

Infectious Diseases Society of America Guidelines for the Diagnosis and Treatment of Asymptomatic Bacteriuria in Adults

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SUMMARY OF RECOMMENDATIONS

1. The diagnosis of asymptomatic bacteriuria should be based on results of culture of a urine specimen collected in a manner that minimizes contamination (A-II) (table 1).

- For asymptomatic women, bacteriuria is defined as 2 consecutive voided urine specimens with isolation of the same bacterial strain in quantitative counts $\geq 10^5$ cfu/mL (B-II).
- A single, clean-catch voided urine specimen with 1 bacterial species isolated in a quantitative count $\geq 10^5$ cfu/mL identifies bacteriuria in men (B-III).
- A single catheterized urine specimen with 1 bacterial species isolated in a quantitative count $\geq 10^2$ cfu/mL identifies bacteriuria in women or men (A-II).

2. Pyuria accompanying asymptomatic bacteriuria is not an indication for antimicrobial treatment (A-II).

3. Pregnant women should be screened for bacteriuria by urine culture at least once in early pregnancy, and they should be treated if the results are positive (A-I).

- The duration of antimicrobial therapy should be

3–7 days (A-II).

- Periodic screening for recurrent bacteriuria should be undertaken following therapy (A-III).
- No recommendation can be made for or against repeated screening of culture-negative women in later pregnancy.

4. Screening for and treatment of asymptomatic bacteriuria before transurethral resection of the prostate is recommended (A-I).

- An assessment for the presence of bacteriuria should be obtained, so that results will be available to direct antimicrobial therapy prior to the procedure (A-III).
- Antimicrobial therapy should be initiated shortly before the procedure (A-II).
- Antimicrobial therapy should not be continued after the procedure, unless an indwelling catheter remains in place (B-II).

5. Screening for and treatment of asymptomatic bacteriuria is recommended before other urologic procedures for which mucosal bleeding is anticipated (A-III).

6. Screening for or treatment of asymptomatic bacteriuria is not recommended for the following persons.

- Premenopausal, nonpregnant women (A-I).
- Diabetic women (A-I).
- Older persons living in the community (A-II).
- Elderly, institutionalized subjects (A-I).
- Persons with spinal cord injury (A-II).
- Catheterized patients while the catheter remains in situ (A-I).

7. Antimicrobial treatment of asymptomatic women with catheter-acquired bacteriuria that persists 48 h after indwelling catheter removal may be considered (B-I).

Received 29 October 2004; accepted 2 November 2004; electronically published 4 February 2005.

These guidelines were developed and issued on behalf of the Infectious Diseases Society of America and have been endorsed by the American Society of Nephrology and the American Geriatric Society.

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Clinical Infectious Diseases 2005;40:643–54

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1058-4838/2005/4005-0001\$15.00

8. No recommendation can be made for screening for or treatment of asymptomatic bacteriuria in renal transplant or other solid organ transplant recipients (C-III).

PURPOSE

The purpose of this guideline is to provide recommendations for diagnosis and treatment of asymptomatic bacteriuria in adult populations >18 years of age. The recommendations were developed on the basis of a review of published evidence, with the strength of the recommendation and quality of the evidence graded using previously described Infectious Diseases Society of America (IDSA) criteria (table 1) [1]. Recommendations are relevant only for the treatment of asymptomatic bacteriuria and do not address prophylaxis for prevention of symptomatic or asymptomatic urinary infection. This guideline is not meant to replace clinical judgment.

Screening of asymptomatic subjects for bacteriuria is appropriate if bacteriuria has adverse outcomes that can be prevented by antimicrobial therapy [2]. Outcomes of interest are short term, such as symptomatic urinary infection (including bacteremia with sepsis or worsening functional status), and longer term, such as progression to chronic kidney disease or hypertension, development of urinary tract cancer, or decreased duration of survival. Treatment of asymptomatic bacteriuria may itself be associated with undesirable outcomes, including subsequent antimicrobial resistance, adverse drug effects, and cost. If treatment of bacteriuria is not beneficial, screening of asymptomatic populations to identify bacteriuria is not indicated, unless performed in a research study to further explore the biology or clinical significance of bacteriuria. Thus, there are 2 topics of interest: whether asymptomatic bacteriuria is associated with adverse outcomes, and whether the interventions of screening and antimicrobial treatment improve these outcomes.

DEFINITIONS

“Asymptomatic bacteriuria,” or asymptomatic urinary infection, is isolation of a specified quantitative count of bacteria in an appropriately collected urine specimen obtained from a person without symptoms or signs referable to urinary infection [3]. “Acute uncomplicated urinary tract infection” is a symptomatic bladder infection characterized by frequency, urgency, dysuria, or suprapubic pain in a woman with a normal genitourinary tract, and it is associated with both genetic and behavioral determinants [4]. “Acute nonobstructive pyelonephritis” is a renal infection characterized by costovertebral angle pain and tenderness, often with fever; it occurs in the same population that experiences acute uncomplicated urinary infection. “Complicated urinary tract infection,” which may involve either the bladder or kidneys, is a symptomatic urinary infection in individuals with functional or structural abnormalities of the genitourinary tract [5]. Uncomplicated urinary infection occurs rarely in men, and urinary infection in men is usually considered complicated. A “relapse” is a recurrent urinary tract infection after therapy resulting from persistence of the pretherapy isolate in the urinary tract. “Reinfection” is recurrent urinary tract infection with an organism originating from outside of the urinary tract, either a new bacterial strain or a strain previously isolated that has persisted in the colonizing flora of the gut or vagina [4]. “Pyuria” is the presence of increased numbers of polymorphonuclear leukocytes in the urine and is evidence of an inflammatory response in the urinary tract [6].

LITERATURE REVIEW

The recommendations in this guideline were developed after a review of studies published in English. These were identified through a search of the PubMed database supplemented by

Table 1. Infectious Diseases Society of America–US Public Health Service Grading System for ranking recommendations in clinical guidelines.

Category, grade	Definition
Strength of recommendation	
A	Good evidence to support a recommendation for use; should always be offered
B	Moderate evidence to support a recommendation for use; should generally be offered
C	Poor evidence to support a recommendation; optional
D	Moderate evidence to support a recommendation against use; should generally not be offered
E	Good evidence to support a recommendation against use; should never be offered
Quality of evidence	
I	Evidence from ≥ 1 properly randomized, controlled trial
II	Evidence from ≥ 1 well-designed clinical trial, without randomization; from cohort or case-controlled analytic studies (preferably from >1 center); from multiple time-series; or from dramatic results from uncontrolled experiments
III	Evidence from opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees

review of references of relevant papers to identify additional reports, particularly early studies not accessed through the PubMed search. In addition, experts in urinary infection were asked to identify any additional trials not accessed through review. Clinical studies include prospective, randomized clinical trials; prospective cohort studies; case-control studies; and other descriptive studies. When appropriate, the methodological rigor of studies was evaluated using accepted criteria (e.g., the CONSORT statement [7]). Studies were excluded if the study population was not adequately characterized to assess generalizability, if procedures for patient follow-up or exclusions may have introduced sufficient bias to limit the credibility of observations, or if there were insufficient numbers of patients enrolled to support valid statistical analysis.

DIAGNOSIS

Asymptomatic bacteriuria is a microbiologic diagnosis determined with a urine specimen that has been collected in a manner to minimize contamination and transported to the laboratory in a timely fashion to limit bacterial growth. The usual quantitative definition is $\geq 10^5$ cfu/mL in 2 consecutive urine specimens [3], initially proposed after studies performed in the 1940s and 1950s [8, 9]. In these studies, a bacterial count of $\geq 10^5$ cfu/mL in a clean, voided specimen was confirmed by a concomitant count in a catheterized specimen in >95% of subjects in several asymptomatic clinical groups, whereas lower quantitative counts in the voided specimen were not usually confirmed by the catheterized specimen [8]. When the screening of asymptomatic women using multiple voided specimens was evaluated, bacteriuria documented in an initial voided urine specimen was confirmed in a second voided specimen, usually obtained several days later, only 80% of the time. If 2 successive bacteriuric voided specimens had similar positive culture results, a third consecutive specimen also yielded consistent results in 95% of cases [9, 10]. Some studies involving women have used a more restrictive criterion of 3 consecutive voided urine specimens collected over 3 weeks with consistent bacteriologic results [11, 12], whereas other studies have used a more permissive criterion of a single positive urine specimen yielding $\geq 10^5$ cfu/mL [13, 14]. Because transient bacteriuria is common in healthy young women [13, 15, 16], the prevalence will be lower if >1 specimen is required for identification of bacteriuria [13].

Microbiologic criteria for diagnosis of asymptomatic bacteriuria in men are not as well validated. The finding of a single voided urine specimen with $\geq 10^5$ cfu/mL of an Enterobacteriaceae was reproducible in 98% of asymptomatic ambulatory men when the culture was repeated within 1 week [17]. A voided specimen with the lower quantitative count of $\geq 10^3$ cfu/mL was 97% sensitive and 97% specific for identification of bacteriuria in ambulatory men, but most of these patients

were symptomatic [18]. If urine specimens are collected using a freshly applied condom catheter and leg bag, however, $\geq 10^5$ cfu/mL is the appropriate quantitative criterion, with 90% validity for identifying asymptomatic bacteriuria in the voided specimen, compared with a paired catheterized specimen [19, 20]. With single urine specimens obtained by urethral catheterization, lower quantitative counts of $\geq 10^2$ cfu/mL are consistent with bacteriuria for both men and women [21, 22]. Patients who have chronic kidney disease, who are experiencing diuresis, or who are infected with selected fastidious organisms may have bacteriuria with lower quantitative counts in voided specimens, but the criteria for bacteriuria in such patients are not standardized [23].

Pyuria is evidence of inflammation in the genitourinary tract and is common in subjects with asymptomatic bacteriuria [13, 24–27]. Pyuria is present with asymptomatic bacteriuria in ~32% of young women [13], 30%–70% of pregnant women [25, 26], 70% of diabetic women [24], 90% of elderly institutionalized patients [27], 90% of hemodialysis patients [28], 30%–75% of bacteriuric patients with short-term catheters in place [29], and 50%–100% of individuals with long-term indwelling catheters in place [30]. Pyuria also accompanies other inflammatory conditions of the genitourinary tract in patients with negative urine culture results. These may be either infectious, such as renal tuberculosis and sexually transmitted diseases, or noninfectious, such as interstitial nephritis. Thus, by itself, the presence of pyuria is not sufficient to diagnose bacteriuria, and the presence or absence of pyuria does not differentiate symptomatic from asymptomatic urinary infection.

Recommendation. The diagnosis of asymptomatic bacteriuria should be based on culture of a urine specimen collected in a manner that minimizes contamination (A-II).

- For asymptomatic women, bacteriuria is defined as 2 consecutive voided urine specimens with isolation of the same bacterial strain in quantitative counts of $\geq 10^5$ cfu/mL (B-II).
- A single, clean-catch, voided urine specimen with 1 bacterial species isolated in a quantitative count of $\geq 10^5$ cfu/mL identifies bacteriuria in asymptomatic men (B-III).
- A single catheterized urine specimen with 1 bacterial species isolated in a quantitative count of $\geq 10^2$ cfu/mL identifies bacteriuria in women or men (A-II).

Pyuria accompanying asymptomatic bacteriuria is not an indication for antimicrobial treatment (A-II).

PREVALENCE OF ASYMPTOMATIC BACTERIURIA

Asymptomatic bacteriuria is common, but the prevalence in populations varies widely with age, sex, and the presence of genitourinary abnormalities (table 2). For healthy women, the prevalence of bacteriuria increases with advancing age, from

Table 2. Prevalence of asymptomatic bacteriuria in selected populations.

Population	Prevalence, %	Reference
Healthy, premenopausal women	1.0–5.0	[31]
Pregnant women	1.9–9.5	[31]
Postmenopausal women aged 50–70 years	2.8–8.6	[31]
Diabetic patients		
Women	9.0–27	[32]
Men	0.7–11	[32]
Elderly persons in the community ^a		
Women	10.8–16	[31]
Men	3.6–19	[31]
Elderly persons in a long-term care facility		
Women	25–50	[27]
Men	15–40	[27]
Patients with spinal cord injuries		
Intermittent catheter use	23–89	[33]
Sphincterotomy and condom catheter in place	57	[34]
Patients undergoing hemodialysis	28	[28]
Patients with indwelling catheter use		
Short-term	9–23	[35]
Long-term	100	[22]

^a Age, ≥70 years.

~1% among schoolgirls to >20% among healthy women ≥80 years of age living in the community [31]. The prevalence of bacteriuria among young women is strongly associated with sexual activity. It was 4.6% among premenopausal married women but only 0.7% among nuns of similar age [12]. Pregnant and nonpregnant women have a similar prevalence of bacteriuria (2%–7%) [31]. Bacteriuria is more common in diabetic women, with a prevalence of 8%–14%, and is usually correlated with duration of diabetes and presence of long-term complications of diabetes, rather than with metabolic parameters of diabetic control [36]. Asymptomatic bacteriuria is rare in healthy young men [37]. The prevalence in men increases substantially after the age of 60 years, presumably because of obstructive uropathy and voiding dysfunction associated with prostatic hypertrophy [27, 37]. From 6% to 15% of men >75 years of age who reside in the community are bacteriuric [31]. Diabetic men do not appear to have an increased prevalence of bacteriuria, compared with nondiabetic men [32].

Many patient groups with chronic disabilities or comorbidities characterized by impaired urinary voiding or with indwelling urinary devices have a very high prevalence of asymptomatic bacteriuria, irrespective of sex. Patients with short-term indwelling urethral catheters acquire bacteriuria at the rate of 2%–7% per day (table 2) [35, 38]. Patients with spinal cord injury have a prevalence of >50%, whether voiding is managed by intermittent catheterization or by sphincterotomy and condom drainage [33, 34]. Patients undergoing hemodialysis have a prevalence of asymptomatic bacteriuria of 28% [28]. Twenty-

five percent to 50% of elderly women and 15%–40% of elderly men in long-term care facilities are bacteriuric [27]. The majority of these elderly persons have chronic neurologic illnesses, with the highest prevalence of bacteriuria observed in the most highly functionally impaired residents. The clinical assessment of elderly bacteriuric residents to ascertain the presence or absence of symptoms may be problematic, and observations of cloudy or smelly urine by themselves should not be interpreted as indications of symptomatic infection [39]. Use of a long-term indwelling catheter [22] or permanent ureteric stent [40] is associated with bacteriuria virtually 100% of the time.

MICROBIOLOGY OF ASYMPTOMATIC BACTERIURIA

Escherichia coli remains the single most common organism isolated from bacteriuric women [11, 12, 41], although this happens proportionally less frequently than for women with acute uncomplicated urinary tract infection. *E. coli* strains isolated from women with asymptomatic bacteriuria are characterized by fewer virulence characteristics than are those isolated from women with symptomatic infection [42]. Other Enterobacteriaceae (such as *Klebsiella pneumoniae*) and other organisms (including coagulase-negative staphylococci, *Enterococcus* species, group B streptococci, and *Gardnerella vaginalis*) are common as well. For men, coagulase-negative staphylococci are also common, in addition to gram-negative bacilli and *Enterococcus* species [43, 44]. Subjects with abnormalities of the genitouri-

nary tract, including elderly institutionalized subjects, have a wide variety of organisms isolated. *E. coli* remains the single most common organism isolated from women, but other organisms, such as *Proteus mirabilis*, are more common in men [27]. Men and women with a long-term urologic device in place usually have polymicrobial bacteriuria, which often includes *Pseudomonas aeruginosa* and urease-producing organisms, such as *P. mirabilis*, *Providencia stuartii*, and *Morganella morganii* [22, 27].

THE MANAGEMENT OF ASYMPTOMATIC BACTERIURIA

Premenopausal, Nonpregnant Women

The natural history of asymptomatic bacteriuria in premenopausal nonpregnant women has been described in short-term [13] and long-term [41, 45–48] prospective cohort studies. In young women, symptomatic urinary infection occurred significantly more frequently in bacteriuric women than in nonbacteriuric women within 1 week after a urine culture (8% of bacteriuric women became symptomatic, compared with 1% of women without bacteriuria) [13]. The increased risk of symptomatic infection remained at 1 month after new-onset bacteriuria [13]. Long-term cohort studies also report an increased frequency of symptomatic urinary infection in women identified with asymptomatic bacteriuria at initial screening [46, 47]. In a Swedish study, after 15 years of follow-up, symptomatic urinary infection and pyelonephritis occurred at least once in 55% and 7.5% of women with bacteriuria at enrollment, respectively, and in 10% and 0% of those without bacteriuria, respectively [47]. Women with bacteriuria at enrollment were also more likely to be bacteriuric at follow-up, regardless of whether antimicrobial therapy was given [41, 47, 49].

In 3 prospective studies from Wales and Jamaica that enrolled women aged 15–84 years, increased mortality was observed among bacteriuric women [49]. The association of bacteriuria and mortality was not as strong when the bacteriuric and nonbacteriuric groups were age- and weight-matched, and no stratification for other potential confounders was performed. In a Swedish study that enrolled women with a median age of 58 years (range, 35–72 years), there were no differences in the rates of hypertension or chronic kidney disease between bacteriuric and nonbacteriuric women after 15 years of follow-up [47]. In another Swedish study of women initially enrolled at 38–60 years of age, the rates of progression to chronic kidney disease and mortality were similar for bacteriuric and nonbacteriuric subjects after 24 years [41]. Bacteriuric women and nonbacteriuric control subjects did not differ with regard to serum creatinine levels and intravenous pyelogram findings after 3–5 years of follow-up in an English study [48].

A prospective, controlled trial randomized bacteriuric women to receive a 1-week course of therapy with nitrofur-

antoin or placebo [50]. The antibiotic group had a significantly lower prevalence of bacteriuria at 6 months but not at 1 year. Episodes of symptomatic infection 1 year after therapy occurred with a similar frequency in the treatment and placebo groups [50].

These studies support the conclusions that healthy, bacteriuric, premenopausal women are at an increased risk for symptomatic urinary infection and are more likely to have bacteriuria at follow-up. However, asymptomatic bacteriuria is not associated with long-term adverse outcomes, such as hypertension, chronic kidney disease, genitourinary cancer, or decreased duration of survival. The association of asymptomatic bacteriuria with symptomatic urinary infection is likely attributable to host factors that promote both symptomatic and asymptomatic urinary infection, rather than symptomatic infection being attributable to asymptomatic bacteriuria. Finally, treatment of asymptomatic bacteriuria neither decreases the frequency of symptomatic infection nor prevents further episodes of asymptomatic bacteriuria.

Recommendation. Screening for and treatment of asymptomatic bacteriuria in premenopausal, nonpregnant women is not indicated (A-I).

Pregnant Women

Women identified with asymptomatic bacteriuria in early pregnancy have a 20–30-fold increased risk of developing pyelonephritis during pregnancy, compared with women without bacteriuria [26, 51–59]. These women also are more likely to experience premature delivery and to have infants of low birth weight. Prospective, comparative clinical trials have consistently reported that antimicrobial treatment of asymptomatic bacteriuria during pregnancy decreases the risk of subsequent pyelonephritis from 20%–35% to 1%–4% (table 3) [60]. Meta-analyses of cohort studies and randomized clinical trials also support the conclusion that antimicrobial treatment of asymptomatic bacteriuria decreases the frequency of low-birth weight infants and preterm delivery [61, 62]. Most of these studies were performed early in the antimicrobial era, with nitrofurantoin and sulfonamides being the most common antimicrobials. The consistency and robustness of observations from multiple studies resulted in screening for and treatment of asymptomatic bacteriuria during pregnancy becoming a standard of care in developed countries. More-recent reports of implementation of screening and treatment programs for asymptomatic bacteriuria in pregnant women report a decrease in rates of pyelonephritis for all pregnant women, from 1.8% to 0.6% in a Spanish health care center [63], and 2.1% to 0.5% in a Turkish health care center [64]. These are consistent with the early reports of benefits with screening for and treatment of asymptomatic bacteriuria during pregnancy.

In the therapeutic studies that established the benefit of treat-

Table 3. Findings of comparative clinical trials of antimicrobial therapy for the treatment of asymptomatic bacteriuria in pregnancy.

Reference(s)	Design	Antimicrobial therapy	No. of patients with pyelonephritis/ total no. of patients (%)		
			Initially negative result ^a	Initially positive result ^a	
				Treated patients	Nontreated patients
LeBlanc and McGanity [55]	Randomized, not blinded	Sulfonamide and mandelamine, nitrofurantoin, or mandelamine alone; mandelamine to term	22/1143 (1.9)	3/69 (4.3)	8/41 (20)
Brumfit [56] and Condie et al. [57]	Randomized, placebo-controlled	Sulfonamides	3/150 (2)	4/67 (6.0)	55/179 (31)
Wren [58]	Alternating between antibiotics and no antibiotics	Nitrofurantoin, ampicillin, sulfonamide, and nalidixic acid to term	...	NS	33/90 (37)
Elder et al. [59]	Alternating, placebo-controlled	Tetracycline for 6 weeks	6/279 (2)	4/133 (3.0)	27/148 (18)
Savage et al. [52]	Alternating, placebo-controlled	Sulfonamide to term	7/496 (1.4)	1/93 (1.1)	26/98 (26)
Kincaid-Smith and Bullen [26]	Cohort, sequential	Various	...	2/61 (3.3)	20/53 (37)
Little [54]	Randomized, not blinded	Sulfonamide to term	19/4735 (0.4)	4/124 (3.2)	35/141 (25)

NOTE. NS, not specified.

^a Microbiologic results from initial screening urine culture in pregnancy.

ment of asymptomatic bacteriuria during pregnancy, administration of antimicrobial therapy usually continued for the duration of the pregnancy (table 3). A prospective, randomized study of continuous antimicrobial therapy to the end of pregnancy compared with 14 days of nitrofurantoin or sulfamethizole, followed by weekly urine culture screening and re-treatment if bacteriuria recurred, reported similar outcomes for the 2 treatment groups [65]. A recent Cochrane systematic review concluded that there was insufficient evidence to recommend a duration of antimicrobial therapy for pregnant women among single-dose, 3-day, 4-day, and 7-day treatment regimens [66]. Thus, the optimal duration of antimicrobial therapy for treatment of bacteriuria in pregnant women has not been determined.

The appropriate screening test is a urine culture [67]. Screening for pyuria has a low sensitivity—only ~50% for identification of bacteriuria in pregnant women [25]. The optimal frequency of screening is not well defined. Women with a negative urine culture result for a single screening specimen at 12–16 weeks have a 1%–2% risk of developing pyelonephritis later in pregnancy (table 3). What proportion of this may be prevented with repeated routine screening is not known. A single urine sample obtained for culture at week 16 of gestation was concluded to be optimal in a Swedish study [68]. An American cost evaluation from the viewpoint of the outcome of pyelonephritis concluded that a single screening culture in the first trimester was cost-effective if the prevalence of bacteriuria was >2% and the risk of pyelonephritis in bacteriuric women was >13% [69].

Recommendation. Pregnant women should be screened for bacteriuria by urine culture at least once in early pregnancy,

and they should be treated if the results are positive (A-I).

- The duration of antimicrobial therapy should be 3–7 days (A-III).
- Periodic screening for recurrent bacteriuria should be undertaken after therapy (A-III).
- No recommendation can be made for or against routine repeated screening of culture-negative women in the later phase of pregnancy.

Diabetic Women

Prospective, cohort studies of diabetic women report no differences in rates of symptomatic urinary infection, mortality, or progression to diabetic complications between initially bacteriuric and nonbacteriuric women at 18 months [70] or 14 years [71] of follow-up. A randomized, controlled trial of antibiotic therapy or no therapy for diabetic women with asymptomatic bacteriuria and continued screening for bacteriuria every 3 months reported, after a maximum of 3 years of follow-up, that antimicrobial therapy did not delay or decrease the frequency of symptomatic urinary infection, nor did it decrease the number of hospitalizations for urinary infection or other causes [72]. There was no acceleration of progression of diabetic complications, such as nephropathy, in bacteriuric subjects who did not receive antimicrobial therapy. Diabetic women who received antimicrobial therapy, however, had 5 times as many days of antimicrobial use and significantly more adverse antimicrobial effects. Thus, there were no benefits for continued screening and treatment of asymptomatic bacteriuria in diabetic women, and there was evidence of some harm.

Recommendation. Screening for or treatment of asymptomatic bacteriuria in diabetic women is not indicated (A-I).

Older Persons Residing in the Community

Large, long-term, cohort studies of asymptomatic bacteriuria have enrolled both pre- and postmenopausal women [41, 46, 47, 49]. These studies uniformly report no excess adverse outcomes in women with asymptomatic bacteriuria. A prospective, randomized study of nitrofurantoin or placebo also enrolled women aged 20–65 years, with a median age between 40–49 years [50]. Thus, these studies report that outcomes of bacteriuria and treatment of bacteriuria in healthy postmenopausal women are similar to those observed in premenopausal, non-pregnant women.

A prospective, randomized clinical trial of antimicrobial treatment versus placebo for bacteriuria enrolled ambulatory women who resided in a geriatric apartment facility and reported a decrease in the prevalence of asymptomatic bacteriuria at 6 months, but there was no significant difference in the number of symptomatic episodes [73]. A prospective cohort study of 134 ambulatory male veterans >65 years of age observed for 1–4.5 years, including 29 subjects with bacteriuria, reported no adverse outcomes attributable to untreated bacteriuria [44]. Population-based cohort studies report no association between bacteriuria and survival for Swedish men and women at 5 years of follow-up [74] or Finnish men and women aged >85 years during 5 years of follow-up [75].

Recommendation. Routine screening for and treatment of

asymptomatic bacteriuria in older persons resident in the community is not recommended (A-II).

Elderly Institutionalized Subjects

Prospective, randomized clinical trials of antimicrobial therapy or no therapy for elderly residents of long-term care facilities have reported no benefits of screening for or treatment of asymptomatic bacteriuria (table 4) [76–79]. There was no decrease in the rate of symptomatic infection or improvement in survival [76–78], and there were no changes in chronic genitourinary symptoms [79] associated with antimicrobial therapy. Treatment of asymptomatic bacteriuria was associated with significantly increased adverse antimicrobial effects [76] and reinfection with organisms of increasing resistance [76]. Prospective cohort studies report similar survival data for long-term care facility residents with and those without bacteriuria among women in the United States [78], men in Canada [80], and women or men in Greece [81].

Recommendation. Screening for and treatment of asymptomatic bacteriuria in elderly institutionalized residents of long-term care facilities is not recommended (A-I).

Subjects with Spinal Cord Injuries

Subjects with spinal cord injuries have a high prevalence of bacteriuria, and they also experience a high incidence of symp-

Table 4. Randomized clinical trials of treatment of asymptomatic bacteriuria in elderly populations.

Population	Age, years ^a	Study description	Duration of follow-up	Outcomes	Reference
Ambulatory women	85.8	Randomized trial of single-dose TMP or cefaclor (500 mg t.i.d. for 3 days); culture repeated at month 6	6 months	At 6 months, bacteriuria was present in 64% of untreated vs. 35% of treated patients; antimicrobial given for symptomatic UTI, 16.4% vs. 7.9% ($P = \text{NS}$)	[73]
Institutionalized women	83.5	Randomized, trial; patients were monitored monthly and re-treated if results were positive for subjects randomized to therapy	12 months	Rate of symptomatic UTI, 0.92 cases per patient-year for the no therapy group vs. 0.67 cases per patient-year for the therapy group ($P = \text{NS}$); mortality at 12 months, 18% vs. 39% ($P = .11$; 95% CI, -0.05 to $+0.47$); therapy recipients had significantly more adverse drug-related events and reinfections with resistant organisms	[74]
Institutionalized veterans	80 ^b	Randomized trial; patients were monitored every 2 weeks and were re-treated if results were positive	24 months	Rates of symptomatic UTI and mortality were similar	[77]
Ambulatory and institutionalized women	81.9	Randomized, placebo-controlled trial of TMP vs. single-dose norfloxacin administered every 14 days; cultures were performed every 6 months	9 years	Similar mortality rates at 9 years (RR, 0.92; 95% CI, 0.50–1.47).	[78]
Institutionalized incontinent women and men	84.5	Randomized trial of norfloxacin given every 7 days	3 days	At 3 days, no difference in continence	[79]

NOTE. RR, relative risk; TMP, trimethoprim; UTI, urinary tract infection.

^a Data are mean age, unless otherwise indicated.

^b Median age.

tomatic urinary infection [34, 82]. When asymptomatic bacteriuria was uniformly treated in a cohort of catheter-free, primarily male, spinal cord-injured subjects, early recurrence of bacteriuria after therapy was the usual outcome. After 7–14 days of antibiotic therapy, 93% of subjects were again bacteriuric by 30 days after completion of therapy, and after a 28-day course of antibiotic therapy, 85% were bacteriuric by 30 days [83]. Reinfesting strains showed increased antimicrobial resistance. When 52 patients with a relatively recent onset of spinal cord injury were observed prospectively for 4–26 weeks, the results of 78% of weekly urine cultures were positive, but only 6 symptomatic episodes occurred, all of which responded promptly to antimicrobial treatment [84]. In a small, randomized, placebo-controlled trial, rates of symptomatic urinary infection and recurrence of bacteriuria were similar among recipients of either antimicrobial or placebo for patients with bladder emptying managed by intermittent catheterization [85]. A prospective, randomized trial of antimicrobial treatment or no treatment of asymptomatic bacteriuria enrolled 50 patients who were treated with intermittent catheterization and reported a similar frequency of symptomatic urinary infection during an average of 50 days of follow-up, irrespective of whether prophylactic antimicrobials were given [86]. Although there have been a limited number of clinical trials, and although interpretation of results is compromised by relatively short durations of follow-up and small study numbers, review articles [87, 88] and consensus guidelines [89] uniformly recommend treatment only of symptomatic urinary tract infection in patients with spinal cord injuries.

Recommendation. Asymptomatic bacteriuria should not be screened for or treated in spinal cord-injured patients (A-II).

Patients with Indwelling Urethral Catheters

Short-term catheters. Approximately 80% of acute care facility patients with short-term (<30 days) indwelling urethral catheters receive antimicrobial therapy, usually for an indication other than urinary infection [90, 91]. This high frequency of concurrent antimicrobial use makes assessment of outcomes unique to treatment of asymptomatic bacteriuria problematic. A prospective, cohort study of 235 catheter-acquired infections among 1497 patients, 90% of whom were asymptomatic, reported only 1 secondary bloodstream infection [92]. A case-control study reported that acquisition of bacteriuria with indwelling urethral catheterization increased mortality 3-fold, but the explanation for this association was not clear, and multivariate analysis found that antimicrobial therapy did not alter the association with mortality [93]. A prospective, randomized, placebo-controlled trial of treatment of funguria in 313 patients, more than one-half of whom had indwelling urethral catheters in place, showed no differences in eradication of fun-

guria 2 weeks after therapy for catheterized subjects and no clinical benefits of treatment [94].

A prospective, randomized, placebo-controlled trial of antimicrobial treatment of asymptomatic bacteriuria persisting 48 h after removal of short-term catheters in women with catheter-acquired bacteriuria reported significantly improved microbiologic and clinical outcomes at 14 days in treated women [95]. Although 15 (36%) of 42 women randomized to receive no therapy had spontaneous microbiologic resolution by 14 days, 7 (17%) developed symptoms. No women in the treatment group became symptomatic. This study enrolled a selected group of hospitalized women characterized by being relatively young (median age, 50 years) and experiencing a short period of catheterization (median duration, 3 days).

Long-term catheters. A prospective, randomized trial of cephalexin therapy versus no antibiotic therapy for bacteriuric patients with long-term indwelling urethral catheters in place and drug-susceptible organisms isolated reported a similar incidence of fever among both treated and untreated patients observed for 12–44 weeks [96]. Rates of reinfection were also similar, but 75% of reinfesting organisms in the control group remained susceptible to cephalexin, compared with only 36% in the cephalexin treatment group. A prospective, noncomparative study of consecutive courses of antimicrobial treatment to eradicate bacteriuria in elderly patients with long-term catheters reported no decrease in the number of episodes of fever with treatment, compared with the pretreatment period, and there was immediate recurrence of bacteriuria after therapy, often with organisms of increasing resistance [97].

Recommendation. Asymptomatic bacteriuria or funguria should not be screened for or treated in patients with an indwelling urethral catheter (A-I).

- Antimicrobial treatment of asymptomatic women with catheter-acquired bacteriuria that persists 48 h after catheter removal may be considered. (B-I)

Urologic Interventions

Patients with asymptomatic bacteriuria who undergo traumatic genitourinary procedures associated with mucosal bleeding have a high rate of postprocedure bacteremia and sepsis. Bacteremia occurs in up to 60% of bacteriuric patients who undergo transurethral prostatic resection, and there is clinical evidence of sepsis in 6%–10% of these persons [98]. Retrospective analysis [99] and prospective, randomized clinical trials [100–103] support the effectiveness of antimicrobial treatment in preventing these complications in bacteriuric men undergoing transurethral resection of the prostate. In one comparative trial, the efficacy of cefotaxime was superior to that of methenamine mandelate [101]. There is little information relevant to other procedures, but any intervention with a high probability of mucosal bleeding

should be considered a risk [104]. Pretreatment of asymptomatic bacteriuria is not beneficial for all invasive procedures. For instance, replacement of a long-term indwelling foley catheter is associated with a low risk of bacteremia, and antimicrobial treatment is not beneficial [105, 106].

The appropriate timing for initiation of antimicrobial therapy is not well defined. Although 72 h before the intervention has been suggested [107], this is likely to be excessive and allows the opportunity for superinfection before the procedure. Initiation of therapy the night before or immediately before the procedure is effective [99, 103]. The optimal time to obtain a sample for culture before the procedure and the duration of antimicrobial therapy are also not addressed in clinical trials. In the absence of an indwelling catheter, antimicrobial therapy can likely be discontinued immediately after the procedure [99, 102, 103]. When an indwelling catheter remains in place after a prostatic resection, it has been recommended by some investigators that antimicrobial therapy be continued until the catheter is removed [98, 99].

Recommendation. Screening for and treatment of asymptomatic bacteriuria before transurethral resection of the prostate is recommended (A-I).

- An assessment for the presence of bacteriuria should be obtained, so results will be available to direct antimicrobial therapy prior to the procedure (A-III).
- Antimicrobial therapy should be initiated shortly before the procedure (A-II).
- Antimicrobial therapy should not be continued beyond the procedure, unless an indwelling catheter remains in place (B-II).

Screening for and treatment of asymptomatic bacteriuria is recommended before other urologic procedures in which mucosal bleeding is anticipated (A-III).

Immunocompromised Patients and Other Patients

Cohort studies performed early in the transplantation era reported a high prevalence of asymptomatic bacteriuria among renal transplant recipients, especially in the first 6 months after transplantation [108, 109]. Evolution in management of transplantation has introduced routine perioperative prophylaxis, minimization of use of indwelling urethral catheters, and long-term antimicrobial prophylaxis to prevent pneumonia and other infections. These interventions also prevent both asymptomatic bacteriuria and symptomatic urinary infection [110, 111]. Recent studies, including a retrospective chart review [112] and a prospective cohort study [113], have not reported an association between asymptomatic bacteriuria and graft survival. Transplant recipients with urinary infection and poor graft outcome are also characterized by urologic abnormalities and are identified by episodes of symptomatic urinary infection,

rather than bacteriuria [113]. Thus, with current management strategies, screening for bacteriuria is unlikely to provide a benefit. Some experts do recommend screening for bacteriuria, at least for the first 6 months after renal transplantation [114]. Recent guidelines for outpatient surveillance of renal transplant recipients, however, make no recommendation for screening for bacteriuria [115, 116].

Screening for or treatment of bacteriuria has not been evaluated for other solid organ transplant recipients. Guidelines for infection prevention in bone marrow transplant recipients make no recommendation for screening for bacteriuria [117]. A small study of women with primary biliary cirrhosis and bacteriuria randomized to receive either antimicrobial therapy or no antimicrobial therapy reported no differences in the time to reinfection or the number of reinfections in the 2 groups [118]. Limited studies involving HIV-infected patients have reported no association between asymptomatic bacteriuria and HIV infection in women, but there was an increased prevalence of bacteriuria among HIV-infected men that was inversely correlated with CD4⁺ cell counts [30]. Adverse clinical outcomes associated with bacteriuria in these populations have not been reported.

Recommendations. No recommendation can be made for screening for or treatment of asymptomatic bacteriuria in renal transplant or other solid organ transplant recipients (C-III).

SUMMARY

Asymptomatic bacteriuria is common. Pregnant women with asymptomatic bacteriuria are at an increased risk for adverse outcomes, and these can be prevented with antimicrobial treatment of asymptomatic bacteriuria. Thus, pregnant women should be screened for bacteriuria and treated if test results are positive. Asymptomatic bacteriuria is also a risk for patients who undergo traumatic urologic interventions with mucosal bleeding, and such patients should be treated prior to such interventions. For all other adult populations, asymptomatic bacteriuria has not been shown to be harmful. Although persons with bacteriuria are at an increased risk of symptomatic urinary infection, treatment of asymptomatic bacteriuria does not decrease the frequency of symptomatic infection or improve other outcomes. Thus, in populations other than those for whom treatment has been documented to be beneficial, screening for or treatment of asymptomatic bacteriuria is not appropriate and should be discouraged.

RESEARCH PRIORITIES

Many issues relevant to asymptomatic bacteriuria require further research and evaluation in appropriately conducted clinical trials.

- Exploration of the clinical and microbiologic implications,

if any, of pyuria in selected populations, such as pregnant women.

- The utility of obtaining a second urine specimen to confirm asymptomatic bacteriuria prior to treatment after an initial positive screening specimen in pregnant women.
- The optimal duration of antimicrobial therapy for treatment of asymptomatic bacteriuria in pregnant women requires evaluation in appropriate clinical trials.
- Further characterization of symptomatic presentations of urinary infection in elderly institutionalized populations with a high prevalence of bacteriuria.
- Management of asymptomatic bacteriuria in subjects with chronic kidney disease.
- Characterization of the natural history and appropriate management of individuals with long-term indwelling urinary devices other than indwelling catheters (e.g., urinary stents and nephrostomy tubes).
- Whether individuals with asymptomatic bacteriuria with urea-splitting organisms but without indwelling devices require a distinct approach for investigation or treatment.
- Select immunocompromised patients, including those with neutropenia or who have undergone solid organ transplantation, require further characterization of the impacts, if any, of asymptomatic bacteriuria.
- The optimal time to initiate therapy, duration of therapy, and antimicrobial choice for treatment of bacteriuria prior to invasive genitourinary procedures require evaluation in further clinical trials.
- Whether there are clinical benefits of screening for and treatment of bacteriuria prior to a surgical procedure with prosthetic implantation, including orthopedic and vascular procedures.

Acknowledgments

We thank the following individuals for review and helpful suggestions in the development of this guideline: Elias Abrutyn, Diana Cardenas, Stephan Fihn, Kalpana Gupta, Jeremy Hamilton-Miller, Godfrey Harding, Andy Hoepelman, James R. Johnson, Calvin Kunin, Leonard Leibovici, Benjamin Lipsky, Kurt G. Naber, Raul Raz, Allan Ronald, Thomas Russo, Jack Sobel, Walter Stamm, Ann Stapleton, and John Warren. Expert secretarial assistance was provided by Brenda DesRosiers.

Potential conflicts of interest. L.E.N. has received research funding from Ortho-McNeil. R.C. has received research funding from Ortho-McNeil and has served on the speakers' bureau for Bayer. A.S. has been a consultant for Ortho-McNeil, Proctor & Gamble, Gerson Lehrman Group, Urologix, DepoMed, Schwarz BioSciences GmbH, and SynerMed Communications. T.M.H. has been a consultant for Bayer and served on the speakers' bureau for Aventis, Bayer, Merck, and Pfizer.

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