Clinical Infectious Diseases

IDSA FEATURES

Clinical Practice Guideline for the Management of Asymptomatic Bacteriuria: 2019 Update by the Infectious Diseases Society of America[a]

Lindsay E. Nicolle,[1] Kalpana Gupta,[2] Suzanne F. Bradley,[3] Richard Colgan,[4] Gregory P. DeMuri,[5] Dimitri Drekonja,[6] Linda O. Eckert,[7] Suzanne E. Geerlings,[8] Béla Köves,[9] Thomas M. Hooton,[10] Manisha Juthani-Mehta,[11] Shandra L. Knight,[12] Sanjay Saint,[13] Anthony J. Schaeffer,[14] Barbara Trautner,[15] Bjorn Wullt,[16] and Reed Siemieniuk[17]

[1]Department of Internal Medicine, School of Medicine, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Canada; [2]Division of Infectious Diseases, Veterans Affairs Boston Healthcare System and Boston University School of Medicine, West Roxbury, Massachusetts; [3]Division of Infectious Diseases, University of Michigan, Ann Arbor; [4]Department of Family and Community Medicine, University of Maryland, Baltimore; [5]Division of Pediatric Infectious Diseases, Department of Pediatrics, University of Wisconsin School of Medicine and Public Health, Madison; [6]Division of Infectious Diseases, University of Minnesota, Minneapolis; [7]Department of Obstetrics and Gynecology and Department of Global Health, University of Washington, Seattle; [8]Department of Internal Medicine, Amsterdam University Medical Center, The Netherlands; [9]Department of Urology, South Pest Teaching Hospital, Budapest, Hungary; [10]Division of Infectious Diseases, University of Miami, Florida; [11]Division of Infectious Diseases, Yale School of Medicine, New Haven, Connecticut; [12]Library and Knowledge Services, National Jewish Health, Denver, Colorado; [13]Department of Internal Medicine, Veterans Affairs Ann Arbor and University of Michigan, Ann Arbor; [14]Department of Urology, Northwestern University, Chicago, Illinois; [15]Section of Health Services Research, Department of Medicine, Baylor College of Medicine, Houston, Texas; [16]Division of Microbiology, Immunology and Glycobiology, Lund, Sweden; and [17]Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario, Canada

Asymptomatic bacteriuria (ASB) is a common finding in many populations, including healthy women and persons with underlying urologic abnormalities. The 2005 guideline from the Infectious Diseases Society of America recommended that ASB should be screened for and treated only in pregnant women or in an individual prior to undergoing invasive urologic procedures. Treatment was not recommended for healthy women; older women or men; or persons with diabetes, indwelling catheters, or spinal cord injury. The guideline did not address children and some adult populations, including patients with neutropenia, solid organ transplants, and nonurologic surgery. In the years since the publication of the guideline, further information relevant to ASB has become available. In addition, antimicrobial treatment of ASB has been recognized as an important contributor to inappropriate antimicrobial use, which promotes emergence of antimicrobial resistance. The current guideline updates the recommendations of the 2005 guideline, includes new recommendations for populations not previously addressed, and, where relevant, addresses the interpretation of nonlocalizing clinical symptoms in populations with a high prevalence of ASB.

Keywords. asymptomatic bacteriuria; bacteriuria; urinary tract infection; pyelonephritis; cystitis; diabetes; pregnancy; renal transplant; endourologic surgery; urologic devices; urinary catheter; older adults; nursing home; long-term care; spinal cord injury; neurogenic bladder.

EXECUTIVE SUMMARY

Asymptomatic bacteriuria (ASB) is the presence of 1 or more species of bacteria growing in the urine at specified quantitative counts ($\geq 10^5$ colony-forming units [CFU]/mL or $\geq 10^8$ CFU/L), irrespective of the presence of pyuria, in the absence of signs or symptoms attributable to urinary tract infection (UTI). ASB is a common finding in some healthy female populations and in many women or men with abnormalities of the genitourinary tract that impair voiding. In 2005, the Infectious Diseases Society of America (IDSA) published a guideline with recommendations for the management of ASB in adults. The current guideline reviews and updates the 2005 guideline, incorporating new evidence that has become available. The recommendations also consider populations not addressed in the 2005 guidelines, such as children and patients with solid organ transplants or neutropenia. Since the previous guideline was published, antimicrobial stewardship programs have identified nontreatment of ASB as an important opportunity for decreasing inappropriate antimicrobial use. Nonlocalizing signs and symptoms are common in

Received 29 November 2018; editorial decision 20 December 2018; accepted 27 December 2018; published online March 21, 2019.

Correspondence: L. E. Nicolle, Department of Internal Medicine, GG-443 Health Sciences Centre 820 Sherbrook St, School of Medicine, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, MB, R3A 1R9, Canada (Lindsay.Nicolle@umanitoba.ca).

Clinical Infectious Diseases® 2019;68(10):e83–75

DOI: 10.1093/cid/ciy1121

individuals in some populations with a high prevalence of ASB and may lead to clinical uncertainty in the diagnosis of symptomatic infection. This may compromise the implementation of nontreatment recommendations. Thus, this updated guideline also addresses the clinical presentation of symptomatic UTI in populations where there is a high prevalence of ASB, such as patients with spinal cord injury or older adults (≥65 years). Candiduria is not addressed, as recommendations for management of this syndrome were included in the recent update of the IDSA Clinical Practice Guidelines for the Management of Candidiasis. The panel followed a process used in the development of other IDSA guidelines, which included a systematic weighting of the strength of recommendation and quality of evidence using Grading of Recommendations Assessment, Development and Evaluation (GRADE) (Figure 1) [1–5].

Summarized below are the 2019 revised recommendations for the management of ASB in adults and children. The guidelines are not intended to replace clinical judgment in the management of individual patients. A detailed description of the methods, background, and evidence summaries that support each recommendation can be found in the full text of the guideline.

RECOMMENDATIONS FOR ASYMPTOMATIC BACTERIURIA

I. Should Asymptomatic Bacteriuria Be Screened for and Treated in Pediatric Patients?

Recommendation

1. In infants and children, we recommend against screening for or treating asymptomatic bacteriuria (ASB) (*strong recommendation, low-quality evidence*).

II. Should ASB Be Screened for or Treated in Healthy Nonpregnant Women?

Recommendation

1. In healthy premenopausal, nonpregnant women or healthy postmenopausal women, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*).

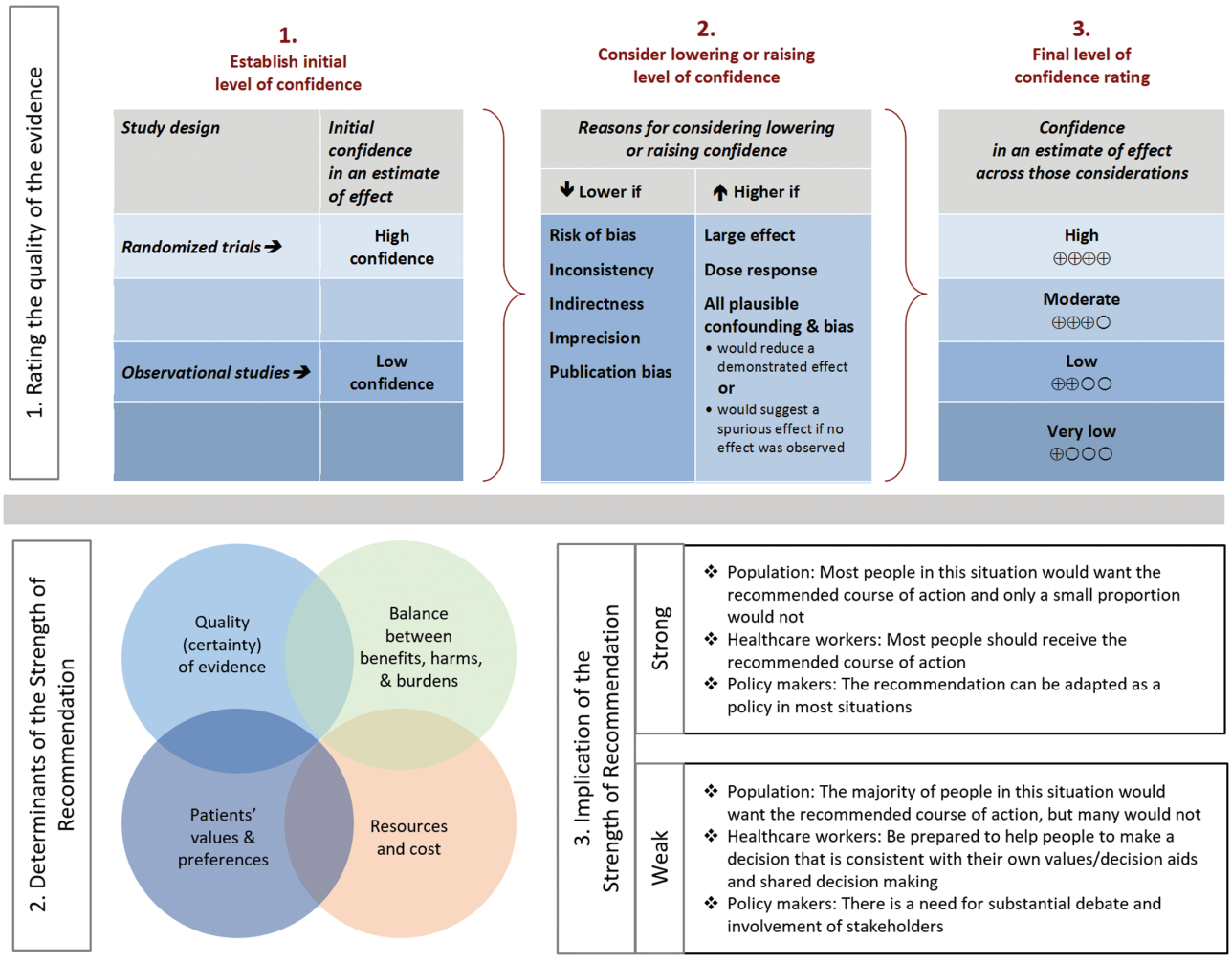

Figure 1. Approach and implications to rating the quality of evidence and strength of recommendations using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (unrestricted use of the figure granted by the US GRADE Network).

III. Should ASB Be Screened for and Treated in Pregnant Women?

Recommendations

1. In pregnant women, we recommend screening for and treating ASB (*strong recommendation, moderate-quality evidence*). **Remarks:** A recent study in the Netherlands suggested that nontreatment of ASB may be an acceptable option for selected low-risk women. However, the committee felt that further evaluation in other populations was necessary to confirm the generalizability of this observation. We suggest a urine culture collected at 1 of the initial visits early in pregnancy. There is insufficient evidence to inform a recommendation for or against repeat screening during the pregnancy for a woman with an initial negative screening culture or following treatment of an initial episode of ASB.
2. In pregnant women with ASB, we suggest 4–7 days of antimicrobial treatment rather than a shorter duration (*weak recommendation, low-quality evidence*). **Remarks:** The optimal duration of therapy will vary depending on the antimicrobial given; the shortest effective course should be used.

IV. Should ASB Be Screened for and Treated in Functionally Impaired Older Women or Men Residing in the Community, or in Older Residents of Long-term Care Facilities?

Recommendations

1. In older, community-dwelling persons who are functionally impaired, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).
2. In older persons resident in long-term care facilities, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*).

V. In an Older, Functionally or Cognitively Impaired Patient, Which Nonlocalizing Symptoms Distinguish ASB From Symptomatic UTI?

Recommendations

1. In older patients with functional and/or cognitive impairment with bacteriuria and delirium (acute mental status change, confusion) and without local genitourinary symptoms or other systemic signs of infection (eg, fever or hemodynamic instability), we recommend assessment for other causes and careful observation rather than antimicrobial treatment (*strong recommendation, very low-quality evidence*).
2. In older patients with functional and/or cognitive impairment with bacteriuria and without local genitourinary symptoms or other systemic signs of infection (fever, hemodynamic instability) who experience a fall, we recommend assessment for other causes and careful observation rather than antimicrobial treatment of bacteriuria (*strong recommendation, very low-quality evidence*). **Values and preferences:** This recommendation places a high value on avoiding adverse outcomes of antimicrobial therapy such as *Clostridioides difficile* infection, increased antimicrobial resistance, or adverse drug effects, in the absence of evidence that such treatment is beneficial for this vulnerable population. **Remarks:** For the bacteriuric patient with fever and other systemic signs potentially consistent with a severe infection (sepsis) and without a localizing source, broad-spectrum antimicrobial therapy directed against urinary and nonurinary sources should be initiated.

VI. Should Diabetic Patients Be Screened or Treated for ASB?

Recommendation

1. In patients with diabetes, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*). **Remarks:** The recommendation for nontreatment of men is inferred from observations in studies that have primarily enrolled women.

VII. Should Patients Who Have Received a Kidney Transplant Be Screened or Treated for ASB?

Recommendation

1. In renal transplant recipients who have had renal transplant surgery >1 month prior, we recommend against screening for or treating ASB (*strong recommendation, high-quality evidence*). **Remarks:** There is insufficient evidence to inform a recommendation for or against screening or treatment of ASB within the first month following renal transplantation.

VIII. Should Patients Who Have Received a Solid Organ Transplant Other Than a Renal Transplant Be Screened or Treated for ASB?

Recommendation

1. In patients with nonrenal solid organ transplant (SOT), we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*). **Values and preferences:** This recommendation places a high value on avoidance of antimicrobial use so as to limit the acquisition of antimicrobial-resistant organisms or *Clostridioides difficile* infection in SOT patients, who are at increased risk for these adverse outcomes. **Remarks:** In nonrenal SOT recipients, symptomatic UTI is uncommon and adverse consequences of symptomatic UTI are extremely rare; the risk of complications from ASB is, therefore, probably negligible.

IX. Should Patients With Neutropenia Be Screened or Treated for ASB?

Recommendation

1. In patients with high-risk neutropenia (absolute neutrophil count <100 cells/mm^3, ≥7 days' duration following chemotherapy), we make no recommendation for or against screening for or treatment of ASB (knowledge gap). **Remarks:** For patients with high-risk neutropenia managed with current standards of care, including prophylactic antimicrobial therapy and prompt initiation of antimicrobial therapy when febrile illness occurs, it is unclear how frequently ASB occurs and how often it progresses to symptomatic UTI. Patients with low-risk neutropenia (>100 cells/mm^3, ≤7 days, clinically stable) have only a very small risk of infection and there

is no evidence to suggest that, in this population, ASB has greater risk than for nonneutropenic populations.

X. Should ASB Be Screened for or Treated in Individuals With Impaired Voiding Following Spinal Cord Injury?

Recommendation

1. In patients with spinal cord injury (SCI), we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*). **Remarks:** Clinical signs and symptoms of UTI experienced by patients with SCI may differ from the classic genitourinary symptoms experienced by patients with normal sensation. The atypical presentation of UTI in these patients should be considered in making decisions with respect to treatment or nontreatment of bacteriuria.

XI. Should Patients With an Indwelling Urethral Catheter Be Screened or Treated for ASB?

Recommendations

1. In patients with a short-term indwelling urethral catheter (<30 days), we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*). **Remarks:** Considerations are likely to be similar for patients with indwelling suprapubic catheters, and it is reasonable to manage these patients similar to patients with indwelling urethral catheters, for both short-term and long-term suprapubic catheterization.
2. In patients with indwelling catheters, we make no recommendation for or against screening for and treating ASB at the time of catheter removal (knowledge gap). **Remarks:** Antimicrobial prophylaxis given at the time of catheter removal may confer a benefit for prevention of symptomatic UTI for some patients. The evidence to support this observation is largely from studies enrolling surgical patients who receive prophylactic antimicrobials at the time of short-term catheter removal, generally without screening to determine if ASB is present. It is unclear whether or not the benefit is greater in patients with ASB.
3. In patients with long-term indwelling catheters, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).

XII. Should Patients Undergoing Elective Nonurologic Surgery Be Screened and Treated for ASB?

Recommendation

1. In patients undergoing elective nonurologic surgery, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).

XIII. Should Patients Undergoing Endourological Procedures Be Screened or Treated for ASB?

Recommendations

1. In patients who will undergo endoscopic urologic procedures associated with mucosal trauma, we recommend screening for and treating ASB prior to surgery (*strong recommendation, moderate-quality evidence*). **Values and preferences:** This recommendation places a high value on the avoidance of the serious postoperative complication of sepsis, which is a substantial risk for patients undergoing invasive endourologic procedures in the presence of bacteriuria. **Remarks:** In individuals with bacteriuria, these are procedures in a heavily contaminated surgical field. High-quality evidence from other surgical procedures shows that perioperative antimicrobial treatment or prophylaxis for contaminated or clean-contaminated procedures confers important benefits.
2. In patients who will undergo endoscopic urologic procedures, we suggest that a urine culture be obtained prior to the procedure and targeted antimicrobial therapy prescribed rather than empiric therapy (*weak recommendation, very low-quality evidence*).
3. In patients with ASB who will undergo a urologic procedure, we suggest a short course (1 or 2 doses) rather than more prolonged antimicrobial therapy (*weak recommendation, low-quality evidence*). **Remarks:** Antimicrobial therapy should be initiated 30–60 minutes before the procedure.

XIV. Should Patients Undergoing Implantation of Urologic Devices or Living With Urologic Devices Be Screened for or Treated for ASB?

Recommendations

1. In patients planning to undergo surgery for an artificial urine sphincter or penile prosthesis implantation, we suggest not screening for or treating ASB (*weak recommendation, very low-quality evidence*). **Remarks:** All patients should receive standard perioperative antimicrobial prophylaxis prior to device implantation.
2. In patients living with implanted urologic devices, we suggest not screening for or treating ASB (*weak recommendation, very low-quality evidence*).

INTRODUCTION

ASB is common in healthy women and in adults and children with urologic abnormalities associated with impaired voiding [6–19] (Table 1). ASB was first described when early studies validating the use of the quantitative urine culture for urinary infection reported a high prevalence of positive urine cultures, with or without pyuria, in some populations of women, without accompanying genitourinary symptoms attributable to infection [20]. At that time, one of the most common causes of renal failure was attributed to "chronic pyelonephritis," a histologic finding that was presumed to be caused by infection. In addition, early studies consistently observed that a high proportion of women with persistent ASB initially identified in early pregnancy developed pyelonephritis and potential negative fetal outcomes later in the

Table 1. Prevalence of Asymptomatic Bacteriuria Reported for Different Populations

Population	Prevalence, %	Reference
Children		
Boys	<1	[7]
Girls	1–2	[8–10]
Healthy women		
Premenopausal	1.0–5.0	[11]
Pregnant	1.9–9.5	[11]
Postmenopausal (age 50–70 y)	2.8–8.6	[11]
Persons with diabetes		
Women	10.8–16	[12]
Men	0.7–11	[12]
Elderly persons in the community (age ≥70 y)		
Women	10.8–16	[13]
Men	3.6–19	[13]
Elderly persons in a long-term care facility		
Women	25–50	[13]
Men	15–50	[13]
Persons with spinal cord injury		
Intermittent catheter use	23–69	[14]
Sphincterotomy/condom catheter	57	[15]
Persons with kidney transplant		
First month posttransplant	23–24	[16, 17]
1 mo–1 y post-transplant	10–17	[16]
>1 y post-transplant	2–9	[16]
Persons with indwelling catheter use		
Short-term	3%–5%/day catheter	[18]
Long-term	100	[19]

pregnancy. Thus, ASB was interpreted as an ominous finding that warranted screening and treatment.

Subsequent observational and intervention studies evaluating long-term screening and treatment in schoolchildren, pregnant women, and healthy women suggested that ASB was benign in children and in women who were not pregnant [6]. In addition, efforts to maintain sterile urine were often futile. Prospective, randomized studies of antimicrobials or no antimicrobials for bacteriuria in children, healthy women, older populations, patients with chronic indwelling or intermittent catheters, and patients with diabetes suggested that antimicrobial treatment did not confer any benefits. At the same time, antimicrobials increased the risk of outcomes such as antimicrobial resistance and *Clostridioides difficile* infection (CDI) and, in some cases, increased the risk of urinary tract infection (UTI) shortly after therapy [21, 22]. For some populations with a high prevalence of ASB, such as patients with chronic indwelling catheters [23], older institutionalized populations [24, 25], patients with spinal cord injury (SCI) [15, 26], and some persons with diabetes [22], a sterile urine cannot be maintained, despite intense antimicrobial use. The Infectious Diseases Society of America (IDSA) guidelines published in 2005 summarized this evidence for adults, and made recommendations for treatment or nontreatment of ASB in relevant populations [6].

Additional evidence that has become available since 2005 for some of the populations addressed in the previous guideline has been reviewed for this guideline update. These updated guidelines also include populations not considered in the previous guideline, including children, solid organ transplant (SOT) recipients, patients with neutropenia, and those undergoing nonurologic surgery. Difficulty in clinical distinction between UTI and ASB in some populations with a high prevalence of bacteriuria has been increasingly recognized. Thus, this update also addresses the assessment of potential nonlocalizing symptoms for subjects in populations with a high prevalence of bacteriuria, where diagnostic uncertainty may compromise implementation of nontreatment recommendations. Asymptomatic candiduria, which was addressed in the 2005 guideline, has been recently reviewed and recommendations made in IDSA's Clinical Practice Guideline for the Management of Candidiasis: 2016 Update [27], and is not included here.

There are important considerations unique to the use of antimicrobials. Antimicrobial use drives antimicrobial resistance in the community, as well as in the individual treated. Since the publication of the 2005 guideline, antimicrobial resistance in bacteria isolated from UTI has evolved substantially, and extended-spectrum β-lactamase–producing and carbapenemase-producing Enterobacteriaceae are isolated frequently from UTI in many areas of the world [28, 29]. Antimicrobial stewardship programs have identified the treatment of ASB as an important contributor to inappropriate antimicrobial use, which promotes resistance [30–34]. A positive urine culture often encourages antimicrobial use, irrespective of symptoms [34–37]. Thus, obtaining urine cultures when not clinically indicated, including for routine screening, promotes inappropriate antimicrobial use. Given the potential negative societal consequence of antimicrobial resistance, the guideline committee felt that screening for bacteriuria and treatment of ASB should be discouraged unless there is evidence to support a benefit of treatment for a given population. This guideline is most applicable to those who similarly place a high value on addressing the problem of increasing antimicrobial resistance and other harms of antimicrobial exposure, and a lower value on very small or uncertain benefits to individuals.

Scope and Purpose

The purpose of this document is to provide evidence-based guidance on the screening and treatment of ASB in populations where ASB has been identified as common or potentially detrimental. The target audience for this guideline includes all healthcare professionals who care for patients who may have ASB. These include general internists, internal medicine subspecialists (infectious diseases, nephrology, endocrinology, and others), surgeons, urologists, pediatricians, obstetricians and gynecologists, geriatricians, physical medicine specialists, family practitioners, hospitalists, pharmacists, nurse practitioners,

and physician assistants. To determine the scope of the current guidelines, the panel considered whether there were any new data that might change the recommendations from the last IDSA guideline for ASB [6]. The panel also reviewed guidelines from other organizations relevant to the management of ASB.

Values and Preferences

Values and preferences were considered from the viewpoint of the patient and from the societal perspective. We believe that most patients would wish to receive antimicrobial therapy for ASB if the potential benefits of treatment outweigh possible harms. Where treatment of ASB is unlikely to confer a benefit, the risks of antimicrobial therapy, including adverse drug effects, CDI [38, 39], and the potential for inducing antimicrobial resistance, suggest that most individuals would not wish to receive antimicrobial treatment. From the societal perspective, avoidance of antimicrobial use where there is no benefit of therapy is preferred to minimize antimicrobial adverse effects and limit emergence of antimicrobial resistance, which may restrict future therapeutic efficacy for treatment of urinary tract or other infections. When the quality of evidence is low, and there is no suggestion of potential harm, we generally recommend against the treatment of ASB because of the high-quality evidence that antimicrobial therapy contributes to antimicrobial resistance. From a payer perspective, the cost of urine screening for ASB and of antimicrobial therapy in patients with ASB is more important than the very uncertain possibility of a small reduction in symptomatic UTI or other outcomes for populations where there is no evidence of benefit with treatment of ASB.

Definitions

The definition of ASB in patients without indwelling catheters is $\geq 10^5$ colony-forming units (CFU)/mL ($\geq 10^8$ CFU/L) in a voided urine specimen without signs or symptoms attributable to UTI [6]. For women, 2 consecutive specimens should be obtained, preferably within 2 weeks, to confirm the persistence of bacteriuria. Between 10% and 60% of women, varying with the population, do not have persistent bacteriuria on repeat screening after an initial positive specimen [22, 24, 40–45]. For men, a single urine specimen meeting these quantitative criteria is sufficient for diagnosis [46]. Patients with indwelling devices often have multiple organisms isolated from the urine, some of which are present at lower quantitative counts. Organisms present in lower quantitative counts likely represent contamination of the urine specimen from organisms present in the biofilm along the device rather than true bacteriuria and, in these patients, $\geq 10^5$ CFU/mL remains the most appropriate diagnostic criteria for bladder bacteriuria [47, 48]. Lower quantitative counts ($\geq 10^2$ to $<10^5$ CFU/mL) isolated from urine specimens collected by "in and out" catheterization or following insertion of a new indwelling catheter suggest true bacteriuria, but the clinical significance of these lower quantitative counts in people without symptoms has not been evaluated.

METHODOLOGY

Panel Composition

The IDSA Guidelines for the Management of Asymptomatic Bacteriuria in Adults were published in 2005 [6]. For this update, the IDSA Standards and Practice Guideline Committee (SPGC) convened a multidisciplinary panel of 15 individuals with expertise relevant to ASB encompassing different patient groups, including infectious diseases as well as representation from family practice, pediatrics, geriatrics, obstetrics and gynecology, and urology. The panel also included individuals with expertise in systematic literature search and guideline/health research methodology.

Disclosure and Management of Potential Conflicts of Interests

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

Clinical Questions and Evidence Review

An initial list of relevant clinical questions for these guidelines was created by the committee members addressing a specific topic, then submitted to the whole panel for review and discussion. After the committee reviewed the proposed topics, the final set of clinical questions was approved by the whole committee. All outcomes of interest were prespecified, with emphasis on outcomes important to patients and society, and a de-emphasis on surrogate outcomes. At least 2 panel members were assigned to review the recent literature for each topic, evaluate the evidence, determine the strength of recommendations, and develop written evidence in support of these recommendations.

Panel subgroups generated a list of key words used by expert librarians to develop PICO (population, intervention, comparison, outcomes) search strategies for Medline In-Process and Other Non-Indexed Citations, Medline, Embase, and Cochrane Central Register of Controlled Trials on the Ovid platform (see Supplementary Tables and Supplementary Figures A–AH for full search details). Results were returned to each primary author and the chair for the review. We restricted the search to

publications in English. For patient groups addressed in recommendations in the 2005 document, the review was limited to publications from January 2005 to June 2017. For populations and topics not addressed in the 2005 guideline, the search included literature from January 1980 to June 2017. Additional relevant articles published prior to 1980 were identified through informal searching by panel experts. Systematic reviews of relevant topics were identified using PubMed and the Cochrane Library. The literature was reviewed by the primary topic authors to develop a list of articles for which abstract review was considered relevant. The primary reviewer and a secondary reviewer evaluated the abstracts and selected and evaluated articles for full text review.

Evidence summaries for each question were prepared by the panel members using the Grading of Recommendations Assessment, Development and Education (GRADE) approach for rating the confidence and the evidence [1–3]. The summaries of evidence were discussed and reviewed by all committee members and edited as appropriate. Once the analyses were completed, the panelists presented their data and findings to the whole panel for deliberation and drafting of recommendations. Literature search strategies, evidence tables, evidence profiles, and additional analyses including meta-analysis results can be found in the Supplementary Tables and Supplementary Figures A–AH.

Development of Clinical Recommendations

All recommendations followed GRADE [1]. Recommendations are either "strong" or "weak" (weak recommendations are also sometimes called discretionary or conditional; see Figure 1) [1, 2]. Recommendations are strong when there is moderate- or high-quality evidence that the desirable consequences outweigh the undesirable consequences for a course of action. They may also be strong when there is high-quality evidence of harm and benefits are uncertain (ie, low or very low quality). Table 2 provides the suggested interpretation of strong and weak recommendations for patients, clinicians, and healthcare policy makers. For recommendations where the comparators are not formally stated, the comparison of interest is implicitly referred to "not using the intervention" (either not using a specific treatment or diagnostic test). GRADE Evidence Profiles were created using MAGICapp version 8.1 (MAGIC, Oslo, Norway).

There are many important research questions for which evidence is currently insufficient. "Research needs" are highlighted questions that the panelists believe are a priority. All members of the panel participated in the preparation of the guideline and approved the final recommendations. Final recommendations represent consensus opinion of the entire panel. For the final version of these guidelines, the panel as a group reviewed all individual sections.

This guideline has been reviewed and endorsed by the Society of Healthcare Epidemiology of America, Pediatric Infectious Diseases Society, American College of Obstetrics and Gynecology, Association of Medical Microbiology and Infectious Diseases Canada, European Society of Clinical Microbiology and Infectious Diseases, European Association of Urology, and the American Urological Association. The IDSA SPGC and the IDSA Board of Directors reviewed and approved the guideline prior to dissemination.

Future Revision Dates

At least every 2 years, the SPGC will determine the need for revisions to the guideline based on an examination of current literature and the likelihood that any new data will have an impact on the recommendations. If necessary, the entire expert panel will be reconvened to discuss potential changes. Any revision to the guideline will be submitted for review and approval to the IDSA SPGC and the Board of Directors.

RECOMMENDATIONS FOR ASYMPTOMATIC BACTERIURIA

I. Should ASB Be Screened for and Treated in Pediatric Patients?

Recommendation

1. In infants and children, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).

Evidence Summary

Evaluation of the benefits and risks of detection and treatment of ASB in children poses unique problems. Young children cannot

Table 2. Interpretation of Strong and Weak (Conditional) Recommendations

	Strong Recommendation	Weak (Conditional) Recommendation
Patients	All or almost all individuals in this situation would want the recommended course of action, and only a small proportion would not.	Most individuals in this situation would probably want the suggested course of action, but many would not.
Clinicians	All or almost all individuals should receive the intervention.	Recognize that fully informed individuals might reasonably choose different courses of action. A shared decision-making process is typically useful in helping individuals to make decisions consistent with their values and preferences.
Policy makers	The recommendation can be adopted as policy in most situations. Adherence to this recommendation according to the guideline can be used as a quality criterion or performance indicator.	Policymaking will require substantial debate and involvement of various stakeholders.

reliably provide a clean-catch urine specimen, and studies using perineal bag collection for urine specimens have found that bacteriuria rates are overstated because of the high likelihood of contamination with this collection method. Important outcomes relevant to children with ASB for whom antimicrobial therapy is being considered include not only symptomatic infection, but also the development of long-term renal scarring. Most of the evidence describing prognosis and treatment of ASB in children was performed in the 1970s and 1980s. Based on current evaluations of the quality of clinical trials, these early studies have substantial methodological limitations, including poor case definitions, small sample size, lack of randomization, no placebo group, inconsistent outcome measures, inconsistent drug choice, and lack of evaluation of risks and adverse events.

ASB is rare in children with a normal urinary tract and does not appear to be associated with important harms. One study from 1987 used suprapubic aspiration to obtain urine cultures at ages 2 weeks, 3 months, and 10 months and reported that ASB was present in 2.5% of boys and 0.9% of girls [49]. Eleven percent of children with ASB had grade 1–2 vesicoureteral reflux (VUR). Of 50 children with ASB, 2 (4% [95% confidence interval {CI}, 0.5%–13.7%]) were subsequently diagnosed with acute pyelonephritis. No cases of renal scarring were observed in any of the children with ASB (95% CI, .7%–7.1%). An observational study of neonates in New Zealand [50] reported that 14 of 1460 urines obtained by bladder puncture had bacteriuria (prevalence, 1% [95% CI, .5%–1.6%]): 5 with nonlocalizing symptoms and 9 asymptomatic. Mild or moderate VUR was detected in 8 infants with bacteriuria (prevalence, 57.1% [95% CI, 28.9%–82.3%]). ASB occurred in 1.8% of female and 0.5% of male infants (aged 3–23 months) evaluated in an office setting in the United States [7] and 0.8% of preschool girls and no boys (aged 2–5 years). Of those with ASB, VUR was present in 46% of infants and 9% of preschool children. One study reported a higher rate of ASB in black compared to white adolescent girls, (2.5% vs 0.8%, respectively), but similar ASB prevalence in younger (5–14 years) white or black girls (0.5%) [51]. ASB was present in 1.8% of 16 800 British schoolgirls aged 5–12 years who were screened for bacteriuria and followed for up to 13 years [9]. In adolescent girls in Boston, 1.6% of females had ASB [10].

A long-term study of the epidemiology and natural history of ASB conducted in Virginia in the 1960s enrolled 8872 school-aged girls followed for a 7-year period [52]. The rate of ASB was 2.9%, and 3% had symptomatic UTI, but the rate of UTI was not compared to girls without ASB. A subset of 60 girls with persistent bacteriuria was followed up in the 1970s and compared to 38 matched controls [53]. Renal scarring or caliectasis were present in 16 cases and none of the controls (risk difference [RD], 32.0% [95% CI, 18.7%–45.3%]). Hospitalization rates for UTI and pyelonephritis were significantly higher in children with ASB (15%) than controls (2.6%; RD, 13.4% [95% CI, 2.0%–24.7%]). The mean serum creatinine was significantly higher in cases than in controls (0.88 vs 0.76 mg/dL) but did not exceed the normal range in any of the participants. There were no differences in mean blood pressure between groups. In a noncomparative study of a cohort of girls with ASB and radiographic evidence of renal scarring, initially aged 4–14 years and followed until 16 years of age, acute pyelonephritis was not observed in girls with persistent bacteriuria or those who spontaneously cleared bacteriuria [54]. The duration of bacteriuria did not influence renal growth or the glomerular filtration rate. It is not clear why the rates of renal sequelae were substantially higher in this study compared with other reports. The long-term consequences of ASB were also reported for a cohort of 116 Swedish schoolgirls followed for 3 years, of whom 12 (10%) had renal scarring, 13 (11%) VUR without scarring, and 91 (78%) no reflux or scarring [55, 56]. Recurrence or persistence of ASB was common; 47% of the girls remained bacteriuric after 3 years. Renal growth and concentrating capacity in these subjects remained normal.

An uncontrolled trial of antimicrobial therapy (sulfonamide, tetracycline, ampicillin, or nitrofurantoin) in school-aged girls with persistent ASB, defined as ≥3 consecutive positive urine cultures, reported a reduction in the rate of recurrent bacteriuria of 25% in white and 40% in black girls; 10% of girls in this study developed clinical episodes of acute pyelonephritis [57]. This study did not address long-term outcomes such as renal scarring. In a trial of short-term antimicrobial therapy in the Swedish cohort, 30 patients received nitrofurantoin and 31 no treatment [56]. There was 1 case of pyelonephritis and 1 case of cystitis in each group (RD for both, 0.1% [95% CI, −8.8% to 9.1%]). In American schoolgirls (5–7 years old) monitored over a 2-year period with an overall rate of ASB of 1.6% [8], a randomized controlled trial (RCT) of short-term antimicrobials (nitrofurantoin, ampicillin, or trimethoprim-sulfamethoxazole [TMP-SMX]) in 63 subjects reported a lower ASB recurrence rate in the first 6 months in the treatment group, but no differences in ASB between groups at 4 years and no differences in renal scarring in treated subjects compared to untreated controls [58]. In the British schoolgirl cohort [9], a nonrandomized, open-label, controlled trial of antimicrobial treatment (TMP-SMX, nitrofurantoin, nalidixic acid, or pivmecillinam) for 7–14 days in 110 of these girls with ASB reported no differences in subsequent symptoms of UTI, resolution of VUR, kidney growth, or renal scarring in treated or untreated girls.

A retrospective observational study described 66 Swedish school-aged girls being followed with long-term *Escherichia coli* ASB who received either penicillin V or erythromycin (both of unspecified dosage or duration), for treatment of streptococcal pharyngitis [21]. In the penicillin group, bacteriuria was eradicated in 5 girls, but 6 girls developed acute pyelonephritis and 1 developed cystitis within 5 months following the penicillin

therapy (7 of 46 [15%]), all with new *E. coli* strains isolated. Bacteriuria persisted in all girls treated with erythromycin, which is not excreted in the urine, and none developed symptomatic infection following antimicrobial therapy. The authors suggested that antimicrobial treatment which resolved ASB in girls with stable, long-term bacteriuria was a risk for short-term development of acute pyelonephritis.

Kemper and Avner [59] performed an analysis of the performance and costs of screening of 100 000 hypothetical preschool children. Screening of children using standard culture techniques would result in nearly 20 000 false-positive tests and 143 false negatives. Total costs for a screening program were estimated at nearly $2 million dollars in 1992.

Rationale

We make a strong recommendation because there is moderate-quality evidence that there is no benefit and high-quality evidence of harm. ASB is uncommon in infants and boys and occurs in about 1%–3% of healthy girls. While there may be an increased risk of symptomatic UTI in bacteriuric children, there is no evidence of a higher risk for subsequent renal scarring or renal insufficiency. In addition, there is no evidence that treatment of ASB prevents symptomatic UTI, including pyelonephritis (low quality), renal scarring, or renal insufficiency (low quality). There is high-quality evidence to suggest that antibiotics cause harm, including adverse effects, increasing costs, and contributing to antimicrobial resistance. Most studies addressing ASB in children were performed >40 years ago, but there are no indications that the incidence or outcomes of ASB would differ today.

Research Needs

Future studies of antimicrobial therapy should include renal scarring as a primary outcome. Studies enrolling children with neuromuscular disorders and immunocompromised states should be a priority.

II. Should ASB Be Screened for or Treated in Healthy Nonpregnant Women?

Recommendation

1. In healthy premenopausal, nonpregnant women or healthy postmenopausal women, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*).

Evidence Summary

The prevalence of ASB in healthy, premenopausal women ranges from 1% to 5%, and in healthy postmenopausal women in the community from 2.8% to 8.6% [6]. While symptomatic UTI occurs significantly more frequently in women with bacteriuria than in nonbacteriuric women, observational studies report no differences in the rates of hypertension, chronic kidney disease, serum creatinine levels, abnormal intravenous pyelogram findings, or mortality in women with or without bacteriuria [6]. There were no differences in the frequency of subsequent UTI during 1 year of follow-up after treatment of bacteriuric women with a 1-week course of therapy with nitrofurantoin or placebo [60]. Thus, the 2005 IDSA ASB Guideline Committee concluded that healthy, premenopausal women with ASB have an increased risk for UTI, but no long-term adverse outcomes [6]. In addition, the Committee concluded that the treatment of ASB neither decreases the frequency of symptomatic infection nor prevents further episodes of ASB.

Other advisory bodies have reached similar conclusions. The US Preventive Services Task Force reaffirmed its 2004 recommendations in 2008 with the recommendation that evidence does not support the screening of nonpregnant women or men for ASB, as improved clinical outcomes cannot be demonstrated [61]. A recent systematic review of antimicrobial treatment of ASB in noncatheterized adults also concluded that antimicrobial treatment of ASB may improve short-term microbiologic outcomes, but the microbiologic resolution is not sustained and there is no measurable improvement in morbidity or mortality [62].

This review identified no additional studies published since 2005 that would alter the previous recommendation. A recent study performed in the Netherlands enrolled women to receive either prophylactic TMP-SMX or *Lactobacillus* species probiotic. During 15 months of follow-up, no difference in the time to a subsequent symptomatic UTI between women with and without ASB at baseline was observed. The authors concluded that ASB was not a predictor for the development of a symptomatic UTI [63].

There is some evidence suggesting that persistent ASB may protect from symptomatic UTI [20]. An early randomized trial of therapy for women with ASB reported that most symptomatic reinfections occurred in the antimicrobial treatment group, suggesting that treatment of bacteriuria may be associated with an increased risk of symptomatic UTI [60]. A recent nonblinded, randomized clinical trial reported outcomes following antimicrobial treatment or no treatment for 673 young women presenting to a sexually transmitted disease clinic. All participants had at least 1 episode of symptomatic UTI in the past year and ASB on 2 consecutive urine specimens when evaluated in the clinic [64]. Antimicrobial therapy for treatment of ASB was an independent risk factor (hazard ratio, 3.09 [95% CI, 2.19–4.20]) for developing symptomatic UTI in the year following treatment. There was 1 episode of pyelonephritis in the untreated group and 2 in the treated group. The authors concluded that ASB in women with a history of recurrent UTI may be protective in preventing symptomatic recurrence. However, a high proportion (33%) of these women had ASB with *Enterococcus* species isolated, which would generally be considered a contaminant, and symptomatic episodes were not confirmed microbiologically.

Rationale

Although women with ASB may also be at increased risk of symptomatic UTI, ASB, even when persistent, appears not to be associated with other adverse outcomes, and there is no evidence to suggest that episodes of symptomatic UTI are attributable to the ASB. Moreover, treatment of ASB may not decrease the frequency of symptomatic UTI, including pyelonephritis (moderate quality). Antibiotics may increase rather than decrease the risk of subsequent UTI (moderate quality). There is high-quality evidence that antibiotics have an increased risk of adverse effects, that screening and treating ASB is extremely costly, and that the use of antibiotics promotes emergence of antimicrobial resistance.

III. Should ASB Be Screened for and Treated in Pregnant Women?

Recommendations

1. In pregnant women, we recommend screening for and treating ASB (*strong recommendation, moderate-quality evidence*). **Remarks:** A recent study in the Netherlands suggested that nontreatment of ASB may be an acceptable option for selected low-risk women. However, the committee felt that further evaluation in other populations was necessary to confirm the generalizability of this observation. We suggest a urine culture collected at one of the initial visits early in pregnancy. There is insufficient evidence to inform a recommendation for or against repeat screening during the pregnancy for a woman with an initial negative screening culture or following treatment of an initial episode of ASB.
2. In pregnant women with ASB, we suggest 4–7 days of antimicrobial treatment rather than a shorter duration (*weak recommendation, low-quality evidence*). **Remarks:** The optimal duration of therapy will vary depending on the antimicrobial given; the shortest effective course should be used.

Evidence Summary

Screening for and Treatment of Bacteriuria

ASB occurs in 2%–7% of pregnant women [6, 65]. The 2005 IDSA guideline recommended screening and treatment of ASB to decrease pyelonephritis in pregnant women, based on prospective randomized studies from the 1960s to 1980s, which uniformly reported that antimicrobial treatment decreased the incidence of pyelonephritis from 20%–35% to 1%–4% [6]. Some studies also reported decreased low birth weight (<2500 g) and premature labor. Guidelines from other organizations including the American College of Obstetrics and Gynecology [66] and the US Preventive Services Task Force [67] support this recommendation.

A 2015 Cochrane review included 14 RCTs, for the most part published in the 1960s and 1970s [68]. Based on 11 RCTs (1932 women), antimicrobials probably reduce the risk of pyelonephritis in pregnant women with ASB (moderate quality). While the Cochrane review rated the quality of evidence very low, we thought that the consistency of the observation of benefit and the large treatment effect warranted a higher rating (see Supplementary Table F). Based on 2 RCTs, antimicrobials may reduce the risk of preterm birth (low quality). The baseline risk of preterm birth in women with untreated ASB is about 53 per 1000 [69]; antibiotics may reduce the risk to approximately 14 per 1000 (RD, –39 [95% CI, –47 to –20]; low quality). Antibiotics probably lower the chance of very low birth weight from approximately 137 per 1000 to 88 per 1000 (RD, –49 [95% CI, –75 to –10]; moderate quality).

In the Netherlands, screening for ASB in pregnancy has not been instituted as a routine practice for prenatal care. A 2015 prospective study undertaken in that country, which included an underpowered nested RCT of treatment of ASB, reported that pregnant women with untreated ASB had higher rates of pyelonephritis than did women without ASB or with ASB that was treated [69]. The frequency of pyelonephritis in women with untreated ASB was, however, substantially lower (2.4%) than reported in earlier studies. Low birth rate and preterm birth rates did not differ significantly between the 2 groups. The generalizability of these observations is limited as ASB was identified with only a single urine culture and the study enrolled women at low risk of preterm birth or complicated UTI, who would be expected to have lower rates of pyelonephritis, preterm labor, and low birth weight. While the authors suggest that routine screening for and treatment of ASB in this population may not be warranted, further evidence from other populations is necessary to evaluate the risks and benefits for all pregnant women and in settings with variable access to healthcare.

The 2005 guideline recommended "periodic" repeat screening for pregnant women following treatment of ASB, with retreatment and prophylactic antimicrobial therapy if there was recurrence. We did not find any direct evidence that addresses whether there is a benefit of repeated screening following treatment of ASB, or of retreatment of women with recurrent ASB. In addition, there was insufficient evidence evaluating the benefits or risks of prophylactic antimicrobial therapy in preventing ASB recurrence for the duration of the pregnancy.

Rationale

In pregnant women with ASB, antimicrobials probably reduce the risk of pyelonephritis and may reduce the risk of low birth weight. Antimicrobials may also reduce the risk of preterm labor. The randomized trials are generally old and limited by lack of allocation concealment and blinding, but all showed a consistently large effect on important outcomes. Serious adverse effects from antimicrobials almost certainly occur much less frequently than the expected reduction in pyelonephritis and preterm birth.

Research Needs

Prenatal management has changed substantially since the studies that identified a benefit of treatment of ASB were published. The Netherlands study suggests that screening and treatment of ASB may not be beneficial for all pregnant women. Rigorous clinical trials to evaluate different approaches to screening and treatment of ASB in populations of pregnant women managed with current standards of practice, which describe both pyelonephritis and neonatal outcomes, would be helpful. The benefits of repeated screening for women following treatment of ASB also need to be evaluated, and the cost-effectiveness of these programs described.

Duration of Treatment of ASB in Pregnant Women

A Cochrane review from 2015 [70] included 13 studies enrolling 1622 women that compared single-dose to short-course (4–7 days) antimicrobials. There was a trend toward lower rates of clearance of bacteriuria with the single-dose regimens (1.28 [95% CI, .87–1.88]; low quality). In 1 moderate-quality study included in this review [71], 714 women enrolled from Thailand, the Philippines, Vietnam, and Argentina received 7 days or single-dose therapy with nitrofurantoin. Seven days of therapy was more effective than a single dose in preventing the adverse outcome of lower birth weight (relative risk [RR], 1.65 [95% CI, 1.06–2.57]), but no differences in pyelonephritis or preterm delivery were observed between the 2 study arms. The review concludes that current recommendations for a 4- to 7-day duration of antimicrobial therapy are reasonable but based on low-quality evidence.

The optimal duration of therapy, however, will be antimicrobial-specific. Nitrofurantoin and β-lactam antimicrobials (usually ampicillin or cephalexin) are preferred because of their safety in pregnant women, but these agents are less effective as short-course therapy for treatment of acute cystitis in women [72]. The Cochrane review findings are consistent with this observation. A single dose of fosfomycin is effective for clearance of bacteria in the urine, but there is limited clinical evaluation of use in pregnancy, and outcomes such as pyelonephritis and preterm labor are not yet well studied for this regimen [72–76].

Research Needs

Studies evaluating the optimal duration of treatment for different antimicrobial regimens for ASB in pregnancy, including fosfomycin and the impacts of the different regimens on neonatal outcomes, are needed.

IV. Should ASB Be Screened for and Treated in Functionally Impaired Older Women or Men Residing in the Community, or in Older Residents of Long-term Care Facilities?

Recommendations

1. In older, community-dwelling persons who are functionally impaired, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).
2. In older persons resident in long-term care facilities, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*).

Evidence Summary

The 2005 guideline recommended that older persons residing in the community or long-term care facilities should not be screened or treated for ASB, based on evidence from long-term cohort studies with follow-up of years to decades, and randomized comparative trials in women and men [24, 25, 77–79]. No additional studies published since 2005 were identified which addressed the question of treatment of ASB in older functionally impaired residents in the community. Thus, the recommendation for nontreatment remains the same.

Prospective cohort studies in long-term care residents published since 2005 have evaluated adherence to minimum clinical criteria [80] for initiation of antimicrobial therapy for UTI in bacteriuric patients. Treatment of presumed UTI, despite absence of these minimum signs and symptoms, is common [81, 82]. Only 16% of bacteriuric residents with advanced dementia met minimum criteria for a diagnosis of symptomatic UTI in 1 report, but 75% of these received treatment [83]. Antimicrobial therapy, regardless of route of administration, conferred no survival benefit, even when adjusted for functional status, highest recorded temperature, or mental status change (adjusted hazard ratio for death, 1.09 [95% CI, .43–2.75] for oral therapy vs no therapy) [83]. No additional benefit, and some adverse outcomes, has been reported because of treatment [84–86]. In another study, an increased frequency of bacteriuric episodes was significantly associated with an increased frequency of receiving an antimicrobial and of subsequent isolation of multidrug-resistant gram-negative bacilli in urine, but not changes in mental status or admission to hospital for UTI [87]. A retrospective study of bacteriuric patients who received treatment for UTI but did not meet minimum diagnostic criteria reported that the risk of CDI within 3 months of therapy was >8.5-fold higher for patients who received antimicrobial treatment than those who did not [88].

Several investigators have evaluated potential biomarkers to assist in differentiating ASB from symptomatic UTI in older residents of nursing homes, given the clinical uncertainty in identifying symptomatic infection in residents with bacteriuria [89–93]. Studies of inflammatory responses in bacteriuric long-term care residents (degree of pyuria, interleukin-6 [IL-6], and heparin-binding protein) have not reliably correlated with typical (localizing) or nonspecific symptoms associated with presumed UTI (fatigue, anorexia, confusion, falls, aggression, restlessness) or with ASB [89, 90]. Neutrophil-driven inflammatory responses including pyuria or urine IL-6 do not reliably discriminate between ASB and symptomatic UTI and are not, at present, helpful to distinguish between them [90–93].

Rationale

We make strong recommendations because there is low- or moderate-quality evidence that there is no benefit and high-quality evidence of harm. In the elderly, antibiotic treatment of ASB likely does not reduce the risk of death (relative difference, 13 per 1000 [95% CI, −25 to 85]; low-quality evidence), or of sepsis (RD, 100 fewer per 1000 [95% CI, −260 to 60]; very low-quality evidence). There are high-quality data to suggest that adverse effects are particularly common following the use of antimicrobials in this population, including CDI and isolation of organisms with increased antimicrobial resistance.

Research Needs

Evaluation of potential biomarkers to differentiate symptomatic UTI and ASB in older functionally impaired persons should be pursued. Identifying objective criteria to diagnose symptomatic UTI is essential to facilitate optimal management for these older populations, including limiting inappropriate antimicrobial use.

V. In an Older, Functionally or Cognitively Impaired Patient, Which Nonlocalizing Symptoms Distinguish ASB From Symptomatic UTI?

Recommendations

1. In older patients with functional and/or cognitive impairment with bacteriuria and delirium (acute mental status change, confusion) and without local genitourinary symptoms or other systemic signs of infection (eg, fever or hemodynamic instability), we recommend assessment for other causes and careful observation rather than antimicrobial treatment (*strong recommendation, low-quality evidence*).
2. In older patients with functional and/or cognitive impairment with bacteriuria and without local genitourinary symptoms or other systemic signs of infection (fever, hemodynamic instability) who experience a fall, we recommend assessment for other causes and careful observation rather than antimicrobial treatment of bacteriuria (*strong recommendation, very low-quality evidence*). **Values and preferences**: This recommendation places a high value on avoiding adverse outcomes of antimicrobial therapy such as CDI, increased antimicrobial resistance, or adverse drug effects, in the absence of evidence that such treatment is beneficial for this vulnerable population. **Remarks:** For the bacteriuric patient with fever and other systemic signs potentially consistent with a severe infection (sepsis) and without a localizing source, broad-spectrum antimicrobial therapy directed against urinary and nonurinary sources should be initiated.

Evidence Summary

Classic symptoms of UTI include focal genitourinary symptoms such as urinary frequency, urgency, dysuria, and costovertebral angle tenderness [80]. Patients without focal genitourinary symptoms are generally considered asymptomatic [81, 82]. However, bacteriuric patients without these symptoms but with systemic signs such as change in mental status, delirium, or falls, may present a diagnostic challenge. In practice, these patients are often treated with antibiotics for UTI [85]. This is particularly true in patients with dementia or other conditions that limit the ability to communicate.

Mental Status Changes

Observational evidence suggests that patients with delirium are more likely to have bacteriuria than patients without delirium [94, 95]. However, confounding factors such as age, comorbidities, and reduced mobility were not fully adjusted for in these observational studies, and there is a high probability of residual confounding. Therefore, a causal relationship between bacteriuria and delirium has not been established. One small cohort study found a higher rate of bacteriuria in patients who were delirious postoperatively (8 of 36 [22%]) compared to those without delirium (7 of 108 [6.5%]) [96], but this study was not large enough to properly control for confounders. In a larger prospective cohort study of nursing home residents [94], change in mental status was associated with bacteriuria plus pyuria in patients treated for UTI (odds ratio [OR], 1.38 [95% CI, 1.03–1.74]). A follow-up study of the same cohort reported that change in mental status was not significantly associated with the number of episodes of bacteriuria (zero, 1, ≥2) after adjusting for resident factors [87]. A cohort study of residents from 22 nursing homes in Sweden also reported no difference in the prevalence of bacteriuria among those with nonspecific symptoms including confusion (31% of 85) compared with those without nonspecific symptoms (32% of 336; *P* = .74) [97]. IL-6 concentrations also did not differ between bacteriuric residents with and without nonspecific symptoms [89]. Thus, observational data suggest that the relationship between delirium and bacteriuria is likely attributable to underlying host factors, and consistent with a high frequency of both of these events in these older populations rather than a true inflammatory or infection-related association.

Outcomes of antimicrobial treatment or no treatment in patients with ASB and mental status change or delirium have been reported for only a few studies. Older residents of a long-term care ward with ASB, without fever or UTI symptoms, were randomized to treatment with norfloxacin 400 mg twice daily or placebo for 7 days (29 patients in each group) and evaluated on a behavioral rating scale before treatment, at end of treatment, and 1 and 3 months posttreatment [98]. The mean scores were higher (worse) in the treatment group, but not statistically different at any time, and worsened in both groups (18.1 to 19.1 with norfloxacin and 15.7 to 16.6 with placebo). Although details of the individual behavioral features are not provided, antimicrobial treatment did not improve mean

behavioral scores in these patients with ASB. In a more recent observational study, outcomes were reported for 320 hospitalized patients who had urine cultures sent to the microbiology laboratory and documentation in the hospital record of the indication for obtaining urine cultures; 191 (57%) had changes in mental status as the indication for the culture [99]. Among the 67 patients with ASB (no focal UTI symptoms), 44 (66%) presented with confusion or delirium and 43 (64%) were treated with antimicrobials. Patients with confusion or mental status change had a higher rate of antimicrobial treatment compared with patients without these presentations (75% vs 43%, respectively; OR, 1.81 [95% CI, 1.19–4.12]). In-hospital mortality did not significantly differ in patients with ASB who were treated or not treated (0% vs 4.2%; *P* = .36). Other outcomes such as CDI and antimicrobial resistance were not reported.

In another recent study [100], hospitalized patients aged ≥70 years were prospectively screened for delirium every 2 days and followed until discharge. The impact of treatment vs no treatment of ASB on death, permanent institutionalization, or functional decline was assessed in patients with and without delirium. Delirious patients treated for ASB had poorer functional outcome compared with ASB patients without delirium who were not treated (adjusted OR, 3.45 [95% CI, 1.27–9.38]). In 68 delirious patients in whom ASB was treated, there was no significant functional recovery when compared to 22 patients without treatment (unadjusted RR, 1.10 [95% CI, .86–1.41]). Delirious patients treated for ASB were more likely to develop CDI than untreated patients (OR, 2.45 [95% CI, .86–6.96]).

Delirium tends to have a fluctuating course. Careful observation of patients with delirium and evaluation for other contributing factors, such as dehydration, is a strategy for reducing unnecessary antimicrobial use for bacteriuria [95]. It is unknown whether antimicrobial therapy for ASB in patients with delirium is beneficial when fever or other systemic signs of infection are present and no other localizing source of infection is apparent [101]. For older patients with severe clinical presentations consistent with sepsis syndrome and for whom an alternate infection site is not apparent, institution of empiric antimicrobial therapy effective for potential UTI, as well as other sites of infection, may be appropriate pending culture results.

Falls

Falls are common among older populations who also have a high prevalence of ASB, and often lead to a diagnosis of UTI and initiation of antimicrobial therapy, in the absence of consistent genitourinary symptoms or systemic signs of infection (such as fever or change in hemodynamic status). A retrospective review of 80 patients in a nursing home who fell on their way to or back from a bathroom reported that 39 (48%) of these had pyuria and bacteriuria and were diagnosed as UTI [102]. Whether these patients had symptoms of urgency or frequency that contributed to a fall on the way to the toilet is not documented. In a more recent cohort study of suspected UTI in nursing home residents, only 9 of 45 (20%) fall episodes occurred in residents with bacteriuria and pyuria present—the remaining 80% had no bacteriuria and pyuria [103]. These studies suggest that most older residents who fall do not have ASB and falls should not immediately trigger suspicion for UTI; other causes are much more likely. Bacteriuria is usually unrelated and simply a confounding factor. Neither of these studies directly addresses whether antimicrobial therapy of bacteriuria in residents who have had a fall and do not have genitourinary symptoms or systemic signs of infection modifies adverse outcomes such as sepsis or death, so the evidence base is rated as low quality. However, taken together with evidence that the treatment of ASB in patients without minimal criteria for UTI is not associated with any demonstrable benefits and antimicrobials have an important risk of harm, the panel believed that the adverse consequences of antimicrobial therapy almost certainly outweigh any desirable consequences of therapy in patients who have fallen and have ASB. In patients who fall and have fever or hemodynamic instability, careful evaluation to identify a site of infection is warranted.

Rationale

We make a strong recommendation because there is high certainty for harm and low certainty of any benefit from treatment of ASB in older adults. Current evidence does not suggest a causal relationship between bacteriuria and presentations without classic localizing UTI symptoms, such as changes in mental status or falls. Treatment of ASB in patients with delirium has not been shown to have any beneficial impact in clinical outcomes compared to no treatment, including reducing severity or duration of delirium and reducing risk of sepsis, death, or hospitalizations (all low or very low certainty). There is high certainty that antimicrobials cause harm. Treatment probably increases the risk of antibiotic-associated diarrhea, including CDI, and increases the risk of antimicrobial resistance for the individual patient, the institution, and the community [87, 88, 100].

Values and Preferences

This recommendation places a high value on avoiding adverse outcomes of antimicrobial therapy in the functionally impaired older individual in the absence of evidence that such treatment is beneficial.

Research Needs

Since bacteriuria is often detected and treated in patients with delirium or falls, further studies—ideally randomized—to evaluate the risks and benefits of antimicrobial treatment and determine if there is any improvement in mental status, frequency of

repeat falls, or benefits in nonlocalizing clinical signs and symptoms, should be undertaken.

VI. Should Patients With Diabetes Be Screened or Treated for ASB?

Recommendation

1. In patients with diabetes, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*). **Remarks:** The recommendation for nontreatment of men is inferred from observations in studies which have primarily enrolled women.

Evidence Summary

In the 2005 IDSA ASB guideline [6], there was a recommendation against screening for or treatment of ASB in people with diabetes. The updated literature review looked for RCTs that compared antimicrobial therapy to no antimicrobial therapy in patients with ASB and diabetes. We did not identify any new studies to inform this recommendation.

The previous recommendation against treating women with diabetes who had ASB was based on 1 RCT [22] and 2 prospective cohort studies [104, 105]. The randomized trial compared antimicrobial therapy or no therapy for women with diabetes and ASB, and the prospective cohort studies compared outcomes among patients initially with and without ASB. In the randomized trial, antimicrobial treatment of ASB (which was blinded for the first 6 weeks, and unblinded for the remainder of the 36-month study) did not lead to a difference in rates of symptomatic UTI (40% vs 42% over the entire study period). Rates of pyelonephritis were also not significantly different between the antimicrobial and placebo groups (0.13 vs 0.28 per 1000 patient-days; RR, 2.13 [95% CI, .81–5.62]). Focusing specifically on the 6-week blinded portion of the study, pyelonephritis was numerically more common in the antimicrobial-treated group compared to the placebo group (8% vs 2%; *P* = .20). Antimicrobial-associated diarrhea and CDI were not reported, although treatment-related adverse effects were more common in the antimicrobial group (18% vs 6%; *P* = .05). Antimicrobial use for symptomatic UTI, prophylaxis, or other infections was significantly more common in the treatment group. These subjects received nearly 5 times more days of antimicrobial therapy than the control group. In the prospective cohort studies [104–106], there were no between-group differences in the outcomes of symptomatic UTI, progression to diabetic complications, and mortality. Among the prespecified subgroups of interest (gender, type 1 vs type 2 diabetes, and poorly controlled vs well-controlled diabetes) there was no evidence to inform specific recommendations.

Rationale

Antimicrobials may not reduce the risk of symptomatic urinary infection, including pyelonephritis in people with diabetes and ASB. Men with diabetes were included in only 1 cohort study and outcomes were similar. There is high-quality evidence that antimicrobials increase the risk of adverse effects. Based on the lack of demonstrated benefit and the possible harms that occur with additional antimicrobial use, we recommend against screening for or treating ASB in persons with diabetes.

Research Needs

There is a subgroup of diabetic women who experience a high frequency of recurrent symptomatic UTI [22]. Further studies to characterize these high-risk women and describe predictors and outcomes of ASB and efficacy of antimicrobial treatment would be warranted. Randomized trials of treatment or nontreatment of ASB in diabetic men are needed.

VII. Should Patients Who Have Received a Kidney Transplant Be Screened or Treated for ASB?

Recommendation

1. In renal transplant recipients who had the renal transplant surgery >1 month prior, we recommend against screening for or treating ASB (*strong recommendation, high-quality evidence*). **Remarks:** There is insufficient evidence to inform a recommendation for or against screening or treatment of ASB within the first month following renal transplantation.

Evidence Summary

ASB is common following renal transplantation, and symptomatic UTI is the most frequent infection identified in these patients [107, 108]. Unique outcomes of concern potentially attributable to UTI include graft loss, acute graft rejection, and impaired long-term graft function. The impact of UTI may be more severe in the immediate posttransplant period (ie, within the first month), when patients are at highest risk for infectious complications because of exposures to new and more intensive immunosuppressive therapy, indwelling urologic devices, and urologic interventions. Prophylactic antimicrobial therapy, usually TMP-SMX, is routinely used for the prevention of *Pneumocystis jirovecii* pneumonia during the initial 6 months following renal transplant. TMP-SMX is also probably effective in decreasing the frequency of both symptomatic UTI and ASB [109]. However, evolution of antimicrobial resistance to TMP-SMX in Enterobacteriaceae may limit the efficacy of TMP-SMX prophylaxis for prevention of UTI [110].

Renal transplant patients with ASB have an increased frequency of symptomatic UTI, including pyelonephritis [16, 110–112]. Risk factors for acquisition of ASB are similar to those described for symptomatic UTI [112–114]. These include female sex, comorbidities, urologic variables, and some immunosuppressive therapies. Retrospective studies, most of which do not differentiate ASB and symptomatic UTI, have reported associations of early, but not late, graft pyelonephritis

with graft loss [115–118], pyelonephritis with decreased long-term creatinine clearance [117, 119], and late UTI with graft loss [120]. Other studies report no adverse outcomes attributable to UTI for either early [121] or long-term [111, 121–123] graft survival or renal function. A prospective study in children (≤18 years) with a renal transplant reported that 39% had at least 1 febrile UTI and, while graft function worsened during the febrile episode, there were no differences in graft function at 2 years for those with and those without febrile infection [124].

A retrospective review of 189 renal transplant recipients followed for 36 months in whom bacteriuria was consistently treated with antimicrobials reported that 51% of patients had 1 or more episodes of ASB (19% 1 episode, 24% 2–5 episodes, and 8% >5 episodes) [16]. The prevalence was 23% in the immediate posttransplant period, 10%–17% monthly during the first year, and 2%–9% in subsequent years. Having ≥2 episodes of ASB was an independent risk factor for acute pyelonephritis, but only 2 of 25 episodes of pyelonephritis could potentially have been prevented by identification and treatment of prior ASB. A prospective study of 209 renal transplant recipients followed for 1 year after transplant, with urine routinely screened with culture every 3 days for the first 2 weeks, weekly to 1 month, and at each outpatient follow-up visit, reported that 53% of subjects had at least 1 positive urine culture; 53% of the bacteriuric episodes were considered asymptomatic, and 40% of patients had at least 1 episode of ASB [112]. More than one-half of positive cultures were identified in the first month after transplantation, when screening was most frequent. All episodes of bacteriuria were treated with antimicrobials. Recurrent ASB was an independent risk factor for symptomatic infection, but only 21 of 152 (14%) symptomatic episodes were preceded by bacteriuria with the same causative organism. ASB was not associated with poorer graft function.

Two retrospective comparative cohort studies report no association of untreated ASB with poorer outcomes in renal transplant recipients [125, 126]. El-Amari et al [125] identified 334 episodes of asymptomatic *E. coli* or *Enterococcus faecalis* bacteriuria in renal transplant recipients 1 month or more after transplantation; 137 specimens had $\geq 10^5$ CFU/mL and, of these, 49% were treated with antimicrobials at the attending physician's discretion. Only 1 untreated patient progressed to symptomatic infection with the same organism. Spontaneous clearance was observed for 38 of 67 (57%) untreated episodes, similar to the microbiologic cure of 41 of 70 (59%) episodes following antimicrobial treatment. There were no episodes of acute graft rejection observed in either group. Green et al [126] evaluated a single episode of ASB identified in 112 patients from 1 to 12 months after transplantation; 19.6% of patients received antimicrobial treatment for bacteriuria, at the attending physician's discretion. The primary outcome of hospitalization for UTI or >25% reduction in estimated glomerular filtration rate at 30 days after documentation of bacteriuria occurred in 18.2% of treated and 5.6% of untreated patients (OR, 3.78 [95% CI, .9–15]). Other outcomes, including changes in serum creatinine, graft loss, pyelonephritis, or urosepsis were similar for treated and untreated patients. These retrospective studies are subject to confounding, however, as physicians would, presumably, be more likely to treat patients with a positive urine culture if they were judged to have a poorer clinical status.

Two prospective, randomized, open-label comparative trials evaluated treatment or nontreatment of ASB following renal transplant. Moradi et al [127] enrolled 88 patients at least 1 year after transplant, who were then followed for 9–12 months. Patients with *Proteus mirabilis* infection were excluded. Outcomes of bacteriuric episodes, symptomatic UTI, and renal function were similar between treated and nontreated subjects. The report does not describe criteria used for identification of symptomatic episodes. Origüen et al [128] enrolled 112 patients with bacteriuria identified ≥2 months following transplant and followed them for up to 24 months. Urine was screened for bacteriuria every 2 weeks for the first 3 months after transplantation, monthly to the first year, and every 1–3 months thereafter. Regimens for treatment of recurrent episodes varied for reinfection or relapse. Antimicrobials were not given for 49% of episodes of ASB in subjects randomized to treatment, often because antimicrobial resistance limited oral options, while 15% of subjects randomized to no treatment received antimicrobial therapy for other indications that was also effective for the bacteriuria. Outcomes were analyzed as intention to treat and per protocol. In addition, a post hoc modified per-protocol analysis of subjects who received effective antimicrobial therapy for all episodes of ASB if they experienced only 1 or 2, or for at least two-thirds of episodes if they experienced ≥3, was reported. The primary outcome of acute pyelonephritis occurred with equal frequency in both groups in all analyses. There were also no differences in any of the secondary outcomes of long-term (12–24 months) graft function, all-cause mortality, cumulative incidence of lower UTI, acute graft rejection, CDI, colonization or infection due to multidrug-resistant bacteria, and graft loss by the end of the follow-up period. Only 16 (3.6%) episodes of ASB (5 treated and 11 untreated) were followed by symptomatic UTI with the same organism; 6 of these 16 episodes were pyelonephritis. Microbiologic cure occurred in only 51% of subjects who received antimicrobial therapy, while 33% of nontreated subjects had spontaneous clearance of bacteriuria. Of the 9 episodes of pyelonephritis in subjects in the intention-to-treat analysis, 3 were not preceded by ASB with the same organism, 3 were preceded by bacteriuria with a time interval too short to allow treatment, and 2 were preceded by bacteriuria recognized over 40 days before pyelonephritis, so a causal link could not be presumed. Thus, no benefits of treatment of

ASB were identified. This study is also evidence of the limited feasibility of consistently identifying and treating all episodes of bacteriuria as a strategy to maintain a sterile urine in renal transplant recipients.

Rationale

Treatment of ASB in renal transplant recipients >1 month after surgery may not prevent pyelonephritis or graft rejection (high-quality evidence) and probably does not improve graft function (moderate-quality evidence). Consistent identification of episodes of ASB in renal transplant patients requires frequent screening as ASB commonly recurs. Antimicrobial-resistant organisms are common in renal transplant recipients, and a high proportion of resistant organisms causing ASB may not be effectively treated with oral therapy. Treatment of ASB probably promotes reinfection with organisms increasingly resistant to antimicrobials, potentially compromising treatment of symptomatic UTI, which is also frequent in these patients. There is also high-quality evidence that antimicrobial therapy has an important risk of adverse effects.

Research Needs

There may be subgroups of transplant recipients at higher risk for developing pyelonephritis (indwelling devices, combined transplant). Further evaluation of these patients and whether proactive management of ASB can prevent pyelonephritis is worthy of additional study. In addition, the efficacy and practicality of screening for and treatment of ASB within 1 month of transplantation needs to be evaluated given the higher risk for infection and complications from infection in the early posttransplant period.

VIII. Should Patients Who Have Received a Solid Organ Transplant Other Than a Renal Transplant Be Screened or Treated for ASB?

Recommendation

1. In patients with nonrenal SOT, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*). **Values and preferences:** This recommendation places a high value on avoidance of antimicrobial use so as to limit the acquisition of antimicrobial-resistant organisms or CDI in SOT patients, who are at increased risk for these adverse outcomes. **Remarks:** In nonrenal SOT recipients, symptomatic UTI is uncommon and adverse consequences of symptomatic UTI are extremely rare; the risk of complications from ASB is, therefore, probably negligible.

Evidence Summary

No studies were identified which addressed the question of treatment or nontreatment of ASB in SOT patients other than renal transplant recipients. As with renal transplants, most nonrenal transplant recipients receive prophylactic antimicrobial therapy to prevent infections for the initial 6 months following transplantation. A prospective registry study reported that the incidence of symptomatic UTI per 1000 patient-days for patients with at least 1 year of follow-up was 0.06 for 1507 liver transplants, 0.07 for 404 heart transplants, and 0.02 for 303 lung transplants, compared with 0.45 for kidney transplants and 0.22 for combined kidney and pancreas transplants [129]. Pyelonephritis accounted for 20% of symptomatic episodes of infection for liver transplant patients, but there were no pyelonephritis episodes reported for heart or lung transplant recipients. ASB was not reported. For liver and heart transplant recipients, 96% and 90% of episodes occurred in the first 6 months, almost all of which occurred in the first posttransplant month. After 6 months, rates of genitourinary infection per 1000 days, excluding uncomplicated cystitis and ASB, were kidney 0.05, kidney-pancreas 0.11, liver 0.03, heart 0, and lung 0.04 [130].

Rationale

UTIs are uncommon in nonkidney SOT, and the evidence suggests that serious harms resulting from symptomatic UTIs are extremely rare. Any serious adverse consequences of ASB in nonrenal transplant recipients would be even more uncommon than symptomatic UTIs and are, therefore, almost certainly negligible. Even with the most optimistic assumptions about antimicrobial efficacy, screening and treatment of ASB in nonrenal SOT recipients would impart only negligible benefits (high-quality evidence). Thus, it is reasonable to make a recommendation for SOT patients other than kidney transplant, which is no stronger than that for kidney transplant patients.

IX. Should Patients With Neutropenia Be Screened or Treated for ASB?

Recommendation

1. In patients with high-risk neutropenia (absolute neutrophil count [ANC] <100 cells/mm^3, ≥7 days' duration, following cytotoxic chemotherapy) we make no recommendation for or against screening for treatment of ASB (knowledge gap). **Remarks:** For patients with high-risk neutropenia (ANC <100 cells/mm^3, ≥7 days following cytotoxic chemotherapy) managed with current standards of care, including prophylactic antimicrobial therapy and prompt initiation of antimicrobial therapy when febrile illness occurs, it is unclear how frequently ASB occurs and how often it progresses to symptomatic UTI. Patients with low-risk neutropenia (>100 cells/mm^3, ≤7 days, clinically stable) have only a very small risk of infection, and there is no evidence to suggest that, in this population, ASB has greater risk than for nonneutropenic populations.

Evidence Summary

Early prospective studies undertaken before antimicrobial prophylaxis became a standard of care for patients with high-risk neutropenia (≥7 days duration, ≤100 cells/mm^3, following cytotoxic chemotherapy) reported that gram-negative organisms

initially isolated from the urine and subsequently isolated from bacteremic episodes were also usually present as colonizers in the gut prior to the episode of bacteremia [131, 132]. However, 1 study [131] reported that 2 neutropenic patients with *P. mirabilis* initially isolated only from urine culture subsequently developed *P. mirabilis* bacteremia, and 3 patients with *Klebsiella pneumoniae* isolated only in the urine became bacteremic with a phenotypically similar strain. This suggests ASB may be a source for bacteremia in some neutropenic patients. Current management for patients with high-risk neutropenia typically includes prophylactic antimicrobial therapy, which also usually resolves bacteriuria, when present [133]. These patients are also monitored closely, and broad-spectrum antimicrobial therapy is initiated promptly when a febrile episode occurs. A recent retrospective review of patients admitted to hospital with febrile neutropenia (ANC ≤1500 cells/mm^3) occurring within 4 weeks of chemotherapy reported that only 2.8% had UTI (2.9% of those with ANC ≤100 cells/mm^3), and only 1 of 109 patients had bacteremia from a urinary source [134].

Rationale

With current management strategies for high-risk neutropenic patients, the urinary tract is an infrequent source for bacteremia. While no studies specifically address this question, screening for bacteriuria with specific antimicrobial treatment, if present, seems unlikely to provide important additional benefits when current standard of care for these patients is followed. Patients with low-risk neutropenia (<7 days, clinically stable, ANC >100 cells/mm^3) have a lower risk of infection and are assumed to have risks similar to nonneutropenic populations.

Research Needs

Further evaluation of the frequency of ASB and severity of UTI for both high-risk and low-risk patients is necessary. These studies should include patients with neutropenia attributable to causes other than chemotherapy, and patients with indwelling bladder catheters.

X. Should ASB Be Screened for or Treated in Individuals With Impaired Voiding Following SCI?

Recommendation

1. In patients with SCI, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).
   Remarks: Clinical signs and symptoms of UTI experienced by patients with SCI may differ from the classic genitourinary symptoms experienced by patients with normal sensation. The atypical presentation of UTI in these patients should be considered in making decisions with respect to treatment or nontreatment of bacteriuria.

Evidence Summary

Subjects with SCI have a high prevalence of bacteriuria and a high incidence of UTI [15, 26]. Treatment of ASB in studies enrolling primarily males with SCI and without indwelling catheters is usually followed by early recurrence of bacteriuria after antimicrobial therapy, and reinfecting strains are more likely to be resistant to antimicrobials [135]. In patients with recent onset of SCI, symptomatic UTI infrequently followed ASB and was easily treated when it occurred [136]. Studies which evaluated antimicrobial treatment or prophylaxis, compared with placebo or no treatment, enrolled patients managed with intermittent catheterization and observed no differences in rates of symptomatic UTI between treatment groups [137, 138]. The evidence is limited by the small numbers of patients enrolled, and relatively short durations of follow-up. However, review articles [139, 140] and consensus guidelines [141], as well as the 2005 IDSA ASB Guideline Committee [6] and 2009 IDSA Catheter-Acquired UTI Guideline Committee [18], concluded that ASB should not be screened for or treated in SCI patients. Guidelines of the European Association of Urology for urological infections also conclude that screening for and treatment of ASB in patients with SCI are not recommended [142].

Some evidence suggests ASB might be protective in these patients, and treatment of ASB may be associated with an increased risk of symptomatic UTI [143]. The inoculation of a nonpathogenic *E. coli* ASB strain (*E. coli* 823972/HU2117) in the lower urinary tract of patients with impaired voiding has been evaluated to mimic the potential protective effect of spontaneously developed ASB [144]. The inoculation of this *E. coli* strain in selected SCI patients with incomplete bladder emptying was generally safe and without side effects [144–147]. Two RCTs in a small number of patients with neurogenic bladders (20 and 27 patients, respectively) reported that this approach protected against symptomatic UTI [148, 149]. However, the small numbers of subjects, methodological limitations, and limited current feasibility of establishing and maintaining bacteriuria means the role of bacterial interference to prevent symptomatic UTI in the SCI population remains undefined. These studies do, however, support the concept of a protective effect of ASB and the conclusion that nontreatment of spontaneously developed long-term *E. coli* ASB in patients with SCI and neurogenic bladder is appropriate.

Patients with neurogenic bladder, such as those with SCI, are often bacteriuric and have genitourinary symptoms that might be compatible with symptomatic UTI, posing a diagnostic problem for clinicians. In contrast to patients with normal sensation, many patients with SCI and symptomatic UTI do not present with classic symptoms of UTI, such as dysuria, and may have symptoms not considered consistent with a presentation for UTI in other populations. This difficulty in ascertainment of the symptoms in a bacteriuric SCI patient is the likely reason for treatment of many patients with ASB [150]. Signs and symptoms that should be considered when assessing SCI patients for UTI are defined in the International Spinal Cord Injury UTI Basic Data Set, and include fever, malaise, lethargy or sense of

unease, or new or worsening urinary incontinence or leaking around the catheter, spasticity, cloudy urine, malodorous urine, back pain, bladder pain, dysuria, and/or autonomic dysreflexia [151]. In a prospective study of individuals with SCI, subjects were better at predicting when they did not have a UTI than when they did have a UTI (defined as bacteriuria with a colony count of at least 10^5 CFU/mL and at least 1 sign or symptom of UTI) [152]. It is reasonable to conclude, therefore, that a SCI patient who presents with recent onset or change in the signs or symptoms described above, in the setting of bacteriuria and pyuria and with no other obvious cause for the signs and/or symptoms, may have a symptomatic UTI and should be offered treatment.

Rationale

The efficacy of antimicrobial therapy for patients with ASB and SCI is uncertain (low-quality evidence). Some preliminary evidence suggests that ASB may be protective in people with SCI and impaired voiding. There is also high-quality evidence that antimicrobials cause harm through adverse effects and costs, as well as increasing the risk for antimicrobial-resistant infections in the individual and the community.

Research Needs

ASB is associated with variable degrees of pyuria, so the validity of conventional urinalysis with dipstick is uncertain to interpret in SCI patients. There is a need for novel biomarkers to differentiate symptomatic UTI and ASB. Some studies have shown promising early results using urinary concentrations of the acute phase reactant IL-6, but more evidence is needed before this or other biomarkers can be routinely adopted in clinical settings [153]. Further studies in SCI patients managed with intermittent or indwelling catheterization are needed to evaluate the significance of nonspecific symptoms, including incontinence and cloudy and malodorous urine, and the outcomes with early or delayed antimicrobial therapy.

XI. Should Patients With an Indwelling Urethral Catheter Be Screened or Treated for ASB?

Recommendations

1. In patients with a short-term indwelling urethral catheter (<30 days), we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*). **Remarks:** Considerations are likely to be similar for patients with indwelling suprapubic catheters, and it is reasonable to manage these patients similar to patients with indwelling urethral catheters, for both short-term and long-term suprapubic catheterization.
2. In patients with indwelling catheters, we make no recommendation for or against screening for and treating ASB at the time of catheter removal (knowledge gap). **Remarks:** Antimicrobial prophylaxis given at the time of catheter removal may confer a benefit for prevention of symptomatic UTI for some patients. The evidence to support this observation is largely from studies enrolling surgical patients who receive prophylactic antimicrobials at the time of short-term catheter removal, generally without screening to determine if ASB is present. It is unclear whether or not the benefit is greater in patients with ASB.
3. In patients with long-term indwelling catheters, we recommend against screening for or treating ASB (*strong recommendation, moderate-quality evidence*).

Evidence Summary

Bacteriuria With Short-term Catheters

The universal formation of biofilm along the indwelling catheter means all patients ultimately develop bacteriuria if an indwelling catheter remains in situ. Acquisition of bacteriuria is 3%–5% per catheter day; antimicrobial therapy may delay but not prevent onset [6]. Once bacteriuria is established in a catheterized urinary tract, antimicrobials can temporarily suppress the bacteriuria, but recurrence with the same or different species, often with organisms of increased antimicrobial resistance, occurs universally. Many individuals with short-term catheters (in place for <30 days) do not develop bacteriuria because the catheter is removed prior to acquisition of bacteriuria. In addition, 60%–80% of acute care patients with short-term indwelling catheters receive an antimicrobial course for an indication other than bacteriuria, and this may delay the onset of bacteriuria and modify the species and resistance profile of organisms isolated [154, 155].

For patients who develop bacteriuria, symptomatic UTI is infrequent. Tambyah et al [154] reported that 235 of 1497 (14.9%) evaluable newly catheterized patients developed bacteriuria (defined as $\geq 10^3$ CFU/mL) at a mean of 6.4 ± 6.1 days. Only 15 of the 194 (7.7%) patients with bacteriuria who could be interviewed reported subjective symptoms; moreover, the prevalence of symptoms referable to the urinary tract, including fever, did not differ for patients with or without bacteriuria. Only 1 episode of bacteremia was considered probably attributable to bacteriuria in 1497 newly catheterized patients. Srinivasan et al [156], in a prospective randomized trial comparing silver coated with uncoated silicone catheters, enrolled 3036 patients with indwelling catheters in situ for ≥48 hours. The study did not differentiate ASB and symptomatic UTI. There were 334 (11%) UTIs, 16 with bacteremia (0.5% of catheters; 4.8% of bacteriuric patients). A retrospective cohort study of 444 episodes of catheter-associated bacteriuria in 308 patients reported 128 (41.6%) had catheter-associated UTI (CAUTI) and 180 (58.4%) had ASB [157]. Only 3 episodes of bacteremia (0.7% of bacteriuric subjects) were directly attributed to bacteriuria. In this cohort, >90% of patients received antimicrobials within 30 days of the urine culture for both urinary and nonurinary indications, and administration of antimicrobials specifically to treat

urinary organisms did not appear to reduce mortality or the 30-day risk of bacteremia from any source.

Whether or not the presence of CAUTI or ASB increases the risk of mortality is controversial. Studies that have reported an association have generally not adjusted for known and important confounders. In a nested case-control study of 3281 French intensive care unit (ICU) patients with an indwelling catheter, 9% of whom developed at least 1 episode of bacteriuria (asymptomatic or symptomatic), crude hospital mortality was 43% with and 32% without bacteriuria, respectively, and crude ICU mortality was 30% and 25%, respectively [158]. Following matching and adjustment, UTI was no longer associated with mortality. A systematic review of studies of CAUTI, mortality, and length of stay in critically ill patients reported that CAUTI was associated with significantly increased mortality and length of stay in unmatched studies, but after adjustment for other prognostic factors there was no association of mortality with UTI [159].

A prospective randomized clinical trial compared antimicrobial treatment together with catheter change to no antimicrobials or catheter change in 60 ICU patients with ASB [160]. There were no differences in outcomes of mortality, recurrent bacteriuria, or duration of mechanical ventilation between the 2 groups. Three patients in each group developed urosepsis. While the focus of this guideline is bacterial infection, a prospective randomized comparative trial in hospitalized patients with asymptomatic candiduria, 56% of whom had indwelling catheters, reported no differences in outcomes between treated and untreated patients in the catheterized subgroup [161].

A Cochrane review published in 2013 addressed the question of whether antimicrobial prophylaxis given during short-term urinary catheter usage confers clinical benefits [162]. The main finding was that bacteriuria was reduced by antimicrobial prophylaxis during catheterization, but the outcome measures and study populations were heterogeneous. In 5 of 6 studies, the outcome measured was ASB, and 4 of these studies were in surgical patients.

Rationale

Most patients with short-term indwelling catheters do not acquire bacteriuria, and short-term catheter-associated bacteriuria does not appear to increase the risk for sepsis or death. When bacteriuria occurs, it infrequently results in symptomatic infection or bacteremia. Whether or not antimicrobials for ASB are effective in preventing symptomatic UTI, sepsis, or death is uncertain. In the acute care hospital setting, the risk of CDI is high; thus, avoiding antimicrobials is particularly important in hospitalized patients. Patients with short-term catheters are also at high risk for nosocomial infections with antimicrobial-resistant organisms, so avoiding antimicrobials is important to the individual and the community.

Bacteriuria at Catheter Removal

No additional clinical trials that screened for ASB at the time of catheter removal and, if present, randomized patients to treatment or no treatment, were published since 2005. One RCT in women, published in 1991 [163], addressed this topic and was included in prior guidelines [6, 18]. Seven of 42 (17%) women randomized to no treatment developed symptomatic UTI within 14 days, while 15 (36%) had spontaneous clearance of bacteriuria during this period. Thus, selected women in whom bacteriuria persists after catheter removal may be at increased short-term risk for symptomatic UTI. However, the generalizability of these observations to the current cohort of women with short-term indwelling catheters is unclear, as women in this study were enrolled only if there was a negative urine culture at catheter insertion, no antimicrobial therapy while the catheter remained in situ, and bacteriuria documented at catheter removal and persisting 48 hours after catheter removal. Many of these women were also catheterized for gynecologic procedures, and current recommendations for limiting indwelling catheter use means these procedures would now likely be managed without an indwelling catheter.

Whether antimicrobial treatment at the time of removal of a short-term urinary catheter prevents subsequent symptomatic UTI has been addressed in a meta-analysis [164]. The analysis included 6 studies, in addition to the study described above [163]; 5 of these enrolled only surgical patients. These studies initiated antimicrobial therapy shortly before catheter removal, irrespective of whether ASB was present or not. Six of the studies were RCTs. In the meta-analysis, antimicrobial treatment at the time of catheter removal reduced the risk of symptomatic UTI in the follow-up period, which ranged from 1 to 6 weeks (RD, −65/1000 [95% CI, −86 to −33]; low quality). The studies were heterogeneous in design and, in general, had a high risk of selection and attrition bias.

Rationale

We make a strong recommendation because there is very low certainty of any benefit and high-quality evidence of harm. There are no studies generalizable to current practice specifically addressing the question of whether screening for or treating ASB at the time of catheter removal confers benefits or results in adverse outcomes. While selected patient groups, such as patients with recent surgery for urinary tract reconstruction, may possibly benefit from treatment of ASB at catheter removal, the extent of benefit, association with bacteriuria, and specific patient groups who may benefit is uncertain. While the benefits of antimicrobial therapy at catheter removal are uncertain, there is high-quality evidence that antimicrobials cause harm including adverse effects and increasing costs, as well as increasing the risk of antimicrobial-resistant infections in the individual and the community.

Chronic Indwelling Catheters

Individuals with chronic indwelling catheters are, generally, always bacteriuric, usually with a polymicrobial flora

[19]. Residents of long-term care facilities who have chronic indwelling catheters have an increased frequency of febrile UTI compared with bacteriuric residents without catheters [165, 166]. CAUTI is the source of more than half of all episodes of bacteremia in long-term care residents, while only 5%–10% of residents have indwelling catheters [167]. Kunin et al [168] reported increased mortality in residents with chronic indwelling catheters, but when adjusted for other differences between catheterized and noncatheterized long-term care facility residents, the CI included no effect. In a subsequent larger prospective study among 1540 residents [166], he reported a significant independent association of chronic urinary catheter use with mortality, and a stepwise increase in mortality with duration of catheterization. However, we did not identify any evidence that antimicrobial treatment of bacteriuria in persons with long-term indwelling catheters can reduce the risk of death.

A prospective cohort study of prophylaxis to prevent ASB and UTI in patients with long-term indwelling catheters reported no benefits [169]. Studies also consistently report that treatment of subjects with ASB and chronic catheters is followed by rapid emergence of antimicrobial resistance in urinary strains [169, 170]. A prospective, randomized comparative trial [23] in residents of long-term care facilities compared 17 patients who received a 10-day course of cephalexin monohydrate, repeated whenever susceptible bacteria were isolated (160 courses), and 18 control patients who received no antimicrobials for bacteriuria. There were no differences between the groups in the incidence or prevalence of bacteriuria, number of bacterial strains isolated, incidence of febrile days, or incidence of catheter obstruction. For subjects who received the antimicrobial, fever occurred with similar frequency when receiving or not receiving cephalexin, and reinfection with cephalexin-resistant bacteria was more frequent. In a recent randomized study of a bundle of interventions implemented with the goal to decrease screening and treatment of ASB in catheterized subjects, the intervention arm was associated with a substantial decrease in screening and treatment for ASB in long-term care patients, and no increase in symptomatic UTI was observed [34].

Rationale

Whether there is a benefit of antimicrobial therapy for ASB while a catheter remains in situ is uncertain (low-quality evidence), and there is high-quality evidence of harm with increased antimicrobial resistance. A positive urine culture in an asymptomatic subject with an indwelling catheter drives inappropriate antimicrobial treatment of ASB, so screening with urine cultures in catheterized patients or obtaining urine cultures for nonspecific symptoms should be discouraged.

Research Needs

Further studies to determine which patients are at increased risk of bacteremia attributable to an indwelling catheter may inform clinical trials addressing the treatment of catheter-associated ASB for these high-risk populations. Exploration of early signs, symptoms, or biomarkers that may predict progression from ASB to CAUTI or bacteremia in catheterized patients is needed. Further studies, enrolling both medical and surgical patients, are needed to identify which patients, if any, benefit from antimicrobial prophylaxis or treatment of established ASB at the time of catheter removal.

XII. Should Patients Undergoing Elective Nonurological Surgery Be Screened and Treated for ASB?

Recommendation

1. In patients undergoing elective nonurologic surgery, we recommend against screening for or treating ASB (*strong recommendation, low-quality evidence*).

Evidence Summary

Antimicrobial therapy for patients with ASB undergoing nonurologic surgery was not addressed in the previous IDSA ASB guideline. Preoperative ASB has been identified as a risk factor for postoperative complications, including deep and superficial surgical-site infections [171–173], and preoperative testing for pyuria and bacteriuria has been a relatively common practice in some settings for at least 30 years [174]. One major clinical concern is prosthetic infection developing in orthopedic patients. We identified 3 studies that informed the recommendation for these patients [175–177] (Figure 2). One clinical trial randomized patients with ASB undergoing total hip arthroplasty to antimicrobial therapy or no therapy [177]. There were 2 cohort studies—1 exclusive to orthopedic surgery [175], and the other enrolling orthopedic, cardiac, and vascular surgery patients [176].

The 3 studies combined screened 3167 preoperative patients for ASB, of which 403 (12.7%) had ASB. Approximately half of the patients received antimicrobials targeting the ASB in addition to perioperative prophylaxis (n = 191 [47%]). Many patients in these studies received preoperative antimicrobial prophylaxis of varying dose, duration, and spectrum of activity, based on institutional and provider practices. None of these studies reported the association between postoperative outcomes and use of standard or expanded perioperative prophylaxis active against the preoperative ASB organism, independent of the targeted ASB therapy. Sousa et al [175] reported that 5 patients with ASB who developed postoperative UTI did not receive targeted ASB treatment but did receive perioperative

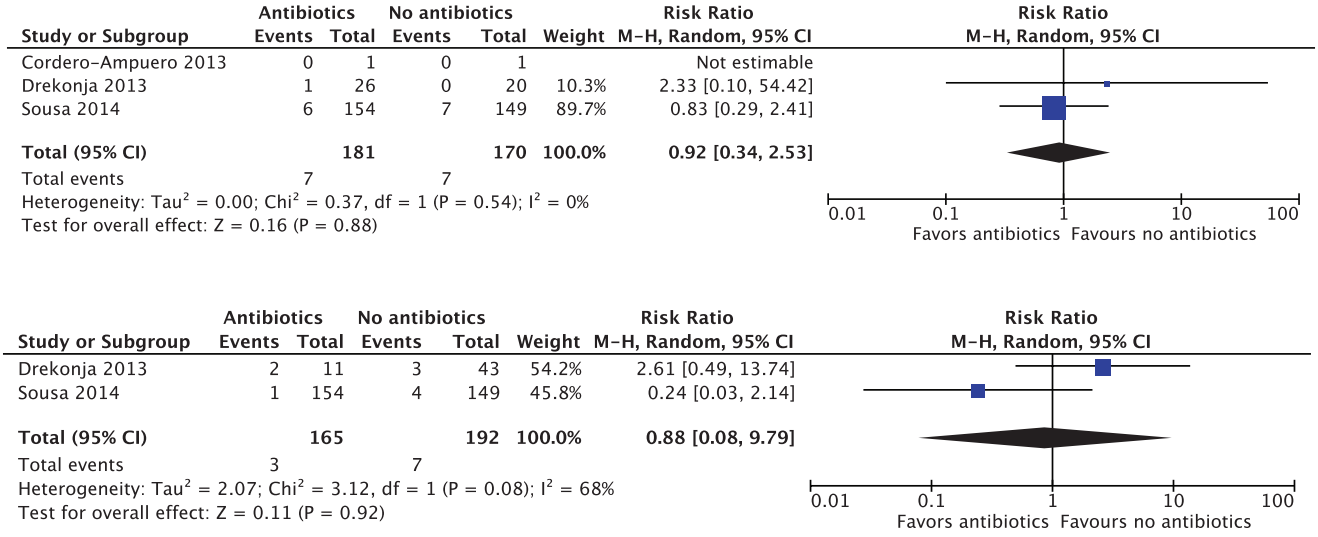

Figure 2. *A,* Risk of prosthetic joint infection in patients treated vs not treated for asymptomatic bacteriuria in patients undergoing orthopedic surgery. *B,* Risk of symptomatic urinary tract infection in the postoperative period in patients treated vs not treated for asymptomatic bacteriuria in patients undergoing orthopedic surgery. Abbreviations: CI, confidence interval; M-H, Mantel-Haenszel.

prophylaxis active against the preoperative ASB strains. However, there is insufficient evidence to address whether the common strategy of expanding perioperative prophylaxis to include coverage of the ASB organism has any benefit.

The baseline risk of symptomatic UTI in patients who did not receive antimicrobial treatment for ASB was approximately 36 per 1000, compared with 140 per 1000 for surgical site infection and 27 per 1000 for prosthetic joint infection. There was very low certainty for an effect of treatment of ASB on all outcomes. Most of the information came from observational studies at high risk for confounding and detection bias, and the CIs included both important benefit and harm. None of the included studies assessed duration of hospitalization, pyelonephritis and/or urosepsis, or antimicrobial-associated diarrhea and CDI. One reported the incidence of surgical site infections including prosthetic joint infections, 2 reported only prosthetic joint infections, and 2 reported the incidence of postoperative symptomatic UTI. Patients with orthopedic implant infections postoperatively had different pathogens isolated from the surgical infection compared to the preoperative urine [175, 176], suggesting a source other than the urine.

Rationale

It is very uncertain whether antimicrobial treatment for ASB in patients undergoing nonurologic surgery, other than standard perioperative prophylaxis, has any important benefits. The magnitude of harm, which probably varies depending on the antimicrobial used, is very uncertain; however, there is high certainty that any antimicrobial increases the risk of harm. Screening for and treating ASB increases costs, and probably contributes to CDI, adverse drug effects, and antimicrobial resistance at an individual and health system level. The issue of whether perioperative antimicrobials should be adjusted to cover the urinary pathogen in patients undergoing orthopedic implants is not well addressed in the literature. The panel did not want to make a recommendation for or against this common practice because the magnitudes of benefits and harms are so uncertain.

Research Needs

Well-designed prospective, randomized trials that evaluate adjusting surgical prophylaxis regimens to ensure activity against ASB are needed. In addition, clinical trials evaluating screening and treatment of ASB in patients, other than those receiving orthopedic implants, are necessary.

XIII. Should Patients Undergoing Endourological Procedures Be Screened or Treated for ASB?

Recommendations

1. In patients who will undergo endoscopic urologic procedures associated with mucosal trauma, we recommend screening for and treating ASB prior to surgery (*strong recommendation, moderate-quality evidence*). **Values and preferences:** This recommendation places a high value on the avoidance of the serious postoperative complication of sepsis, which is a substantial risk for patients undergoing invasive endourologic procedures in the presence of bacteriuria. **Remarks:** In individuals with bacteriuria, these are procedures in a heavily contaminated surgical field. High-quality evidence for other surgical procedures consistently shows that preoperative antimicrobial treatment

or prophylaxis for contaminated or clean-contaminated procedures confers important benefits.

2. In patients who will undergo endoscopic urologic procedures, we suggest that a urine culture be obtained prior to the procedure and targeted antimicrobial therapy prescribed, rather than empiric therapy (*weak recommendation, very low-quality evidence*).
3. In patients with ASB who will undergo a urologic procedure, we suggest short course (1 or 2 doses), rather than more prolonged antimicrobial therapy (*weak recommendation, low-quality evidence*). **Remarks:** Antimicrobial therapy should be initiated 30–60 minutes before the procedure.

Evidence Summary

ASB is a well-established risk factor for development of febrile UTI after urological procedures, but the risk is highly dependent on the type of procedure performed [178, 179]. The risk for infectious complications is considered high in all procedures with a risk of breaching the mucosal lining (eg, transurethral surgery of the prostate [TURP] or the bladder, ureteroscopy including lithotripsy, percutaneous stone surgery). Diagnostic or other urological procedures that do not breach the mucosal lining (eg, uncomplicated catheter removal/exchange, diagnostic cystoscopy, cystoscopy including removing of internal ureteric stents) are considered low risk for infectious complications. Studies comparing different approaches to reduce postsurgical infection rates, including antimicrobial prophylaxis, often need to enroll subjects undergoing "high-volume" procedures to facilitate adequate participant recruitment numbers. In urology, TURP is a high-volume procedure and has been the "model" for randomized trials; indirect evidence from TURP must then be applied to procedures performed less frequently. For diagnostic, nontraumatic procedures, randomized studies of outpatient cystoscopy have generally been the standard for other, less frequent nontraumatic endoscopic procedures [180].

Treatment of ASB Prior to Endourological Procedures

Two RCTs [181, 182] and 2 prospective nonrandomized studies [183, 184] enrolling a total of 570 patients with ASB, all published prior to the 2005 guideline, compared the effect of antimicrobial treatment to no treatment before TURP or bladder tumor resection (TURBT). In a trial comparing the effect of short-course cefotaxime compared to no treatment prior to TURP in 192 patients [181], 43% in the treatment and 40% in the control groups had preoperative bacteriuria ($\geq 10^7$ CFU/L). For patients with ASB, bacteriuria was eliminated in 67% and 30%, respectively ($P < .02$) after 6 weeks. None of the 26 patients in the cefotaxime group and 3 of the 23 (13%) patients in the control group developed postoperative upper UTI. The second randomized trial compared the efficacy of short (started the day prior to operation and continued until the catheter was removed) or more prolonged (continued for 5 days after the catheter was removed) courses of perioperative ciprofloxacin or no antimicrobial treatment in patients undergoing TURP [182]. Preoperative bacteriuria ($\geq 10^7$ CFU/L) was present in 46 of 76 (61%) patients who received a short course, 34 of 75 (45%) receiving a prolonged course, and 38 of 71 (54%) in the no treatment group. ASB was eliminated postoperatively in 65.2%, 91.2% (significant intergroup difference: *P* = .012), and 7.9%, respectively. There were no cases of postoperative bacteremia, and only 1 patient with postoperative upper UTI in each of the ciprofloxacin groups. Four patients developed bacteremia and 4 patients had upper UTI in the control group (5.6%, *P* = .02 for bacteremia and 5.6%, *P* = .004 for bacteremia and upper UTI, compared with ciprofloxacin). An open prospective study enrolled bacteriuric patients prior to transurethral procedures and compared the effect of antimicrobial treatment (different regimens based on bacterial susceptibility, n = 180) to no treatment (n = 111) [183]. There were no episodes of bacteremia identified in patients who received appropriate antimicrobials 2–12 hours before operation, while 7 patients (6.15%) not receiving appropriate antimicrobials developed bacteremia. Another prospective comparative trial [184] reported that postoperative bacteremia and fever in patients with treated or untreated preoperative ASB prior to transurethral operations occurred in 8 of 25 (32%) patients who did not receive appropriate antimicrobials, and 10 of 87 (11.5%) patients who received appropriate antimicrobials. No patient developed postoperative septicemia.

Antimicrobial Regimens Prior to Traumatic Endourological Surgery

Six studies [185–190] compared different perioperative ASB treatment regimens and durations. Two of these [189, 190] were published after the previous guideline. Two early RCTs compared the efficacy of perioperative antimicrobial treatment to methenamine hippurate treatment. Of 79 patients with ASB ($\geq 10^5$ CFU/mL) prior to TURP, 37 patients were randomized to treatment preoperatively and for 10 days postoperatively with cefazolin-cephalexin, and 42 randomized to receive methenamine hippurate [185]. Two (5.4%) patients receiving antimicrobials developed chills postoperatively without serious clinical illness, while 7 patients (16.7%) receiving methenamine had postoperative sepsis. ASB resolved at 4–9 weeks postoperatively in 56.8% in the cephalosporin group and 26.2% in the methenamine hippurate group (*P* = .0082). In a trial [186] of 42 patients with ASB undergoing TURP randomized to receive cefotaxime preoperatively and then daily for 5 days or methenamine hippurate from the day prior to operation for a total of 6 days, postoperative fever occurred in 1 of 22 (4.5%) patients receiving cefotaxime and 9 of 20 (45%) receiving methenamine hippurate ($P < .05$). No cefotaxime patients and 2 methenamine patients had septicemia, but this difference was not statistically significant. Thus, these studies support perioperative

antimicrobial treatment of ASB being superior to methenamine treatment.

Two RCTs assessed different antimicrobial regimens for treatment of preoperative ASB [187, 188]. A randomized trial of TURP patients compared 20 days' treatment with a combination of pivmecillinam-pivampicillin (25 patients) or with TMP-SMX (28 patients), both initiated 1 day prior to surgery [187]. Bacteriologic cure on day 4 posttreatment was 88% with pivmecillinam-pivampicillin and 78.6% with TMP-SMX. TMP-SMX was compared to norfloxacin for 5 days' treatment, starting the evening before the procedure, in 165 randomized patients with ASB (>10^5 CFU/mL) prior to TURP [188]. The accumulated elimination rates for the 10- to 42-day follow-up period were 68.5% and 76.2%, respectively. No patient had any clinical signs of upper UTI or septicemia.

Two RCTs reported since the publication of the previous guideline assess the efficacy of single-dose compared to longer-course antimicrobial treatment of preoperative ASB [189, 190]. In 1 trial [189], 31 patients were randomized to a single dose given 30–60 minutes before the surgical procedure and a second dose if a catheter was placed postoperatively, and 28 patients to antimicrobial treatment starting 3 days prior to and continuing for 15 days after surgery. Urologic procedures included TURP, TURBT, double J insertion and exchange, cystostomy insertion, nephrostomy tube insertion or exchange, extracorporeal shock wave lithotripsy, and ureterorenoscopy. None of the patients enrolled in the study developed sepsis or upper UTI. Short-course treatment of ASB resulted in a significantly decreased length of stay and cost of antimicrobial therapy, while longer therapy was associated with subsequent isolation of an increased number of resistant microorganisms. The second trial [190] enrolled patients with SCI and ASB undergoing elective endoscopic urological surgeries, and compared a single dose (35 patients) given 30 minutes prior to the procedure to 3–5 days of preprocedural antimicrobial treatment (25 patients). There were no significant differences in the frequency of postoperative UTI between the 2 groups. However, the single-dose regimen was associated with a significant decrease in antimicrobial cost (3.6 ± 6.1 US dollars vs 33.1 ± 47.6 US dollars; *P* = .01), and individuals who received the longer course reported greater preprocedural anxiety (18 vs 0%; $P < .05$). These 2 studies suggest that single-dose preoperative treatment of ASB is likely sufficient and associated with fewer adverse events.

Rationale

Bacteriuria may be an important cause of serious postoperative infectious complications in patients undergoing transurethral surgery. Perioperative antimicrobials probably reduce the risk of sepsis by approximately 6% (moderate certainty) and of UTIs by approximately 9% (moderate certainty). Evidence from other surgical procedures consistently supports antimicrobial treatment or prophylaxis for patients prior to contaminated or clean-contaminated procedures. There may not be an important difference between a short course (ie, single dose) and more prolonged antimicrobials in decreasing the risk of sepsis or UTI (both low quality). However, prolonged antimicrobial courses increase cost and adverse effects (high quality), and probably increase length of stay and patient anxiety (moderate quality).

Research Needs

Further studies are required to define the optimal preoperative antimicrobial regimen for endoscopic urologic procedures.

XIV. Should Patients Undergoing Implantation of Urologic Devices or Living With Urologic Devices Be Screened or Treated for ASB?

Recommendations

1. In patients planning to undergo surgery for artificial urine sphincter or penile prothesis implantation, we suggest not screening for or treating ASB (*weak recommendation, very low-quality evidence*). **Remarks:** All patients should receive standard perioperative prophylaxis prior to device implantation.
2. In patients living with implanted urological devices, we suggest not screening for or treating ASB (*weak recommendation, very low-quality evidence*).

Evidence Summary

The prevalence of ASB in older men is 3.6%–19% in the community [6, 11], and 15%–40% in long-term care facilities [6, 191] (Table 1). Most men requiring artificial urine sphincter (AUS) or penile prothesis (PP) are older or have other comorbidities such as diabetes or catheters, so this population has a high prevalence of ASB. A recent review reported that 45% of men undergoing AUS and 18% undergoing PP had preoperative ASB [192].

Treatment of ASB Prior to Urological Device Implantation

Prosthetic device infection has been reported to occur in 1%–2% of AUS implants and 2%–8% of PP implants [193, 194]. Although AUS and PP implantations are conducted without entry into the urinary tract (aside from initial catheterization), obtaining urine cultures and treatment of patients with positive results before implantation has been recommended [195]. A recent survey of high-volume implanters reported that as many as 50% do not routinely obtain preoperative urine cultures, although many obtain a urinalysis [196]. This practice is of questionable efficacy to prevent prosthetic device infection, as prosthetic infections are typically associated with biofilm-producing skin flora rather than common urinary pathogens [197, 198].

Our systematic literature search identified only 1 publication assessing the role of ASB treatment prior to urological device implantation. In a retrospective study [192], 721 AUS and PP

procedures were performed in 689 patients by a single surgeon at a tertiary institution. For the 454 patients with a preoperative urine culture, 337 were negative and 117 had untreated ASB. All patients received routine broad-spectrum perioperative antimicrobial prophylaxis. At a median follow-up of 15 months, postoperative prosthetic device infections occurred in 15 of 454 (3.3%) devices implanted, and the frequency was similar for patients with or without bacteriuria (3% and 4.3%, respectively). The frequency of preoperative ASB was 2-fold higher in the AUS cases, but subsequent device infection rates were similar for subjects with AUS or PP implantation. Only 1 of 15 (7%) device infections had the same organism isolated from the infection and the preoperative urine culture.

Treatment of ASB in Patients Living With Urological Devices

No evidence identified through the systematic literature search addressed the treatment of ASB in patients living with previously implanted urological devices. Screening for ASB in this patient group is likely associated with significant cost. Furthermore, in most other nonsurgical patient groups, the treatment of ASB has not been beneficial.

Rationale

ASB is common in this population, and we did not identify evidence that ASB present during device implantation surgery is associated with an increased risk for device infection following surgery. The universal use of perioperative antimicrobials for prophylaxis of surgical infection is effective for resolution of most episodes of ASB [199]. Therefore, any additional benefit from screening and treating ASB would be negligible. Bacterial species isolated from device infections are usually distinct from organisms isolated from ASB. We also did not identify any evidence that ASB in patients with a urological device in situ is a risk factor for urological device infection. Similar to other recommendations where the benefits of screening and treatment of ASB are very uncertain but there is high-quality evidence for adverse consequences, costs, and burdens of screening for and treating ASB, the consensus of the panel was that ASB should not be screened for or treated in patients living with urological devices.

Research Needs

Current recommendations for treatment of ASB prior to urologic device implantation are based on the results of a single retrospective study. Further prospective studies of high methodologic quality should be undertaken to validate these results.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Acknowledgments. The expert panel expresses its gratitude for thoughtful reviews of an earlier version by Drs Florian Wagenlehner, James R. Johnson, and Ann Stapleton. The panel thanks the Infectious Diseases Society of America (IDSA) for supporting guideline development, and specifically Vita Washington and Rebecca Goldwater for their continued support throughout the guideline process. The panel expresses its gratitude for librarian Shandra Knight for continued literature support throughout the development of the guideline.

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

Potential conflicts of interest. The following list is a reflection of what has been reported to the IDSA. To provide thorough transparency, the IDSA requires full disclosure of all relationships, regardless of relevancy to the guideline topic. Evaluation of such relationships as potential conflicts of interest is determined by a review process which includes assessment by the Standards and Practice Guideline Committee (SPGC) Chair, the SPGC liaison to the development panel and the Board of Directors liaison to the SPGC, and if necessary, the Conflicts of Interests (COI) Task Force of the Board. This assessment of disclosed relationships for possible COI will be based on the relative weight of the financial relationship (ie, monetary amount) and the relevance of the relationship (ie, the degree to which an association might reasonably be interpreted by an independent observer as related to the topic or recommendation of consideration). The reader of these guidelines should be mindful of this when the list of disclosures is reviewed. S. F. B. has received research grants from the National Institutes of Health (NIH), the Veterans Affairs (VA) Cooperative Studies Program, VA Health Services Research and Development Service (HSR&D)/CREATE, the VA/Centers for Disease Control and Prevention (CDC) Network, and Pfizer. D. D. has served as a consultant for Tetraphase and received research grants from VA Clinical Science Research and Development Merit Review, and the VA Cooperative Studies Program, K. G. has served as a consultant for Paratek, Ocean Spray, Iterum, and Tetraphase and has received other remuneration from UpToDate. S. G. has served as a consultant for Nordic Pharma, T. M. H. has served as a consultant for Damone, Melnata, Melinta OM Pharma, GlaxoSmithline (GSK), Ocean Spray, Paratek, Shionogi, Achaogen, and Cubist; has ownership interest in Fimbrion Therapeutics; and has received other remuneration from Fimbrion Therapeutics and UpToDate. M. J. M. has received research grants from NIH and has served as a consultant to Iterum Therapeutics. B. K. has received research grants from the European Association of Urology and served as a consultant for F. Hoffmann-La Roche Ltd. L. N. has served as a consultant for Paratek, Tetraphase, Utility, and GSK. R. S. is a member of the GRADE Working Group. S. S. has received research grants and contracts from the Department of the Veterans Administration, American Hospital Association, European Commission, NIH, CDC, and Agency for Healthcare Research and Quality (AHRQ); has received honoraria from Doximity and numerous individual hospitals and nonprofit organizations to discuss infection prevention, leadership, and patient safety; has ownership interest in Doximity and Jvion; and has a patent pending. B. T. has received research grants from VA HSR&D, AHRQ, CDC, NIH, and Zambon Pharmaceuticals, and one-time consulting fees from Paratek and Zambon Pharmaceuticals. B. W. has received research grants from Vifor; has served as a consultant for Vifor, Bionorica, and Leo Pharma; and has received honoraria from Vifor, Binorica, Astellas, and Leo Pharma. All other authors report no potential conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Guyatt GH, Oxman AD, Vist GE, et al; GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ **2008**; 336:924–6.
2. Jaeschke R, Guyatt GH, Dellinger P, et al; GRADE Working Group. Use of GRADE grid to reach decisions on clinical practice guidelines when consensus is elusive. BMJ **2008**; 337:a744.

3. Schünemann HJ, Oxman AD, Brozek J, et al. GRADE: assessing the quality of evidence for diagnostic recommendations. Evid Based Med **2008**; 13:162–3.
4. Guyatt GH, Oxman AD, Kunz R, Vist GE, Falck-Ytter Y, Schünemann HJ; GRADE Working Group. What is "quality of evidence" and why is it important to clinicians? BMJ **2008**; 336:995–8.
5. Guyatt GH, Oxman AD, Kunz R, et al; GRADE Working Group. Going from evidence to recommendations. BMJ **2008**; 336:1049–51.
6. Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM; Infectious Diseases Society of America; American Society of Nephrology; American Geriatric Society. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. Clin Infect Dis **2005**; 40:643–54.
7. Siegel SR, Siegel B, Sokoloff BZ, Kanter MH. Urinary infection in infants and preschool children. Five-year follow-up. Am J Dis Child **1980**; 134:369–72.
8. Savage DC. Natural history of covert bacteriuria in schoolgirls. Kidney Int Suppl **1975**; 4:S90–5.
9. Turner GRA, Farnsworth R, Wichen B, Robinson H. Sequelae of covert bacteriuria in schoolgirls. A four-year follow-up study. Lancet **1978**; 1:889–93.
10. Emans SJ, Grace E, Masland RP Jr. Asymptomatic bacteriuria in adolescent girls: I. Epidemiology. Pediatrics **1979**; 64:433–7.
11. Nicolle LE. Asymptomatic bacteriuria: when to screen and when to treat. Infect Dis Clin North Am **2003**; 17:367–94.
12. Zhanel GG, Harding GK, Nicolle LE. Asymptomatic bacteriuria in patients with diabetes mellitus. Rev Infect Dis **1991**; 13:150–4.
13. Nicolle LE. Urinary tract infections in the older adult. Clin Geriatr Med **2016**; 32:523–38.
14. Bakke A, Digranes A. Bacteriuria in patients treated with clean intermittent catheterization. Scand J Infect Dis **1991**; 23:577–82.
15. Waites KB, Canupp KC, DeVivo MJ. Epidemiology and risk factors for urinary tract infection following spinal cord injury. Arch Phys Med Rehabil **1993**; 74:691–5.
16. Fiorante S, López-Medrano F, Lizasoain M, et al. Systematic screening and treatment of asymptomatic bacteriuria in renal transplant recipients. Kidney Int **2010**; 78:774–81.
17. Goh YSB, Deng Z, Cheong PSC, et al. Screening for asymptomatic bacteruria at one month after adult kidney transplantation: clinical factors and implications. Clin Transplant **2017**; 31. doi:10.1111/ctr.12954.
18. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 international clinical practice guidelines from the Infectious Diseases Society of America. Clin Infect Dis **2010**; 50:625–63.
19. Warren JW, Tenney JH, Hoopes JM, Muncie HL, Anthony WC. A prospective microbiologic study of bacteriuria in patients with chronic indwelling urethral catheters. J Infect Dis **1982**; 146:719–23.
20. Nicolle LE. The paradigm shift to non-treatment of asymptomatic bacteriuria. Pathogens **2016**; 5. doi:10.3390/pathogens5020038.
21. Hansson S, Jodal U, Lincoln K, Svanborg-Edén C. Untreated asymptomatic bacteriuria in girls: II—Effect of phenoxymethylpenicillin and erythromycin given for intercurrent infections. BMJ **1989**; 298:856–9.
22. Harding GK, Zhanel GG, Nicolle LE, Cheang M; Manitoba Diabetes Urinary Tract Infection Study Group. Antimicrobial treatment in diabetic women with asymptomatic bacteriuria. N Engl J Med **2002**; 347:1576–83.
23. Warren JW, Anthony WC, Hoopes JM, Muncie HL Jr. Cephalexin for susceptible bacteriuria in afebrile, long-term catheterized patients. JAMA **1982**; 248:454–8.
24. Nicolle LE, Mayhew WJ, Bryan L. Prospective randomized comparison of therapy and no therapy for asymptomatic bacteriuria in institutionalized elderly women. Am J Med **1987**; 83:27–33.
25. Nicolle LE, Bjornson J, Harding GK, MacDonell JA. Bacteriuria in elderly institutionalized men. N Engl J Med **1983**; 309:1420–5.
26. Erickson RP, Merritt JL, Opitz JL, Ilstrup DM. Bacteriuria during follow-up in patients with spinal cord injury: I. Rates of bacteriuria in various bladder-emptying methods. Arch Phys Med Rehabil **1982**; 63:409–12.
27. Pappas PG, Kauffman CA, Andes DR, et al. Executive summary: clinical practice guideline for the management of candidiasis: 2016 update by the Infectious Diseases Society of America. Clin Infect Dis **2016**; 62:409–17.
28. Flokas ME, Detsis M, Alevizakos M, Mylonakis E. Prevalence of ESBL-producing Enterobacteriaceae in paediatric urinary tract infections: a systematic review and meta-analysis. J Infect **2016**; 73:547–57.
29. Bader MS, Loeb M, Brooks AA. An update on the management of urinary tract infections in the era of antimicrobial resistance. Postgrad Med **2017**; 129:242–58.
30. Collins CD, Kabara JJ, Michienzi SM, Malani AN. Impact of an antimicrobial stewardship care bundle to improve the management of patients with suspected or confirmed urinary tract infection. Infect Control Hosp Epidemiol **2016**; 37:1499–501.
31. Leis JA, Rebick GW, Daneman N, et al. Reducing antimicrobial therapy for asymptomatic bacteriuria among noncatheterized inpatients: a proof-of-concept study. Clin Infect Dis **2014**; 58:980–3.
32. Kelley D, Aaronson P, Poon E, McCarter YS, Bato B, Jankowski CA. Evaluation of an antimicrobial stewardship approach to minimize overuse of antibiotics in patients with asymptomatic bacteriuria. Infect Control Hosp Epidemiol **2014**; 35:193–5.
33. Hartley S, Valley S, Kuhn L, et al. Overtreatment of asymptomatic bacteriuria: identifying targets for improvement. Infect Control Hosp Epidemiol **2015**; 36:470–3.
34. Trautner BW, Grigoryan L, Petersen NJ, et al. Effectiveness of an antimicrobial stewardship approach for urinary catheter-associated asymptomatic bacteriuria. JAMA Intern Med **2015**; 175:1120–7.
35. Sloane PD, Kistler CE, Reed D, Weber DJ, Ward K, Zimmerman S. Urine culture testing in community nursing homes: gateway to antibiotic overprescribing. Infect Control Hosp Epidemiol **2017**; 38:524–31.
36. Spivak ES, Burk M, Zhang R, et al. Management of bacteriuria in Veterans Affairs hospitals. Clin Infect Dis **2017**; 65:910–7.
37. Phillips CD, Adepoju O, Stone N, et al. Asymptomatic bacteriuria, antibiotic use, and suspected urinary tract infections in four nursing homes. BMC Geriatr **2012**; 12:73.
38. Brown E, Talbot GH, Axelrod P, Provencher M, Hoegg C. Risk factors for *Clostridium difficile* toxin–associated diarrhea. Infect Control Hosp Epidemiol **1990**; 11:283–90.
39. Stevens V, Dumyati G, Fine LS, Fisher SG, van Wijngaarden E. Cumulative antibiotic exposures over time and the risk of *Clostridium difficile* infection. Clin Infect Dis **2011**; 53:42–8.
40. Hooton TM, Scholes D, Stapleton AE, et al. A prospective study of asymptomatic bacteriuria in sexually active young women. N Engl J Med **2000**; 343:992–7.
41. Takala J, Jousimies H, Sievers K. Screening for and treatment of bacteriuria in a middle-aged female population. I. The prevalence of bacteriuria, urinary tract infections under treatment and symptoms of urinary tract infections in the Säkylä-Köyliö project. Acta Med Scand **1977**; 202:69–73.
42. Kaitz AL, Hodder EW. Bacteriuria and pyelonephritis of pregnancy. A prospective study of 616 pregnant women. N Engl J Med **1961**; 265:667–72.
43. Savage WE, Hajj SN, Kass EH. Demographic and prognostic characteristics of bacteriuria in pregnancy. Medicine (Baltimore) **1967**; 46:385–407.
44. Rodhe N, Löfgren S, Matussek A, et al. Asymptomatic bacteriuria in the elderly: high prevalence and high turnover of strains. Scand J Infect Dis **2008**; 40:804–10.
45. Hedin K, Petersson C, Widebäck K, Kahlmeter G, Mölstad S. Asymptomatic bacteriuria in a population of elderly in municipal institutional care. Scand J Prim Health Care **2002**; 20:166–8.
46. Gleckman R, Esposito A, Crowley M, Natsios GA. Reliability of a single urine culture in establishing diagnosis of asymptomatic bacteriuria in adult males. J Clin Microbiol **1979**; 9:596–7.
47. Stark RP, Maki DG. Bacteriuria in the catheterized patient. What quantitative level of bacteriuria is relevant? N Engl J Med **1984**; 311:560–4.
48. Tenney JH, Warren JW. Bacteriuria in women with long-term catheters: paired comparison of indwelling and replacement catheters. J Infect Dis **1988**; 157:199–202.
49. Jodal U. The natural history of bacteriuria in childhood. Infect Dis Clin North Am **1987**; 1:713–29.
50. Abbott GD. Neonatal bacteriuria: a prospective study in 1460 infants. Br Med J **1972**; 1:267–9.
51. Kunin CM, Deutscher R, Paquin A Jr. Urinary tract infection in school children: an epidemiologic, clinical and laboratory study. Medicine (Baltimore) **1964**; 43:91–130.
52. Kunin CM. Emergence of bacteriuria, proteinuria, and symptomatic urinary tract infections among a population of school girls followed for 7 years. Pediatrics **1968**; 41:968–76.
53. Gillenwater JY, Harrison RB, Kunin CM. Natural history of bacteriuria in schoolgirls. A long-term case-control study. N Engl J Med **1979**; 301:396–9.
54. Hansson S, Jodal U, Norén L, Bjure J. Untreated bacteriuria in asymptomatic girls with renal scarring. Pediatrics **1989**; 84:964–8.
55. Lindberg U, Claesson I, Hanson LA, Jodal U. Asymptomatic bacteriuria in schoolgirls. VIII. Clinical course during a 3-year follow-up. J Pediatr **1978**; 92:194–9.
56. Lindberg U. Asymptomatic bacteriuria in school girls. V. The clinical course and response to treatment. Acta Paediatr Scand **1975**; 64:718–24.
57. Kunin CM. The natural history of recurrent bacteriuria in schoolgirls. N Engl J Med **1970**; 282:1443–8.
58. Savage DC, Howie G, Adler K, Wilson MI. Controlled trial of therapy in covert bacteriuria of childhood. Lancet **1975**; 1:358–61.
59. Kemper KJ, Avner ED. The case against screening urinalyses for asymptomatic bacteriuria in children. Am J Dis Child **1992**; 146:343–6.

60. Asscher AW, Sussman M, Waters WE, et al. Asymptomatic significant bacteriuria in the non-pregnant woman. II. Response to treatment and follow-up. Br Med J **1969**; 1:804–6.
61. United States Preventive Services Task Force. Screening for asymptomatic bacteriuria in adults: U.S. Preventive Services Task Force reaffirmation recommendation statement. Ann Intern Med **2008**; 149:43–7.
62. Dull RB, Friedman SK, Risoldi ZM, Rice EC, Starlin RC, Destache CJ. Antimicrobial treatment of asymptomatic bacteriuria in noncatheterized adults: a systematic review. Pharmacotherapy **2014**; 34:941–60.
63. Beerepoot MA, den Heijer CD, Penders J, Prins JM, Stobberingh EE, Geerlings SE. Predictive value of *Escherichia coli* susceptibility in strains causing asymptomatic bacteriuria for women with recurrent symptomatic urinary tract infections receiving prophylaxis. Clin Microbiol Infect **2012**; 18:E84–90.
64. Cai T, Mazzoli S, Mondaini N, et al. The role of asymptomatic bacteriuria in young women with recurrent urinary tract infections: to treat or not to treat? Clin Infect Dis **2012**; 55:771–7.
65. Patterson TF, Andriole VT. Detection, significance, and therapy of bacteriuria in pregnancy. Update in the managed health care era. Infect Dis Clin North Am **1997**; 11:593–608.
66. American Academy of Pediatrics, American College of Obstetricians and Gynecologists. Guidelines for perinatal care. 7th ed. Elk Grove Village, Illinois and Washington, DC: AAP/ACOG, **2012**:112–7.
67. United States Preventive Services Task Force. Final update summary: asymptomatic bacteriuria in adults: screening. Available at: https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/asymptomatic-bacteriuria-in-adults-screening. Accessed 10 May 2017.
68. Smaill FM, Vazquez JC. Antibiotics for asymptomatic bacteriuria in pregnancy. Cochrane Database Syst Rev **2015**; CD000490.
69. Kazemier BM, Koningstein FN, Schneeberger C, et al. Maternal and neonatal consequences of treated and untreated asymptomatic bacteriuria in pregnancy: a prospective cohort study with an embedded randomised controlled trial. Lancet Infect Dis **2015**; 15:1324–33.
70. Widmer M, Lopez I, Gulmezoglu AM, Mignini L, Roganti A. Duration of treatment for asymptomatic bacteriuria during pregnancy. Cochrane Database Syst Rev **2015**; CD000491.
71. Lumbiganon P, Villar J, Laopaiboon M, et al; World Health Organization Asymptomatic Bacteriuria Trial Group. One-day compared with 7-day nitrofurantoin for asymptomatic bacteriuria in pregnancy: a randomized controlled trial. Obstet Gynecol **2009**; 113:339–45.
72. Gupta K, Hooton TM, Naber KG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: a 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis **2011**; 52:e103–20.
73. Reeves DS. Treatment of bacteriuria in pregnancy with single dose fosfomycin trometamol: a review. Infection **1992**; 20(Suppl 4):S313–6.
74. Keating GM. Fosfomycin trometamol: a review of its use as a single-dose oral treatment for patients with acute lower urinary tract infections and pregnant women with asymptomatic bacteriuria. Drugs **2013**; 73:1951–66.
75. Estebanez A, Pascual R, Gil V, Ortiz F, Santibáñez M, Pérez Barba C. Fosfomycin in a single dose versus a 7-day course of amoxicillin-clavulanate for the treatment of asymptomatic bacteriuria during pregnancy. Eur J Clin Microbiol Infect Dis **2009**; 28:1457–64.
76. Khawaja AR, Khan FB, Dar TI, Bhat AH, Wani MS, Wazir BS. Fosfomycin tromethamine. Antibiotic of choice in the female patient: a multicenter study. Cent European J Urol **2015**; 68:371–5.
77. Boscia JA, Kobasa WD, Knight RA, Abrutyn E, Levison ME, Kaye D. Therapy vs no therapy for bacteriuria in elderly ambulatory nonhospitalized women. JAMA **1987**; 257:1067–71.
78. Abrutyn E, Mossey J, Berlin JA, et al. Does asymptomatic bacteriuria predict mortality and does antimicrobial treatment reduce mortality in elderly ambulatory women? Ann Intern Med **1994**; 120:827–33.
79. Ouslander JG, Schapira M, Schnelle JF, et al. Does eradicating bacteriuria affect the severity of chronic urinary incontinence in nursing home residents? Ann Intern Med **1995**; 122:749–54.
80. Loeb M, Bentley DW, Bradley S, et al. Development of minimum criteria for the initiation of antibiotics in residents of long-term-care facilities: results of a consensus conference. Infect Control Hosp Epidemiol **2001**; 22:120–4.
81. High KP, Bradley SF, Gravenstein S, et al. Clinical practice guideline for the evaluation of fever and infection in older adult residents of long-term care facilities: 2008 update by the Infectious Diseases Society of America. J Am Geriatr Soc **2009**; 57:375–94.
82. Stone ND, Ashraf MS, Calder J, et al; Society for Healthcare Epidemiology Long-Term Care Special Interest Group. Surveillance definitions of infections in long-term care facilities: revisiting the McGeer criteria. Infect Control Hosp Epidemiol **2012**; 33:965–77.
83. Dufour AB, Shaffer ML, D'Agata EM, Habtemariam D, Mitchell SL. Survival after suspected urinary tract infection in individuals with advanced dementia. J Am Geriatr Soc **2015**; 63:2472–7.
84. Mitchell SL, Shaffer ML, Loeb MB, et al. Infection management and multidrug-resistant organisms in nursing home residents with advanced dementia. JAMA Intern Med **2014**; 174:1660–7.
85. D'Agata E, Loeb MB, Mitchell SL. Challenges in assessing nursing home residents with advanced dementia for suspected urinary tract infections. J Am Geriatr Soc **2013**; 61:62–6.
86. Giamarellou H, Dontas AS, Petrikkos G, Gnardellis C, Zorbas P, Philippou P. Survival of elderly bacteriuric subjects following long-term quinolone therapy. J Chemother **2007**; 19:185–92.
87. Das R, Towle V, Van Ness PH, Juthani-Mehta M. Adverse outcomes in nursing home residents with increased episodes of observed bacteriuria. Infect Control Hosp Epidemiol **2011**; 32:84–6.
88. Rotjanapan P, Dosa D, Thomas KS. Potentially inappropriate treatment of urinary tract infections in two Rhode Island nursing homes. Arch Intern Med **2011**; 171:438–43.
89. Sundvall PD, Elm M, Ulleryd P, et al. Interleukin-6 concentrations in the urine and dipstick analyses were related to bacteriuria but not symptoms in the elderly: a cross sectional study of 421 nursing home residents. BMC Geriatr **2014**; 14:88.
90. Kjölvmark C, Tschernij E, Öberg J, Påhlman LI, Linder A, Åkesson P. Distinguishing asymptomatic bacteriuria from urinary tract infection in the elderly—the use of urine levels of heparin-binding protein and interleukin-6. Diagn Microbiol Infect Dis **2016**; 85:243–8.
91. Yu Y, Zielinski MD, Rolfe MA, et al. Similar neutrophil-driven inflammatory and antibacterial responses in elderly patients with symptomatic and asymptomatic bacteriuria. Infect Immun **2015**; 83:4142–53.
92. Rodhe N, Löfgren S, Strindhall J, Matussek A, Mölstad S. Cytokines in urine in elderly subjects with acute cystitis and asymptomatic bacteriuria. Scand J Prim Health Care **2009**; 27:74–9.
93. Sundén F, Wullt B. Predictive value of urinary interleukin-6 for symptomatic urinary tract infections in a nursing home population. Int J Urol **2016**; 23:168–74.
94. Juthani-Mehta M, Quagliarello V, Perrelli E, Towle V, Van Ness PH, Tinetti M. Clinical features to identify urinary tract infection in nursing home residents: a cohort study. J Am Geriatr Soc **2009**; 57:963–70.
95. Balogun SA, Philbrick JT. Delirium, a symptom of UTI in the elderly: fact or fable? A systematic review. Can Geriatr J **2014**; 17:22–6.
96. Bhattacharya B, Maung A, Barre K, et al. Postoperative delirium is associated with increased intensive care unit and hospital length of stays after liver transplantation. J Surg Res **2017**; 207:223–8.
97. Sundvall PD, Ulleryd P, Gunnarsson PK. Urine culture doubtful in determining etiology of diffuse symptoms among elderly individuals: a cross sectional study of 32 nursing homes. BMC Fam Pract **2011**; 12:36. doi:10.1186/1471-2296-12-36.
98. Potts L, Cross S, MacLennan WJ, Watt B. A double-blind comparative study of norfloxacin versus placebo in hospitalised elderly patients with asymptomatic bacteriuria. Arch Gerontol Geriatr **1996**; 23:153–61.
99. Silver SA, Baillie L, Simor AE. Positive urine cultures: a major cause of inappropriate antimicrobial use in hospitals? Can J Infect Dis Med Microbiol **2009**; 20:107–11.
100. Dasgupta M, Brymer C, Elsayed S. Treatment of asymptomatic UTI in older delirious medical in-patients: a prospective cohort study. Arch Gerontol Geriatr **2017**; 72:127–34.
101. Nace DA, Drinka PJ, Crnich CJ. Clinical uncertainties in the approach to long term care residents with possible urinary tract infection. J Am Med Dir Assoc **2014**; 15:133–9.
102. Rhoads J, Clayman A, Nelson S. The relationship of urinary tract infections and falls in a nursing home. Director **2007**; 15:22–6.
103. Rowe T, Towle V, Van Ness PH, Juthani-Mehta M. Lack of positive association between falls and bacteriuria plus pyuria in older nursing home residents. J Am Geriatr Soc **2013**; 61:653–4.
104. Geerlings SE, Stolk RP, Camps MJ, et al. Consequences of asymptomatic bacteriuria in women with diabetes mellitus. Arch Intern Med **2001**; 161:1421–7.
105. Semetkowska-Jurkiewicz E, Horoszek-Maziarz S, Galiński J, Manitius A, Krupa-Wojciechowska B. The clinical course of untreated asymptomatic bacteriuria in diabetic patients—14-year follow-up. Mater Med Pol **1995**; 27:91–5.
106. Meiland R, Geerlings SE, Stolk RP, Netten PM, Schneeberger PM, Hoepelman AI. Asymptomatic bacteriuria in women with diabetes mellitus: effect on renal function after 6 years of follow-up. Arch Intern Med **2006**; 166:2222–7.
107. Parasuraman R, Julian K; AST Infectious Diseases Community of Practice. Urinary tract infections in solid organ transplantation. Am J Transplant **2013**; 13(Suppl 4):327–36.

108. Coussement J, Abramowicz D. Should we treat asymptomatic bacteriuria after renal transplantation? Nephrol Dial Transplant **2014**; 29:260–2.
109. Green H, Rahamimov R, Gafter U, Leibovitci L, Paul M. Antibiotic prophylaxis for urinary tract infections in renal transplant recipients: a systematic review and meta-analysis. Transpl Infect Dis **2011**; 13:441–7.
110. Singh R, Bemelman FJ, Hodiamont CJ, Idu MM, Ten Berge IJ, Geerlings SE. The impact of trimethoprim-sulfamethoxazole as *Pneumocystis jiroveci* pneumonia prophylaxis on the occurrence of asymptomatic bacteriuria and urinary tract infections among renal allograft recipients: a retrospective before-after study. BMC Infect Dis **2016**; 16:90.
111. Fiorante S, Fernández-Ruiz M, López-Medrano F, et al. Acute graft pyelonephritis in renal transplant recipients: incidence, risk factors and long-term outcome. Nephrol Dial Transplant **2011**; 26:1065–73.
112. Gołębiewska JE, Dębska-Ślizień A, Rutkowski B. Treated asymptomatic bacteriuria during first year after renal transplantation. Transpl Infect Dis **2014**; 16:605–15.
113. Vidal E, Cervera C, Cordero E, et al. Management of urinary tract infection in solid organ transplant recipients: consensus statement of the Group for the Study of Infection in Transplant Recipients (GESITRA) of the Spanish Society of Infectious Diseases and Clinical Microbiology (SEIMC) and the Spanish Network for Research in Infectious Diseases (REIPI). Enferm Infecc Microbiol Clin **2015**; 33:679.e1–21.
114. Ooms L, J IJ, Voor In 't Holt A, Betjes M, Vos M, Terkivatan T. Urinary tract infections after kidney transplantation: a risk factor analysis of 417 patients. Ann Transplant **2017**; 22:402–8.
115. Giral M, Pascuariello G, Karam G, et al. Acute graft pyelonephritis and long-term kidney allograft outcome. Kidney Int **2002**; 61:1880–6.
116. Dharnidharka VR, Agodoa LY, Abbott KC. Effects of urinary tract infection on outcomes after renal transplantation in children. Clin J Am Soc Nephrol **2007**; 2:100–6.
117. Bodro M, Sanclemente G, Lipperheide I, et al. Impact of urinary tract infections on short-term kidney graft outcome. Clin Microbiol Infect **2015**; 21:1104.e1–8.
118. Kroth LV, Barreiro FF, Saitovitch D, Traesel MA, d'Avila DO, Poli-de-Figueiredo CE. Acute graft pyelonephritis occurring up to 30 days after kidney transplantation: epidemiology, risk factors, and survival. Transplant Proc **2016**; 48:2298–300.
119. Pellé G, Vimont S, Levy PP, et al. Acute pyelonephritis represents a risk factor impairing long-term kidney graft function. Am J Transplant **2007**; 7:899–907.
120. Abbott KC, Swanson SJ, Richter ER, et al. Late urinary tract infection after renal transplantation in the United States. Am J Kidney Dis **2004**; 44:353–62.
121. Papasotiriou M, Savvidaki E, Kalliakmani P, et al. Predisposing factors to the development of urinary tract infections in renal transplant recipients and the impact on the long-term graft function. Ren Fail **2011**; 33:405–10.
122. Kamath NS, John GT, Neelakantan N, Kirubakaran MG, Jacob CK. Acute graft pyelonephritis following renal transplantation. Transpl Infect Dis **2006**; 8:140–7.
123. Tawab KA, Gheith O, Al Otaibi T, et al. Recurrent urinary tract infection among renal transplant recipients: risk factors and long-term outcome. Exp Clin Transplant **2017**; 15:157–63.
124. Weigel F, Lemke A, Tönshoff B, et al. Febrile urinary tract infection after pediatric kidney transplantation: a multicenter, prospective observational study. Pediatr Nephrol **2016**; 31:1021–8.
125. El Amari EB, Hadaya K, Bühler L, et al. Outcome of treated and untreated asymptomatic bacteriuria in renal transplant recipients. Nephrol Dial Transplant **2011**; 26:4109–14.
126. Green H, Rahamimov R, Goldberg E, et al. Consequences of treated versus untreated asymptomatic bacteriuria in the first year following kidney transplantation: retrospective observational study. Eur J Clin Microbiol Infect Dis **2013**; 32:127–31.
127. Moradi M, Abbasi M, Moradi A, Boskabadi A, Jalali A. Effect of antibiotic therapy on asymptomatic bacteriuria in kidney transplant recipients. Urol J **2005**; 2:32–5.
128. Origüen J, López-Medrano F, Fernández-Ruiz M, et al. Should asymptomatic bacteriuria be systematically treated in kidney transplant recipients? Results from a randomized controlled trial. Am J Transplant **2016**; 16:2943–53.
129. Vidal E, Torre-Cisneros J, Blanes M, et al; Spanish Network for Research in Infectious Diseases (REIPI). Bacterial urinary tract infection after solid organ transplantation in the RESITRA cohort. Transpl Infect Dis **2012**; 14:595–603.
130. San Juan R, Aguado JM, Lumbreras C, et al; RESITRA Network, Spain. Incidence, clinical characteristics and risk factors of late infection in solid organ transplant recipients: data from the RESITRA study group. Am J Transplant **2007**; 7:964–71.
131. Gurwith MJ, Brunton JL, Lank BA, Ronald AR, Harding GK. Granulocytopenia in hospitalized patients: I. Prognostic factors and etiology of fever. Am J Med **1978**; 64:121–6.
132. Daw MA, Munnelly P, McCann SR, Daly PA, Falkiner FR, Keane CT. Value of surveillance cultures in the management of neutropenic patients. Eur J Clin Microbiol Infect Dis **1988**; 7:742–7.
133. Freifeld AG, Bow EJ, Sepkowitz KA, et al. Clinical practice guideline for the use of antimicrobial agents in neutropenic patients with cancer: 2010 update by the Infectious Diseases Society of America. Clin Infect Dis **2011**; 52:e56–93.
134. Cunha BA, Lee P, Sahn R, Cai B. Does febrile neutropenia in adult oncology patients predispose to urinary tract infections or urosepsis? Infect Dis (Lond) **2015**; 47:195–6.
135. Waites KB, Canupp KC, DeVivo MJ. Eradication of urinary tract infection following spinal cord injury. Paraplegia **1993**; 31:645–52.
136. Lewis RI, Carrion HM, Lockhart JL, Politano VA. Significance of asymptomatic bacteriuria in neurogenic bladder disease. Urology **1984**; 23:343–7.
137. Mohler JL, Cowen DL, Flanigan RC. Suppression and treatment of urinary tract infection in patients with an intermittently catheterized neurogenic bladder. J Urol **1987**; 138:336–40.
138. Maynard FM, Diokno AC. Urinary infection and complications during clean intermittent catheterization following spinal cord injury. J Urol **1984**; 132:943–6.
139. Ditunno JF Jr, Formal CS. Chronic spinal cord injury. N Engl J Med **1994**; 330:550–6.
140. Cardenas DD, Hooton TM. Urinary tract infection in persons with spinal cord injury. Arch Phys Med Rehabil **1995**; 76:272–80.
141. The prevention and management of urinary tract infections among people with spinal cord injuries. National Institute on Disability and Rehabilitation Research Consensus Statement. January 27–29, 1992. J Am Paraplegia Soc **1992**; 15:194–204.
142. Grabe M, Bartoletti R, Bjerklund Johansen TE, et al. Guidelines on urological infections. Arnhem, the Netherlands: European Association of Urology, **2015**.
143. Wullt B, Svanborg C. Deliberate establishment of asymptomatic bacteriuria-a novel strategy to prevent recurrent UTI. Pathogens **2016**; 5. doi:10.3390/pathogens5030052.
144. Wullt B, Connell H, Röllano P, Månsson W, Colleen S, Svanborg C. Urodynamic factors influence the duration of *Escherichia coli* bacteriuria in deliberately colonized cases. J Urol **1998**; 159:2057–62.
145. Andersson P, Engberg I, Lidin-Janson G, et al. Persistence of *Escherichia coli* bacteriuria is not determined by bacterial adherence. Infect Immun **1991**; 59:2915–21.
146. Hull R, Rudy D, Donovan W, et al. Urinary tract infection prophylaxis using *Escherichia coli* 83972 in spinal cord injured patients. J Urol **2000**; 163:872–7.
147. Darouiche RO, Donovan WH, Del Terzo M, Thornby JI, Rudy DC, Hull RA. Pilot trial of bacterial interference for preventing urinary tract infection. Urology **2001**; 58:339–44.
148. Darouiche RO, Thornby JI, Cerra-Stewart C, Donovan WH, Hull RA. Bacterial interference for prevention of urinary tract infection: a prospective, randomized, placebo-controlled, double-blind pilot trial. Clin Infect Dis **2005**; 41:1531–4.
149. Sundén F, Håkansson L, Ljunggren E, Wullt B. *Escherichia coli* 83972 bacteriuria protects against recurrent lower urinary tract infections in patients with incomplete bladder emptying. J Urol **2010**; 184:179–85.
150. Pannek J. Treatment of urinary tract infection in persons with spinal cord injury: guidelines, evidence, and clinical practice. A questionnaire-based survey and review of the literature. J Spinal Cord Med **2011**; 34:11–5.
151. Goetz LL, Cardenas DD, Kennelly M, et al. International spinal cord injury urinary tract infection basic data set. Spinal Cord **2013**; 51:700–4.
152. Massa LM, Hoffman JM, Cardenas DD. Validity, accuracy, and predictive value of urinary tract infection signs and symptoms in individuals with spinal cord injury on intermittent catheterization. J Spinal Cord Med **2009**; 32:568–73.
153. Sundén F, Butler D, Wullt B. Triggered urine interleukin-6 correlates to severity of symptoms in nonfebrile lower urinary tract infections. J Urol **2017**; 198:107–15.
154. Tambyah PA, Maki DG. Catheter-associated urinary tract infection is rarely symptomatic: a prospective study of 1497 catheterized patients. Arch Intern Med **2000**; 160:678–82.
155. Hustinx WN, Mintjes-de Groot AJ, Verkooyen RP, Verbrugh HA. Impact of concurrent antimicrobial therapy on catheter-associated urinary tract infection. J Hosp Infect **1991**; 18:45–56.
156. Srinivasan A, Karchmer T, Richards A, Song X, Perl TM. A prospective trial of a novel, silicone-based, silver-coated Foley catheter for the prevention of nosocomial urinary tract infections. Infect Control Hosp Epidemiol **2006**; 27:38–43.
157. Kizilbash QF, Petersen NJ, Chen GJ, Naik AD, Trautner BW. Bacteremia and mortality with urinary catheter-associated bacteriuria. Infect Control Hosp Epidemiol **2013**; 34:1153–9.
158. Clec'h C, Schwebel C, Français A, et al; OutcomeRea Study Group. Does catheter-associated urinary tract infection increase mortality in critically ill patients? Infect Control Hosp Epidemiol **2007**; 28:1367–73.

159. Chant C, Smith OM, Marshall JC, Friedrich JO. Relationship of catheter-associated urinary tract infection to mortality and length of stay in critically ill patients: a systematic review and meta-analysis of observational studies. Crit Care Med **2011**; 39:1167–73.
160. Leone M, Perrin AS, Granier I, et al. A randomized trial of catheter change and short course of antibiotics for asymptomatic bacteriuria in catheterized ICU patients. Intensive Care Med **2007**; 33:726–9.
161. Sobel JD, Kauffman CA, McKinsey D, et al. Candiduria: a randomized, double-blind study of treatment with fluconazole and placebo. The National Institute of Allergy and Infectious Diseases (NIAID) Mycoses Study Group. Clin Infect Dis **2000**; 30:19–24.
162. Lusardi G, Lipp A, Shaw C. Antibiotic prophylaxis for short-term catheter bladder drainage in adults. Cochrane Database Syst Rev **2013**; 7:CD005428.
163. Harding GK, Nicolle LE, Ronald AR, et al. How long should catheter-acquired urinary tract infection in women be treated? A randomized controlled study. Ann Intern Med **1991**; 114:713–9.
164. Marschall J, Carpenter CR, Fowler S, Trautner BW; CDC Prevention Epicenters Program. Antibiotic prophylaxis for urinary tract infections after removal of urinary catheter: meta-analysis. BMJ **2013**; 346:f3147.
165. Warren JW, Damron D, Tenney JH, Hoopes JM, Deforge B, Muncie HL Jr. Fever, bacteremia, and death as complications of bacteriuria in women with long-term urethral catheters. J Infect Dis **1987**; 155:1151–8.
166. Kunin CM, Chin QF, Chambers S. Morbidity and mortality associated with indwelling urinary catheters in elderly patients in a nursing home–confounding due to the presence of associated diseases. J Am Geriatr Soc **1987**; 35:1001–6.
167. Mylotte JM, Tayara A, Goodnough S. Epidemiology of bloodstream infection in nursing home residents: evaluation in a large cohort from multiple homes. Clin Infect Dis **2002**; 35:1484–90.
168. Kunin CM, Douthitt S, Dancing J, Anderson J, Moeschberger M. The association between the use of urinary catheters and morbidity and mortality among elderly patients in nursing homes. Am J Epidemiol **1992**; 135:291–301.
169. Breitenbucher RB. Bacterial changes in the urine samples of patients with long-term indwelling catheters. Arch Intern Med **1984**; 144:1585–8.
170. Bjork DT, Pelletier LL, Tight RR. Urinary tract infections with antibiotic resistant organisms in catheterized nursing home patients. Infect Control **1984**; 5:173–6.
171. Irvine R, Johnson BL Jr, Amstutz HC. The relationship of genitourinary tract procedures and deep sepsis after total hip replacements. Surg Gynecol Obstet **1974**; 139:701–6.
172. David TS, Vrahas MS. Perioperative lower urinary tract infections and deep sepsis in patients undergoing total joint arthroplasty. J Am Acad Orthop Surg **2000**; 8:66–74.
173. Ollivere BJ, Ellahee N, Logan K, Miller-Jones JC, Allen PW. Asymptomatic urinary tract colonisation predisposes to superficial wound infection in elective orthopaedic surgery. Int Orthop **2009**; 33:847–50.
174. Lawrence VA, Kroenke K. The unproven utility of preoperative urinalysis. Clinical use. Arch Intern Med **1988**; 148:1370–3.
175. Sousa R, Muñoz-Mahamud E, Quayle J, et al. Is asymptomatic bacteriuria a risk factor for prosthetic joint infection? Clin Infect Dis **2014**; 59:41–7.
176. Drekonja DM, Zarmbinski B, Johnson JR. Preoperative urine cultures at a Veterans Affairs medical center. JAMA Intern Med **2013**; 173:71–2.
177. Cordero-Ampuero J, González-Fernández E, Martínez-Vélez D, Esteban J. Are antibiotics necessary in hip arthroplasty with asymptomatic bacteriuria? Seeding risk with/without treatment. Clin Orthop Relat Res **2013**; 471:3822–9.
178. Grabe M. Antimicrobial agents in transurethral prostatic resection. J Urol **1987**; 138:245–52.
179. Rao PN, Dube DA, Weightman NC, Oppenheim BA, Morris J. Prediction of septicemia following endourological manipulation for stones in the upper urinary tract. J Urol **1991**; 146:955–60.
180. Herr HW. Should antibiotics be given prior to outpatient cystoscopy? A plea to urologists to practice antibiotic stewardship. Eur Urol **2014**; 65:839–42.
181. Grabe M, Forsgren A, Hellsten S. The effect of a short antibiotic course in transurethral prostatic resection. Scand J Urol Nephrol **1984**; 18:37–42.
182. Grabe M, Forsgren A, Björk T, Hellsten S. Controlled trial of a short and a prolonged course with ciprofloxacin in patients undergoing transurethral prostatic surgery. Eur J Clin Microbiol **1987**; 6:11–7.
183. Cafferkey MT, Falkiner FR, Gillespie WA, Murphy DM. Antibiotics for the prevention of septicaemia in urology. J Antimicrob Chemother **1982**; 9:471–7.
184. Murphy DM, Stassen L, Carr ME, Gillespie WA, Cafferkey MT, Falkiner FR. Bacteraemia during prostatectomy and other transurethral operations: influence of timing of antibiotic administration. J Clin Pathol **1984**; 37:673–6.
185. Schönebeck J, Almgård LE, Boman J. Antibiotics to patients with urinary infections in connection with transurethral prostatectomy. Scand J Infect Dis **1980**; 12:129–31.
186. Olsen JH, Friis-Møller A, Jensen SK, Korner B, Hvidt V. Cefotaxime for prevention of infectious complications in bacteriuric men undergoing transurethral prostatic resection. A controlled comparison with methenamine. Scand J Urol Nephrol **1983**; 17:299–301.
187. Holmquist B, Lundgren R. Pivmecillinam plus pivampicillin versus co-trimoxazole in patients undergoing transurethral prostate resection. Pharmatherapeutica **1984**; 3:686–91.
188. Adolfsson J, Köhler C, Falck L. Norfloxacin versus trimethoprim-sulfamethoxazole. A study in patients with known bacteriuria undergoing transurethral resection of the prostate. Scand J Urol Nephrol **1989**; 23:255–9.
189. Sayin Kutlu S, Aybek Z, Tekin K, et al. Is short course of antimicrobial therapy for asymptomatic bacteriuria before urologic surgical procedures sufficient? J Infect Dev Ctries **2012**; 6:143–7.
190. Chong JT, Klausner AP, Petrossian A, et al. Pre-procedural antibiotics for endoscopic urological procedures: initial experience in individuals with spinal cord injury and asymptomatic bacteriuria. J Spinal Cord Med **2015**; 38:187–92.
191. Nicolle LE. Asymptomatic bacteriuria in the elderly. Infect Dis Clin North Am **1997**; 11:647–62.
192. Kavoussi NL, Siegel JA, Viers BR, et al. Preoperative urine culture results correlate poorly with bacteriology of urologic prosthetic device infections. J Sex Med **2017**; 14:163–8.
193. Carson CC. Penile prosthesis implantation and infection for sexual medicine society of North America. Int J Impot Res **2001**; 13(Suppl 5):S35–8.
194. Petero VG Jr, Diokno AC. Comparison of the long-term outcomes between incontinent men and women treated with artificial urinary sphincter. J Urol **2006**; 175:605–9.
195. Katz BF, Gaunay GS, Barazani Y, et al. Use of a preoperative checklist reduces risk of penile prosthesis infection. J Urol **2014**; 192:130–5.
196. Katz DJ, Stember DS, Nelson CJ, Mulhall JP. Perioperative prevention of penile prosthesis infection: practice patterns among surgeons of SMSNA and ISSM. J Sex Med **2012**; 9:1705–12; quiz 712–4.
197. Selph JP, Carson CC 3rd. Penile prosthesis infection: approaches to prevention and treatment. Urol Clin North Am **2011**; 38:227–35.
198. Bryan DE, Mulcahy JJ, Simmons GR. Salvage procedure for infected noneroded artificial urinary sphincters. J Urol **2002**; 168:2464–6.
199. Cai T, Verze P, Palmieri A, et al. Is preoperative assessment and treatment of asymptomatic bacteriuria necessary for reducing the risk of postoperative symptomatic urinary tract infections after urologic surgical procedures? Urology **2017**; 99:100–5.