# 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).

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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 $\geqslant 10^5$ 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 $\geqslant 10^5$ 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 $\geqslant 10^5$ 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 $\geqslant 10^5$ 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 $\geqslant 10^3$ 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, $\geqslant 10^5$ 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 $\geqslant 10^2$ 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 $\geqslant 10^5$ cfu/mL (B-II).
- A single, clean-catch, voided urine specimen with 1 bacterial species isolated in a quantitative count of $\geqslant 10^5$ cfu/mL identifies bacteriuria in asymptomatic men (B-III).
- A single catheterized urine specimen with 1 bacterial species isolated in a quantitative count of $\geqslant 10^2$ 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 nitrofurantoin 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, nonpregnant 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% ($P$ = 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 ($P$ = 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]. Reinfecting 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 funguria 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 reinfecting 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 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.

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## References

1. McGowan JE, Chesney PJ, Crossley KB, La Forea FM. Guidelines for the use of systemic glucocorticosteroids in the management of selected infections. J Infect Dis **1992**; 165:1–13.
2. US Preventive Services Task Force. Screening for asymptomatic bacteriuria. In: Guide to clinical preventive services. 2nd edition. **1996**. Available at: http://www.ahcpr.gov/clinic/uspstfix.htm. Accessed May 2004.
3. Rubin RH, Shapiro ED, Andriole VT, Davis RJ, Stamm WE. Evaluation of new anti-infective drugs for the treatment of urinary tract infection. Clin Infect Dis **1992**; 15(Suppl 1):S216–27.
4. Hooton TM, Stamm WE. Diagnosis and treatment of uncomplicated urinary tract infection. Infect Dis Clin North Am **1997**; 11:551–82.
5. Nicolle LE. A practical approach to the management of complicated urinary tract infection. Drugs Aging **2001**; 18:243–54.
6. Stamm WE. Measurement of pyuria and its relation to bacteriuria. Am J Med **1983**; 75(Suppl 1B):53–58.
7. Moher D, Schulz KF, Altman DG. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. CONSORT Group (Consolidated Standards of Reporting Trials). Ann Intern Med **2001**; 134:657–62.
8. Kass EH. Bacteriuria and the diagnosis of infections of the urinary tract. Arch Intern Med **1957**; 100:709–14.
9. Kass EH. Pyelonephritis and bacteriuria: a major problem in preventive medicine. Ann Intern Med **1962**; 56:46–53.
10. Kunin CM. Asymptomatic bacteriuria. Ann Rev Med **1966**; 17: 383–406.
11. Evans DA, Williams DN, Laughlin LW, et al. Bacteriuria in a population-based cohort of women. J Infect Dis **1978**; 138:768–73.
12. Kunin CM, McCormack RC. An epidemiologic study of bacteriuria and blood pressure among nuns and working women. N Engl J Med **1968**; 278:635–42.
13. Hooton TM, Scholees D, Stapleton AE, et al. A prospective study of asymptomatic bacteriuria in sexually active young women. N Engl J Med **2000**; 343:992–7.
14. Geerlings SE, Stolk RP, Camps MJ, et al. Asymptomatic bacteriuria may be considered a complication in women with diabetes. Diabetes Care **2000**; 23:744–9.
15. Kunin CM, Polyak F, Postel E. Periurethral bacterial flora in women: prolonged intermittent colonization with *E. coli*. JAMA **1980**; 243: 134–9.
16. Nicolle LE, Harding GKM, Preiksaitis J, Ronald AR. The association of urinary tract infection with sexual intercourse. J Infect Dis **1982**; 146:579–83.
17. 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.
18. Lipsky BA, Ireton RC, Fihn SD, Hackett R, Berger RE. Diagnosis of bacteriuria in men: specimen collection and culture interpretation. J Infect Dis **1987**; 155:847–54.
19. Ouslander JG, Greengold BA, Silverblatt FJ, Garcia JP. An accurate method to obtain urine for culture in men with external catheters. Arch Intern Med **1987**; 147:286–8.
20. Nicolle LE, Harding GKM, Kennedy J, McIntyre M, Aoki F, Murray D. Urine specimen collection with external devices for diagnosis of bacteriuria in elderly incontinent men. J Clin Microbiol **1988**; 26: 1115–9.
21. Saint SJ, Chenoweth CE. Biofilms and catheter-associated urinary tract infections. Infect Dis Clin North Am **2003**; 17:411–32.
22. 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.
23. Kass EH. Asymptomatic infections of the urinary tract. Trans Assoc Amer Phys **1956**; 69:56–64.
24. Zhanel GG, Nicolle LE, Harding GM. Prevalence of asymptomatic bacteriuria and associated host factors in women with diabetes mellitus. Manitoba Diabetic Urinary Infection Study Group. Clin Infect Dis **1995**; 21:316–22.
25. Bachman JW, Heise RH, Naessons JM, Timmerman MG. A study of various tests to detect asymptomatic urinary tract infections in an obstetric population. JAMA **1993**; 270:1971–4.

26. Kincaid-Smith P, Bullen M. Bacteriuria in pregnancy. Lancet **1965**; 1: 395–9.
27. Nicolle LE. Asymptomatic bacteriuria in the elderly. Infect Dis Clin North Am **1997**; 11:647–62.
28. Chaudhry A, Stone WJ, Breyer JA. Occurrence of pyuria and bacteriuria in asymptomatic hemodialysis patients. Am J Kid Dis **1993**; 21:180–3.
29. Tambyah PA, Maki DG. The relationship between pyuria and infection in patients with indwelling urinary catheters. Arch Intern Med **2000**; 160:673–82.
30. Steward DK, Wood GL, Cohen RL, Smith JW, Mackowiak PA. Failure of the urinalysis and quantitative urine culture in diagnosing symptomatic urinary tract infections in patients with long-term urinary catheters. Am J Infect Control **1985**; 13:154–60.
31. Nicolle LE. Asymptomatic bacteriuria: when to screen and when to treat. Infect Dis Clin North Am **2003**; 17:367–94.
32. Zhanel G, Harding GKM, Nicolle LE. Asymptomatic bacteriuria in diabetics. Rev Infect Dis **1991**; 13:150–4.
33. Bakke A, Digranes A. Bacteriuria in patients treated with clean, intermittent catheterization. Scand J Infect Dis **1991**; 23:577–82.
34. 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.
35. Stamm WS. Catheter-associated urinary tract infections: epidemiology, pathogenesis and prevention. Am J Med **1991**; 91(Suppl B): 65S–71S.
36. Zhanel GG, Nicolle LE, Harding GKM, Prevalence of asymptomatic bacteriuria in women with diabetes mellitus. Manitoba Diabetic Urinary Infection Study Group. Clin Infect Dis **1995**; 21:316–22.
37. Lipsky B. Urinary tract infections in men: epidemiology, pathophysiology, diagnosis, and treatment. Ann Intern Med **1989**; 110:138–50.
38. Garibaldi RA, Burke JP, Dickman ML, Smith CB. Factors predisposing to bacteriuria during indwelling urethral catheterization. N Engl J Med **1974**; 291:215–9.
39. Nicolle LE. Urinary tract infections in long-term care facilities. SHEA Long Term Care Committee. Infect Control Hosp Epidemiol **2001**; 22:167–75.
40. Reidl CR, Plas E, Hubner WA, Zimmer IH, Ulrish W, Pfluger H. Bacterial colonization of ureteral stents. Eur Urol **1999**; 36:53–9.
41. Bengtsson C, Bengtsson U, Bjorkelund C, Lincoln KM, Sigurdson JA. Bacteriuria in a population sample of women: 24-year follow-up study. Results from the prospective population-based study of women in Gottenburg, Sweden. Scand J Urol Nephrol **1998**; 32:284–9.
42. Svanborg C, Godaly G. Bacterial virulence in urinary tract infection. Infect Dis Clin North Am **1997**; 11:513–30.
43. Lipsky BA, Inui TS, Plorde JJ, Berger RE. Is the clean-catch midstream void procedure necessary for obtaining urine culture specimens from men? Am J Med **1984**; 76:257–62.
44. Mims AD, Norman DC, Yamamura RH, Yoshikawa TT. Clinically inapparent (asymptomatic) bacteriuria in ambulatory elderly men: epidemiological, clinical, and microbiological findings. J Am Geriatr Soc **1990**; 38:1209–14.
45. Freedman LR. Natural history of urinary infection in adults. Kidney Inter Suppl **1975**; 4:S96–100.
46. Alwall N. On controversial and open questions about the course and complications of non-obstructive urinary tract infection in adult women. Acta Med Scand **1978**; 203:369–77.
47. Tencer J. Asymptomatic bacteriuria—a long term study. Scand Jour Urol Nephrol **1988**; 22:31–4.
48. Asscher AW, Chick S, Radford N. Natural history of asymptomatic bacteriuria in non-pregnant women. In: Urinary tract infection. Brumfit W, Asscher AW, eds. London: Oxford University Press, **1973**: 51–60.
49. Evans DA, Kass EH, Hennekens CH, et al. Bacteriuria and subsequent mortality in women. Lancet **1982**; 1:156–58.
50. Asscher AW, Sussman M, Waters WE, et al. Asymptomatic bacteriuria in the non-pregnant woman. II. Response to treatment and follow-up. BMJ **1969**; 1:804–6.
51. Nicolle LE. Screening for asymptomatic bacteriuria in pregnancy. In: The Canadian guide to clinical preventive health care. The Canadian Task Force on the Periodic Health Examination, ed. Ottawa: Canada Communication Group, **1994**:P100–6.
52. Savage WE, Hajj SN, Kass EH. Demographic and prognostic characteristics of bacteriuria in pregnancy. Medicine **1967**; 46:385–407.
53. Gilstrap LC, Leveno KJ, Cunningham EF, et al. Renal infection and pregnancy outcome. Am J Obstet Gynecol **1981**; 141:709–16.
54. Little PJ. The incidence of urinary infection in 5000 pregnant women. Lancet **1966**; 2:925–8.
55. LeBlanc AL, McGanity WJ. The impact of bacteriuria in pregnancy—a survey of 1300 pregnant patients. Biol Med (Paris) **1964**; 22:336–47.
56. Brumfitt W. The effects of bacteriuria in pregnancy on maternal and fetal health. Kidney Int Suppl **1975**; 8:S113–9.
57. Condie AP, Williams JD, Reeves DS, Brumfitt W. Complications of bacteriuria in pregnancy. In: O'Grady FW, Brumfitt W, eds. Urinary tract infection. London: Oxford University Press, **1968**:148.
58. Wren BG. Subclinical renal infection and prematurity. Med J Aust **1969**; 2:596–600.
59. Elder HA, Santamarina BAG, Smith S, Kass EH. The natural history of asymptomatic bacteriuria during pregnancy: the effect of tetracycline on the clinical course and the outcome of pregnancy. Am J Obstet Gynecol **1971**; 111:441–62.
60. Smaill F. Antibiotics for asymptomatic bacteriuria in pregnancy. Cochrane Database Syst Rev **2001**; 2:CD000490.
61. Mittendorf R, Williams MA, Kass EH. Prevention of preterm delivery and low birth weight associated with asymptomatic bacteriuria. Clin Infect Dis **1992**; 14:927–32.
62. Romero R, Oyarzun E, Mazor M, Sirtori M, Hobbins JC, Bracken M. Meta-analysis of the relationship between asymptomatic bacteriuria and preterm delivery/low birth weight. Obstet Gynecol **1989**; 73: 576–82.
63. Gratacos E, Torres P-J, Vila J, Alonso PL, Cararach V. Screening and treatment of asymptomatic bacteriuria in pregnancy prevent-pyelonephritis. J Infect Dis **1994**; 169:1390–2.
64. Uncu Y, Uncu G, Esmer A, Bilgel N. Should asymptomatic bacteriuria be screened in pregnancy? Clin Exp Obstet Gynecol **2002**; 29:281–5.
65. Whalley PJ, Cunningham FG. Short-term versus continuous antimicrobial therapy for asymptomatic bacteriuria in pregnancy. Obstet Gynecol **1977**; 49:262–5.
66. Villar J, Lydon-Rochelle MT, Gulmezoglu AM, Roganti A. Duration of treatment for asymptomatic bacteriuria during pregnancy. Cochrane Database Syst Rev **2000**; 2:CD000491.
67. The US Preventive Services Task Force. Screening for asymptomatic bacteriuria, hematuria and proteinuria. Am Fam Physician **1990**; 42: 389–95.
68. Stenqvist K, Kahlen-Nilsson I, Lidin-Janson G, et al. Bacteriuria in pregnancy: frequency and risk of acquisition. Am J Epidemiol **1989**; 129:372–9.
69. Wadland WC, Plante DA. Screening for asymptomatic bacteriuria in pregnancy: a decision and cost analysis. J Fam Pract **1989**; 29:372–6.
70. Geerlings SE, Stolk RP, Camps MJL, et al. Consequences of asymptomatic bacteriuria in women with diabetes mellitus. Arch Intern Med **2001**; 161:1421–7.
71. Semetkowska-Jurkicwicz E, Horoszek-Maziarz S, Galinski 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.
72. Harding GKM, Zhanel GG, Nicolle LE, Cheang M. Antimicrobial treatment in diabetic women with asymptomatic bacteriuria. Manitoba Diabetes Urinary Tract Infection Study Group. N Engl J Med 2002; 347:1576–83.
73. 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.

74. Nordenstam GR, Brandberg CA, Oden AS, Svanborg-Eden CM, Svanborg A. Bacteriuria and mortality in an elderly population. N Engl J Med **1986**; 314:1152–6.
75. Heinamaki P, Haavesto M, Hakulinen T, Mattila K, Rajola S. Mortality in relation to urinary characteristics in the very aged. Gerontology **1986**; 32:167–71.
76. 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.
77. Nicolle LE, Bjornson J, Harding GK, MacDonell JA. Bacteriuria in elderly institutionalized men. N Engl J Med **1983**; 309:1420–5.
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. Nicolle LE, Henderson E, Bjornson J, McIntyre M, Harding GK, MacDonell JA. The association of bacteriuria with resident characteristics and survival in elderly institutionalized men. Ann Intern Med **1987**; 106:682–6.
81. Dontas AS, Tzonou A, Kasviki-Charvati P, Georgiades GL, Christakis G, Trichopoulos D. Survival in a residential home: an eleven-year longitudinal study. J Am Geriatr Soc **1991**; 39:641–9.
82. 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.
83. Waites KB, Canupp KC, DeVivo MJ. Eradication of urinary tract infection following spinal cord injury. Paraplegia **1993**; 31:645–52.
84. Lewis RI, Carrion HM, Lockhart JL, Politano VA. Significance of asymptomatic bacteriuria in neurogenic bladder disease. Urology **1984**; 23:343–7.
85. 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.
86. Maynard FM, Diokno AC. Urinary infection and complications during clean intermittent catheterization following spinal cord injury. J Urol **1984**; 132:943–6.
87. Ditunno JF, Formal CS. Chronic spinal cord injury. N Engl J Med **1994**; 330:550–6.
88. Cardenas DD, Hooton TM. Urinary tract infection in persons with spinal cord injury. Arch Phys Med Rehabil **1995**; 76:272–80.
89. National Institute on Disability and Rehabilitation Research Consensus Statement: Jan 27–29, 1992. The prevention and management of urinary tract infections among people with spinal cord injuries. J Am Paraplegia Soc **1992**; 15:194–204.
90. Johnson JR, Roberts PL, Olsen RJ, Moyer KA, Stamm WG. Prevention of catheter-associated urinary tract infection with a silver-oxide–coated urinary catheter: clinical and microbiologic correlates. J Infect Dis **1990**; 162:1145–50.
91. Riley DK, Classen DC, Stevens LE, Burke JP. A large, randomized clinical trial of a silver-impregnated urinary catheter: lack of efficacy and staphylococcal superinfection. Am J Med **1995**; 98:349–56.
92. 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.
93. Platt R, Polk BI, Murdock B, Rosner B. Mortality associated with nosocomial urinary-tract infection. N Engl J Med **1982**; 307:637–42.
94. Sobel JP, 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 Mycoses Study Group. Clin Infect Dis **2000**; 30:19–24.
95. Harding GKM, Nicolle LE, Ronald AR, et al. How long should catheter-associated urinary tract infection in women be treated. Ann Intern Med **1991**; 114:713–9.
96. Warren JW, Anthony WC, Hoopes JM, Muncie HL Jr. Cephalexin for susceptible bacteriuria in afebrile, long-term catheterized patients. JAMA **1982**; 248:454–8.
97. Alling B, Brandberg A, Secberg S, Svanborg A. Effect of consecutive antibacterial therapy on bacteriuria in hospitalized geriatric patients. Scand J Infect Dis **1975**; 7:201–7.
98. Grabe M. Antimicrobial agents in transurethral prostatic resection. J Urol **1987**; 138:245–52.
99. Cafferkey MT, Falkiner FR, Gillespie DM, Murphy DM. Antibiotics for the prevention of septicaemia in urology. J Antimicrob Chemother **1982**; 9:471–7.
100. Grabe M, Forsgren A, Bjork T, Hellsten S. Controlled trial of a short and a prolonged course with ciprofloxacin in transurethral prostatic surgery. Eur J Clin Microbiol **1987**; 6:11–7.
101. Olsen JH, Friis-Moller 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.
102. 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.
103. Allan WR, Kumar A. Prophylactic mezlocillin for transurethral prostatectomy. Brit J Urol **1985**; 57:46–9.
104. 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.
105. Bregenzer T, Frei R, Widmer AF, et al. Low risk of bacteremia during catheter replacement in patients with long term urinary catheters. Arch Intern Med **1997**; 157:521–5.
106. Jewes LA, Gillespie WA, Leadbetter A, et al. Bacteriuria and bacteremia in patients with long-term indwelling catheter—a domiciliary study. J Med Microbiol **1988**; 26:61–5.
107. Scherz HC, Parson CL. Prophylactic antibiotics in urology. Urol Clin North Am **1987**; 14:265–71.
108. Ramsey DE, Finch WT, Birch AG. Urinary tract infections in kidney transplant recipients. Arch Surg **1979**; 114:1022–5.
109. Prat LV, Jorcickova M, Matousovic K, Hatala M, Liska M. Urinary tract infection in renal transplant patients. Infection **1985**; 13:207–10.
110. Hoy WE, Kissel SM, Freeman RB, Sterling WA Jr. Altered patterns of post-transplant urinary tract infections associated with perioperative antibiotics and curtailed catheterization. Am J Kidney Dis **1985**; 6:212–6.
111. Fox BC, Sollinger HW, Belzer FO, Maki DG. A prospective, randomized, double-blind study of trimethoprim-sulfamethoxazole for prophylaxis of infection in renal transplantation: clinical efficacy, absorption of trimethoprim/sulfamethoxazole, effects on the microflora, and the cost-benefit of prophylaxis. Am J Med **1990**; 89:255–74.
112. Takai K, Tollemar J, Wilczek HE, Groth CG. Urinary tract infections following renal transplantation. Clin Transplant **1998**; 12:19–23.
113. Lyerova L, Lacha J, Skibova J, Teplan V, Virko S, Schuck O. Urinary tract infection in patients with urological complications after renal transplantation with respect to long-term function and allograft survival. Ann Transplant **2001**; 6:19–20.
114. Snydman DR. Posttransplant microbiological surveillance. Clin Infect Dis **2001**; 33(Suppl 1):S22–5.
115. Ghasemian SM, Guleria AS, Khawand NY, Light JA. Diagnosis and management of the urologic complications of renal transplantation. Clin Transplant **1996**; 10:218–23.
116. Kasiske BL, Vazquez MA, Harmon WE, et al. Recommendations for the outpatient surveillance of renal transplant recipients. American Society of Transplantation. J Am Soc Nephrol **2000**; 11:S1–86.
117. Centers for Disease Control and Prevention. Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients. MMWR Morb Mortal Wkly Rep **2000**; 49(RR-10):1–125.
118. Butler P, Hamilton-Miller JM, McIntyre N, Burroughs AK. National history of bacteriuria in women with primary biliary cirrhosis and the effect of antimicrobial therapy in symptomatic and asymptomatic groups. Gut **1995**; 36:931–4.

# ERRATA

An error appeared in an editorial commentary published in the 1 April 2005 issue of the journal (Chambers HF. Staphylococcal purpura fulminans: A toxin mediated disease? Clin Infect Dis 2005; 40:948–50). The last sentence of the third paragraph should read "Thus, *S. aureus* as a cause of purpura fulminans is not new" (*not* "Thus, *S. aureus* as a cause of purpura fulminans is new"). The authors regret this error.

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Two errors appeared in a guideline published in the 1 March 2005 issue of the journal (Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM. Infectious Diseases Society of America Guidelines for the Diagnosis and Treatment of Asymptomatic Bacteriuria in Adults. Clin Infect Dis 2005; 40:643–54). Both errors occur in table 4. In the row labelled "Ambulatory and institutionalized women," the entry in the column labelled "Study description" should read "Randomized, placebo-controlled trial of variable antimicrobial courses" (*not* "Randomized, placebo-controlled trial of TMP vs. single-dose norfloxacin administered every 14 days"). In addition, in the row labelled "Institutionalized women," the entry under the column labelled "Reference" should read "[76]" (*not* "[74]"). The corrected table appears below. The authors regret these errors.

**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% ($P$ = 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 ($P$ = 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 | [76] |
| 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 variable antimicrobial courses; 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.

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