whether meatal cleansing reduces the risk of CA-UTI.

Evidence Summary

Bacteria causing CA-bacteriuria in closed catheter systems predominantly enter the bladder along the catheter-urethral interface [34, 80]. Thus, reducing meatal colonization would seem to be a reasonable measure to reduce the risk of CA-UTI. However, results of large randomized trials have shown no benefit to meatal cleansing with either green soap or application of antimicrobials in men or women [259, 260]. In a trial that evaluated 2 interventions, twice-daily application of a povidone-iodine solution and ointment to the urethral meatus-catheter interface and once-daily meatal cleansing with a nonantiseptic solution of green soap and water were compared with usual care (debris removal at daily baths) [259]. CA-bacteriuria rates were higher in both treated groups, compared with rates in the untreated groups. In addition, a subset of high-risk women in each treatment group had significantly increased rates of CA-bacteriuria. In other trials, meatal care with polyantibiotic ointment or cream applied twice or 3 times daily, respectively, was not statistically significantly better than usual care in preventing CA-bacteriuria, although application of the polyantibiotic ointment showed significant benefit in a subset of high-risk women [29, 260]. Silver sulfadiazine 1% cream applied twice daily to the meatus was also found to be ineffective in preventing CA-bacteriuria, compared with usual care [33]. Another randomized, controlled trial was performed to assess whether simultaneous interventions to block the 3 potential sites of bacterial entry—namely, the urethral insertion site, the catheter drainage tube junction, and the outflow tube of the drainage bag—was beneficial. The interventions included daily catheter care, use of a preconnected sealed catheter system, and disinfection of the outflow tube of the drainage bag with povidone-iodine [29]. Among treated patients, 14 (4.7%) of 300 acquired CA-bacteriuria, compared with 15 (4.9%) of 306 who did not receive the protocol interventions. The authors concluded that the use of these simultaneous measures to reduce CA-bacteriuria was not effective and was more expensive than usual care.

Possible reasons why meatal care has not been effective in reducing CA-bacteriuria include the negative effect of increased catheter manipulation, inadequate residual antiseptic activity of the topical agent, lack of effect on the intraluminal route of infection, and the possible development of protective biofilms at the catheter-urethra interface [33, 259, 261].

Catheter Irrigation

Recommendations

35. Catheter irrigation with antimicrobials should not be used routinely to reduce or eradicate CA-bacteriuria (A-I) or CA-UTI (A-II) in patients with indwelling catheters.

36. Catheter irrigation with antimicrobials may be considered in selected patients who undergo surgical procedures and short-term catheterization to reduce CA-bacteriuria (C-I).

i. Data are insufficient to make a recommendation about whether bladder irrigation in such patients reduces CA-UTI.

37. Catheter irrigation with normal saline should not be used routinely to reduce CA-bacteriuria, CA-UTI, or obstruction in patients with long-term indwelling catheterization (B-II).

Evidence Summary

Periodic catheter irrigation is intended to prevent catheter obstruction and infection, but little overall benefit has been seen in studies with closed systems [262]. Agents used for continuous or intermittent bladder irrigation include antiseptics (povidone-iodine or chlorhexidine digluconate) and antibiotics (neomycin or polymyxin B sulfate) [30]. Warren et al [204] randomized 187 nonbacteriuric adult patients who required short-term urinary catheterization to closed drainage with a triple-lumen, neomycin-polymyxin irrigated system or a double-lumen nonirrigated catheter system. There was no significant difference in the proportion (16% vs 18%, respectively) or in the cumulative prevalence of CA-bacteriuria between the 2 groups, but uropathogens in the irrigation group were significantly more resistant to the irrigating antibiotic than were those in the other group. In a prospective randomized trial involving 52 elderly men and women without neurogenic blad-

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ders who were managed with indwelling urinary catheters, twice-daily bladder instillation of chlorhexidine had no effect, compared with normal saline, on CA-bacteriuria (all patients were bacteriuric, and colony counts did not drop in either group) or CA-UTI [263]. Likewise, in a randomized double-blind study of 89 community-residing persons with neurogenic bladders with indwelling catheters and CA-bacteriuria, there was no effect on levels of CA-bacteriuria from twice-daily bladder irrigation with neomycin-polymyxin or acetic acid versus sterile saline [264].

On the other hand, bladder irrigation with antiseptics has been effective in preventing CA-bacteriuria in some studies involving patients who undergo surgical procedures and have short-term catheterization. In a randomized, controlled study of 57 orthopedic patients who underwent single or short-term intermittent urethral catheterization, bladder irrigation after each catheterization with povidone-iodine, compared with no irrigation, reduced the percentage of patients who developed CA-bacteriuria to 4%, compared with 28% in the control group ($P = .03$) [265]. In a randomized, controlled study of 89 men who underwent transurethral operations, postoperative bladder irrigation with chlorhexidine reduced the percentage of patients with postoperative CA-bacteriuria to 12.8%, compared with 36.7% of saline control group patients ($P < .02$) [266]. In a pre-post study involving 156 consecutive patients with an indwelling catheter and bacteriuria who underwent open prostatectomy with preoperative bladder washing with povidone-iodine, compared with no irrigation, the rate of postoperative CA-bacteriuria remained unchanged in the control group (100%) but was reduced to 22.5% in the treated group ($P = .001$) [267].

Catheter blockage can result from encrustation formed by urease-producing organisms in the catheter biofilm. In 1135 weekly urine specimens from 32 patients with long-term catheterization, 86% had urease-positive bacterial species at $\geqslant 10^5$ cfu/mL; *P. mirabilis*, but no other urease-positive species, was significantly associated with the 67 obstructions observed in 23 patients [268]. Patients with blocked catheters are more often colonized with *P. mirabilis* and *P. stuartii* than are patients without blocked catheters [93]. In a randomized cross-over trial involving 32 women with long-term catheterization and bacteriuria in whom 10 weeks of once-daily normal saline irrigation was compared with 10 weeks of no irrigation, the prevalence and species of CA-bacteriuria and the incidence of catheter obstructions and febrile episodes, including those that appeared to be of urinary origin (ie, CA-UTIs), were similar [269].

These data suggest that catheter irrigation is not effective in preventing or eradicating CA-bacteriuria in patients with indwelling catheterization but may reduce CA-bacteriuria in selected surgical populations who undergo short-term catheterization. However, catheter irrigation is time consuming, and some studies, at least those with long-term use of antimicrobial irrigating solutions, have shown that irrigation may promote infection due to organisms that are resistant to the antimicrobials. Routine bladder irrigation may also cause irritation of the bladder mucosa [270].

Antimicrobials in the Drainage Bag

Recommendations

38. Routine addition of antimicrobials or antiseptics to the drainage bag of catheterized patients should not be used to reduce CA-bacteriuria (A-I) or CA-UTI (A-I).

Evidence Summary

Both animal and human studies have demonstrated that CA-bacteriuria rapidly follows entrance of bacteria into the drainage bag [14, 27, 82]. Studies have also shown that as many as 34%–42% of CA-bacteriuria episodes originated from an intraluminal source [80, 271]. Raising the drainage bag above the level of the bladder or collecting tube will facilitate this.

Randomized trials of the addition of antimicrobials (including chlorhexidine, hydrogen peroxide, povidone-iodine, or slowly released silver ions) to the drainage bag to decrease the risk of CA-bacteriuria have generally shown no benefit [29, 150, 272–274]. For example, in 668 patients with indwelling urethral catheters (mean duration, 4 days), there was no difference between the hydrogen peroxide group and the control group with respect to the mean duration of catheterization before the onset of bacteriuria, the rate of CA-bacteriuria, or the spectrum of etiologic agents recovered [150]. However, bag contamination with the same organism responsible for bacteriuria preceded infection in only 5 (7%) of the 68 patients who developed bacteriuria, which suggests that infections arising intraluminally from contamination of the drainage bag are uncommon among catheterized patients in some general hospital settings. An intraluminal source of infection may be more common among patients catheterized for longer periods of time [201], but CA-bacteriuria or CA-UTI rates were not reduced with bag disinfection with hydrogen peroxide in a randomized trial involving 134 patients catheterized for $\geqslant 5$ days (mean duration, 9.6 days) [272].

The evidence strongly suggests that bag disinfection does not result in reduced risk of CA-bacteriuria or CA-UTI. Adherence to the closed drainage system minimizes the importance of the drainage bag as the source of CA-bacteriuria and thus the usefulness of drainage bag disinfection [273]. Because of the potential role of contaminated drainage bags in infection clusters [58, 63], it may be appropriate to consider drainage bag disinfection as an infection prevention measure during nosocomial outbreaks [275, 276], but this has not been evaluated in randomized trials.

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Routine Catheter Change

Recommendations

39. Data are insufficient to make a recommendation as to whether routine catheter change (eg, every 2–4 weeks) in patients with functional long-term indwelling urethral or suprapubic catheters reduces the risk of CA-ASB or CA-UTI, even in patients who experience repeated early catheter blockage from encrustation.

Evidence Summary

Urinary catheters readily develop biofilms on their inner and outer surfaces once they are inserted [32]. Established biofilms inherently protect uropathogens from antimicrobials and the host immune response. Many species decrease substantially in prevalence when paired indwelling urethral catheter urine cultures and replacement catheter urine cultures are compared, especially for patients with long-term catheterization [89–91]. Catheters are often changed routinely at periodic intervals (eg, monthly) to reduce the risk of CA-bacteriuria or obstruction, but this practice is not evidence-based. It has also been recommended that the subgroup of patients who experience repeated early catheter blockage should have their catheters changed every 7–10 days to avoid obstruction, but this intervention has also not been evaluated in clinical trials [92]. The common practice of routine periodic change of indwelling urinary catheters to prevent CA-bacteriuria and obstruction warrants study.

Prophylactic Antimicrobials at Time of Catheter Removal or Replacement

Recommendations

40. Prophylactic antimicrobials, given systemically or by bladder irrigation, should not be administered routinely to patients at the time of catheter placement to reduce CA-UTI (A-I) or at the time of catheter removal (B-I) or replacement (A-III) to reduce CA-bacteriuria.

i. Data are insufficient to make a recommendation as to whether administration of prophylactic antimicrobials to such patients reduces bacteremia.

Evidence Summary

Fever and/or bacteremia can occur at the time of removal or replacement of a urethral catheter in a patient with CA-bacteriuria. In addition, CA-bacteriuria can occur after a catheter has been removed, although the frequency with which this happens is not known. Prophylactic antimicrobials are sometimes used to prevent such events. In a questionnaire study of health care professionals in England, 60% advocated the use of antimicrobials for either all or selected groups of patients at the time of removal of a urethral catheter, citing concerns about the potential for bacteremia, infection in a prosthesis, or UTI [277]. In a study describing catheterized and bacteriuric women in LTCFs, Warren et al [28] reported an incidence of 2.1 cases of fever per 100 resident-days that occurred within 24 h of catheter replacement, compared with 1.1 cases of fever per 100 resident-days that did not occur within 24 h of catheter replacement. The episodes of fever that occurred within 24 h of catheter replacement generally resolved promptly, even without antibacterial therapy.

Several studies evaluating the risk of bacteremia associated with catheter removal or replacement have been performed. In a study describing 115 men and women with long-term catheterization (most patients did not have a neurogenic bladder) who were bacteriuric and living at home, Jewes et al [73] reported bacteremia after 20 (10%) of 197 urethral catheter changes and 1 (5%) of 19 suprapubic catheter changes. All bacteremic episodes were asymptomatic, and patients were afebrile. Other prospective studies in geriatric populations with long-term catheterization and bacteriuria have found a ~4% rate of transient bacteremia among patients who had removal or replacement of their indwelling catheters, and none of the patients were clinically symptomatic [74, 75].

Studies have evaluated the effectiveness of antimicrobial prophylaxis in preventing CA-bacteriuria in patients who are having a catheter placed or removed. In a randomized double-blind, placebo-controlled trial involving 162 elderly hospitalized patients who needed indwelling urethral catheterization, single-dose aztreonam versus placebo administered 3 h before catheterization resulted in no CA-UTIs at 7 days in 89% of the patients in the aztreonam group and 46% of the patients in the placebo group [278]. Concerns about this study include the unexpectedly high rates of CA-UTI during the first week of catheterization, short follow-up, and the absence of data on antimicrobial resistance in infection episodes. In another randomized, double-blind, placebo-controlled study involving 48 patients across specialties with a urethral catheter in situ for 2–7 days, patients (15% with CA-bacteriuria) assigned to a 48-h course of either ciprofloxacin or placebo tablets starting 2 h before catheter removal reported no difference in the rates of CA-bacteriuria by 2 weeks after removing the urethral catheter (16% vs 13%) [279]. Likewise, in a randomized, controlled trial involving 264 catheterized patients (14% with CA-bacteriuria) on a urological ward whose catheters were being removed, bladder irrigation with povidone-iodine before catheter removal, compared with no irrigation, showed no benefit with respect to subsequent CA-bacteriuria rates (47 [18%] of 264 patients vs 52 [22%] of 233 patients) [280]. On the other hand, a more recent prospective, randomized, nonblinded trial involving 239 patients who underwent elective abdominal surgical procedures in which patients were randomized to 3 doses of trimethoprim-sulfamethoxazole or no treatment at urinary catheter removal showed significantly fewer CA-UTIs (4.9% vs 21.6%; $P < .001$) and fewer cases of CA-bacteriuria (16.5% vs 41.2%; $P < .001$)

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in the treatment group [281]. There are no published studies of the efficacy of prophylactic antimicrobials in preventing CA-bacteriuria or CA-UTI in patients whose catheters are being replaced or in preventing bacteremia in patients whose catheters are being removed or replaced.

On the basis of these observations and concerns about increasing antimicrobial resistance, prophylactic antimicrobials are not routinely recommended for catheter placement, removal, or replacement. This recommendation is also supported by the low rate of serious complications among the large number of patients who undergo long-term intermittent catheterization with clean technique in the setting of chronic bacteriuria. However, this is an area that warrants further study, given the findings reported above.

III. IN CATHETERIZED PATIENTS WITH ASB, WHAT IS THE APPROPRIATE MANAGEMENT TO REDUCE THE RISK OF CA-UTI?

Screening for and Treatment of CA-ASB in Catheterized Patients to Reduce CA-UTI

Recommendations

41. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI in patients with short-term (A-II) or long-term (A-I) indwelling urethral catheters.

42. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI in patients with neurogenic bladders managed with intermittent catheterization (A-II).

43. Screening for and treatment of CA-ASB are not recommended to reduce subsequent CA-bacteriuria or CA-UTI in other catheterized patients (A-III), except in pregnant women (A-III) and patients who undergo urologic procedures for which visible mucosal bleeding is anticipated (A-III).

Evidence Summary

The recommendations and supporting data for screening for and treatment of CA-ASB in catheterized patients were previously published in the IDSA guidelines for the diagnosis and treatment of ASB in 2005 [105]. To summarize, patients with short-term indwelling catheters in acute care facilities often receive antimicrobial therapy, usually for an indication other than UTI [26, 224, 226], which complicates assessment of outcomes unique to treatment of CA-ASB. However, complications of CA-ASB in patients with short-term catheterization are rare, as shown in a large prospective cohort study of CA-bacteriuria [40]. In a prospective randomized trial in a medical-surgical ICU, 60 patients who had an indwelling urethral catheter for >48 h and developed CA-ASB were randomized to receive either a 3-day course of antimicrobials associated with the replacement of the indwelling urethral catheter or no antimicrobials and no catheter replacement [282]. There were no statistically significant differences between the 2 groups with respect to the subsequent occurrence of urosepsis or CA-bacteriuria. Furthermore, in a case-control study that involved hospitalized patients and showed that CA-bacteriuria was associated with increased mortality, multivariate analysis demonstrated that antimicrobial therapy did not alter the association with mortality [4].

Residents in LTCFs frequently receive antimicrobials for ASB. For these residents, the ordering of urine cultures and prescribing of antimicrobials is influenced by a wide range of nonspecific symptoms and signs, and nurses play a central role in both the ordering of urine cultures and the decision as to whether antimicrobials are prescribed [115]. A prospective, randomized trial of cephalexin or no antimicrobial therapy for episodes of CA-ASB caused by susceptible organisms, conducted among 35 patients with long-term catheterization, reported no differences between the 2 groups in incidence or prevalence of CA-bacteriuria, CA-UTI, or obstructed catheters in patients who were followed up for 12–44 weeks [283]. Although rates of reinfection were similar, 47% of reinfecting organisms in the cephalexin group but only 26% of reinfecting organisms in the control group were highly resistant to cephalexin. In a pre-post noncomparative study of consecutive courses of different antimicrobials to eradicate bacteriuria among elderly hospitalized patients, most of whom had indwelling catheters, there was no decrease in the number of episodes of fever, compared with the pretreatment period, and when bacteriuria was eliminated, replacement by antimicrobial-resistant strains was common [284].

Screening for and treatment of CA-ASB in patients with spinal cord injury are also not beneficial [105]. Treatment of CA-ASB is followed by early recurrence with more-resistant strains in catheter-free patients with spinal cord injury [285], has no effect on the rate of subsequent CA-ASB or CA-UTI among patients managed by intermittent catheterization [235, 286], and when CA-UTIs do occur, they respond promptly to treatment [287]. Although there are limited clinical trials, and although interpretation is compromised by relatively short follow-up periods and small study numbers, review articles [288] and consensus guidelines [98] uniformly recommend that only CA-UTI should be treated in patients with spinal cord injury.

In summary, patients with short-term and long-term catheterization with CA-ASB have a low rate of complications, and treatment is not beneficial in reducing subsequent CA-bacteriuria or CA-UTI, although it does lead to selection of antimicrobial-resistant uropathogens. One exception is pregnant women; randomized, controlled treatment trials involving noncatheterized women have shown that eradication of ASB reduces the risk of pyelonephritis and adverse consequences of pregnancy [105]. There are no CA-ASB treatment trials in-

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volving pregnant catheterized women. Another exception is patients with CA-ASB who undergo traumatic genitourinary procedures associated with mucosal bleeding, for whom studies have shown a high rate of postprocedure bacteremia and sepsis [105]. Avoiding inappropriate treatment of CA-ASB in adults should reduce the risk of development of antimicrobial resistance and is consistent with the IDSA [105] and US Preventive Services Task Force [289, 290] guidelines on bacteriuria. A proposal has been made that a hospital and ambulatory performance measure should be developed for not treating ASB in adults [291].

Screening for and Treatment of CA-ASB at Catheter Removal to Reduce CA-UTI

Recommendations

44. Antimicrobial treatment of CA-ASB that persists 48 h after short-term indwelling catheter removal in women may be considered to reduce the risk of subsequent CA-UTI (C-I).

i. Data are insufficient, however, to make a recommendation as to whether all women should be uniformly screened for CA-ASB at catheter removal.

ii. Data are insufficient to make a recommendation about screening for or treatment of persistent CA-ASB in men.

Evidence Summary

A prospective, randomized, placebo-controlled trial of antimicrobial treatment of CA-ASB persisting at 48 h after short-term catheter removal (median duration of catheterization, 3 days) in hospitalized women (median age, 50 years) reported significantly improved microbiologic and clinical outcomes at 14 days in treated women [292]. Seven (17%) of 42 women who were randomized to receive no therapy developed CA-UTI by 14 days, whereas none of 70 women in the treatment group became symptomatic. The long-term benefit of screening for and eradicating postcatheterization CA-ASB to reduce CA-UTI warrants further study [16].

IV. WHAT ARE THE APPROPRIATE MANAGEMENT STRATEGIES FOR PATIENTS WITH CA-UTI?

Urine Culture and Catheter Replacement before Treatment

Recommendations

45. A urine specimen for culture should be obtained prior to initiating antimicrobial therapy for presumed CA-UTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance (A-III).

46. If an indwelling catheter has been in place for >2 weeks at the onset of CA-UTI and is still indicated, the catheter should be replaced to hasten resolution of symptoms and to reduce the risk of subsequent CA-bacteriuria and CA-UTI (A-I).

i. The urine culture should be obtained from the freshly placed catheter prior to the initiation of antimicrobial therapy to help guide treatment (A-II).

ii. If use of the catheter can be discontinued, a culture of a voided midstream urine specimen should be obtained prior to the initiation of antimicrobial therapy to help guide treatment (A-III).

Evidence Summary

CA-UTIs are often polymicrobial and caused by multidrug-resistant uropathogens. Urine cultures are recommended prior to treatment to confirm that an empirical regimen provides appropriate coverage and to allow tailoring of the regimen on the basis of antimicrobial susceptibility data [293]. A prospective, randomized, controlled trial evaluated whether long-term urinary catheters should be replaced prior to treatment of CA-UTI [107]. Twenty-one male and 33 female elderly nursing home residents with long-term indwelling urinary catheters (time since most recent replacement, 2.5–5 weeks) and CA-UTI were randomized to indwelling catheter replacement or no replacement before initiating antimicrobial therapy with a fluoroquinolone. Patients who underwent catheter replacement had significantly decreased polymicrobic CA-bacteriuria 28 days after antimicrobials were discontinued ($P = .02$), a shorter time to improved clinical status at 72 h after the initiation of therapy ($P < .001$) and a lower rate of CA-UTI within 28 days after therapy ($P = .015$). These findings support catheter replacement prior to antimicrobial treatment for CA-UTI if the catheter has been in place for at least 2 weeks and its use cannot be discontinued. Because catheter urine culture results in a patient with a catheter biofilm may not accurately reflect the status of infection in the bladder [89–91], urine culture specimens should be obtained from the freshly placed catheters, if feasible, prior to the initiation of antimicrobial therapy.

Duration of Treatment

Recommendations

47. Seven days is the recommended duration of antimicrobial treatment for patients with CA-UTI who have prompt resolution of symptoms (A-III), and 10–14 days of treatment is recommended for those with a delayed response (A-III), regardless of whether the patient remains catheterized or not.

i. A 5-day regimen of levofloxacin may be considered in patients with CA-UTI who are not severely ill (B-III). Data are insufficient to make such a recommendation about other fluoroquinolones.

ii. A 3-day antimicrobial regimen may be considered for women aged ≤65 years who develop CA-UTI without upper urinary tract symptoms after an indwelling catheter has been removed (B-II).

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Evidence Summary

There is a wide spectrum of conditions represented in patients with complicated UTI, including those with CA-UTI, such as simple cystitis, pyelonephritis, pyelonephritis with abscess, prostatitis, and bacteremia. There are no published trial data that provide treatment outcomes for these different types of patients with CA-UTI, and thus the optimal duration of antimicrobial treatment for CA-UTI is not known. In published reviews, recommended treatment durations for complicated UTI have included 7–10 days [18], 7–14 days [77], and 10–21 days [237], depending on the severity of the infection. Courses of 5–14 days have often been recommended for CA-UTI in patients with neurogenic bladders [98]. It is desirable to limit the duration of treatment, especially for milder infections and infections that respond promptly to treatment, to reduce the selection pressure for drug-resistant flora, especially in patients with long-term catheterization. Harding et al [292] demonstrated in a randomized, controlled trial that women with lower urinary tract CA-UTI after catheter removal had similar resolution rates with single-dose therapy and 10 days of therapy with trimethoprim-sulfamethoxazole (11 [79%] of 14 patients vs 13 [81%] of 16 patients), with better outcomes among women <65 years of age. In an open trial involving women with upper urinary tract CA-UTI, 10 days of treatment led to resolution in 6 (67%) of 9 patients [292].

In a study involving 46 men and women with neurogenic bladders managed by intermittent catheterization, a 10-day course of an antimicrobial to which the infecting strain was susceptible (most patients received trimethoprim-sulfamethoxazole) was no more effective than a 3-day course in treating episodes (29 in each group) of CA-bacteriuria, approximately one-half of which were CA-UTI (41% in the 3-day group vs 55% in the 10-day group) [235]. Rates of cure, persistence, and relapse were similar in the 2 treatment groups. A more recent randomized, double-blind, placebo-controlled trial was performed that compared 3-day and 14-day regimens of ciprofloxacin (250 mg twice daily) for the treatment of mild CA-UTI in a group of 60 patients with spinal cord injury, most of whom used intermittent catheterization [294]. Microbiological cure, but not clinical cure, at long-term follow-up was significantly better among patients who received therapy for 14 days than it was among patients who received therapy for 3 days. Microbiological and symptomatic relapse were significantly more common in the 3-day treatment group. The authors concluded that, for patients with spinal cord injury, treatment of CA-UTI for 14 days leads to improved clinical and microbiological outcomes, compared with short-course therapy. Because there was no difference in clinical outcome between the 2 treatment groups at long-term follow-up, it seems likely that the optimal treatment duration in such patients is between 3 and 14 days.

In another recent multicenter, double-blind, randomized, noninferiority study involving 619 patients with acute pyelonephritis or complicated UTI (only 68 [11%] of whom were catheterized), levofloxacin (750 mg intravenously or orally once daily for 5 days) was compared with ciprofloxacin (400 mg intravenously and/or ciprofloxacin 500 mg orally twice daily for 10 days) [295]. A detailed description of the types of complicated UTI in the treatment groups was not provided. Clinical success rates after treatment were similar (81% vs 80%), as were microbiologic eradication rates (80% vs 80%). Microbiologic eradication was lower among subjects with a catheter than it was among those without a catheter, but among catheterized patients, the microbiologic eradication rate was higher in the levofloxacin group (79%) than it was in the ciprofloxacin group (53%; 95% CI, 3.6%–47.7%). Clinical outcomes for catheterized subjects were not reported.

Use of the urinary catheter should always be discontinued as soon as appropriate. A 7–14-day regimen is recommended for most patients with CA-UTI, regardless whether the patient remains catheterized or not. A 5-day regimen with levofloxacin is likely to be sufficient for most patients with mild CA-UTI. A shorter course, such as a 3-day regimen commonly used in uncomplicated UTI [296], is reasonable for younger women with mild CA-UTI after the catheter has been removed. Moxifloxacin should be avoided for the treatment of UTI because of uncertainty regarding effective concentrations in urine. Data on local antimicrobial resistance, when available, should be used to help guide empirical treatment. Shorter durations of treatment are preferred in appropriate patients to limit development of resistance. Regimens should be adjusted as appropriate depending on the culture and susceptibility results and the clinical course. Treatment may need to be extended and a urologic evaluation may need to be performed if the patient does not have a prompt clinical response with defervescence by 72 h.

FUTURE DIRECTIONS AND GAPS IN KNOWLEDGE IN DIAGNOSIS, PREVENTION, AND MANAGEMENT OF CA-UTI

There are many gaps in our knowledge about CA-ASB and CA-UTI. This is attributable in part to the poor quality of many clinical studies, which are often poorly designed and underpowered. Methodology in these studies is often not adequately described, the terminology is not standardized, and outcomes are usually limited to CA-bacteriuria (which is largely comprised of CA-ASB). A better understanding of the relationship between CA-ASB and CA-UTI is needed, particularly whether a reduction in CA-ASB results in a reduction in CA-UTI, inappropriate antimicrobial use, or cross-infection. How bacteria ascend into the bladder in catheterized patients and why meatal cleansing strategies have not been successful in reducing CA-bacteriuria, given the apparent importance of meatal coloni-

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zation in the pathogenesis of CA-UTI, are important questions. There is a need for better tools to distinguish CA-ASB from CA-UTI, including colony count criteria, because the classic symptoms and signs that denote symptomatic infection are seldom useful for catheterized patients. Nonspecificity of symptoms and signs leads to frequent inappropriate treatment of CA-bacteriuria. Further analysis of the cost-benefit of interventions, such as use of antimicrobial-coated catheters, is warranted. Funguria is more common among nosocomial UTIs than is widely recognized, and more research is warranted into its diagnosis, need for treatment, and prevention.

Continued development of intraurethral alternatives to indwelling catheterization in men and women and external urine collection alternatives to indwelling catheterization in women, as well as evaluations of whether these devices reduce the risk of CA-UTI, are needed. Use of bacterial interference by inoculation of organisms of low virulence into the bladder to reduce the risk of CA-UTI in patients with long-term catheterization is promising, but the clinical data are sparse [297]. Major advances in the prevention of CA-ASB and CA-UTI will require development of biomaterials that prevent or limit biofilm formation. Unfortunately, despite significant advances in basic science research involving biocompatibility issues and biofilm formation, infection and encrustation remain associated with the use of biomaterials in the urinary tract and, therefore, limit their long-term indwelling time [298], but research is promising in this area [96, 97, 299].

PERFORMANCE MEASURES

Performance measures are indicators to help guideline users gauge potential effects and benefits of implementation of the guidelines. Such tools can be indicators of the actual process, short-term and long-term outcomes, or both. Reduction of indwelling urinary catheterization is the most effective way to reduce the morbidity and mortality associated with CA-bacteriuria.

1. Institutions should develop a list of appropriate indications for inserting indwelling urinary catheters, educate staff about such indications, and periodically assess adherence to the institution-specific guidelines. A reasonable target is that at least 90% of indwelling urinary catheters placed in the institution be for appropriate indications.
2. Institutions should require a physician's order in the chart before an indwelling catheter is placed and periodically assess adherence to this requirement. A reasonable target is that at least 95% of indwelling urinary catheters placed in the institution be preceded by a physician's order.
3. Institutions should consider nurse-based or electronic physician reminder systems and/or automatic stop-orders to reduce inappropriate urinary catheterization. A reasonable target is that at least 90% of indwelling urinary catheter–days be for appropriate indications.

Acknowledgments

The Guideline Panel wishes to express its gratitude to Drs Alan Ronald, Jack Warren, and Barbara Trautner, for their thoughtful reviews of earlier drafts of the manuscript.

Financial support. Support for these guidelines was provided by the Infectious Diseases Society of America.

Potential conflicts of interest. T.M.H. has served as a consultant to Alita Pharmaceuticals. D.D.C. has served as a consultant to Coloplast A/S, has received research funding from Coloplast A/C and AstraTech and has received honoraria from Alita Pharmaceuticals. A.J.S. has served as a consultant to Pfizer, Novabay Pharmaceuticals, Exoxemis, Alita Pharmaceuticals, American Medical Systems, Monitor Company Group, Propagate Pharma, Hagen/Sinclair Research Recruiting, and Advanstar Communications; has received honoraria from Haymarket Media, CombinatoRx, The Scientific Consulting Group, and the Multidisciplinary Alliance Against Device–Related Infections; and has received other remuneration from the American Society of Microbiology and the American Urological Association. S.E.G. has served as a consultant to and received honoraria from Merck, GlaxoSmithKline, Bristol-Myers Squibb, and AstraZeneca. S.S. has received honoraria from VHA. P.A.T. has received research support from Baxter, Merck, Pfizer, Merlion Pharma, and Interimmune. R.C. has served as consultant to Johnson & Johnson. L.E.N. has served as a consultant to Pfizer, Johnson & Johnson, and Leo Pharmaceuticals. All other authors: no conflicts.

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