Urinary Tract Infections in Special Populations
Diabetes, Renal Transplant, HIV Infection, and Spinal Cord Injury

Lindsay E. Nicolle, MD, FRCPC

INTRODUCTION
Some populations have unique considerations relevant to urinary tract infection. This article addresses 4 of these groups: patients with diabetes, patients with a renal transplant, patients with HIV infection, and patients with a spinal cord injury. Urinary tract infection occurring in these individuals is considered within the clinical category of complicated urinary infection; that is, infection that occurs in a patient with functional or structural abnormalities of the genitourinary tract. It is always important to distinguish between symptomatic urinary infection and asymptomatic infection, also referred to as bacteriuria, for optimal management of infection.
PATIENTS WITH DIABETES

Unique Aspects of Urinary Infection

It is generally accepted that persons with diabetes have an increased frequency of urinary infection, but there is limited evidence confirming the magnitude of excess risk. In addition, the diabetic population is heterogeneous and the risk of urinary infection varies with patient characteristics. Several explanations have been proposed to explain an increased risk for infection, including glucosuria and impaired immune or leukocyte function, but experimental studies have not consistently supported any single mechanism. The important diabetes-specific risk factors for urinary infection are usually duration of diabetes or presence of long-term complications, such as neuropathy, rather than current glucose control (Table 1). There is limited evidence describing aspects of urinary infection in diabetic men. Of interest, the SGLT2 (serum glucose cotransporter-2) inhibitors, a new class of agents for treatment of diabetes that produce high levels of glucosuria, are associated with only a small increase in symptomatic urinary infection for both men and women.

Epidemiology

Rates of urinary infection were compared between diabetic women enrolled in the epidemiology of diabetes interventions and complications study (Uro-EDIC) and nondiabetic women in the National Health and Nutrition Examination Survey III. The adjusted prevalence of cystitis in the preceding 12 months was similar (odds ratio [OR] 0.78; 95% confidence interval [CI]: 0.51, 1.22). In the Uro-EDIC study, only sexual intercourse was associated with cystitis (OR 8.28; 95% CI 1.45, 158.32), similar to the nondiabetic population. Neither cystitis nor pyelonephritis was associated with duration of diabetes, hemoglobin A1c, retinopathy, neuropathy, nephropathy, vascular complications, or glycemic therapy. A prospective study from the Netherlands also reported that only sexual intercourse was associated with symptomatic infection in women with type 1 diabetes (relative risk [RR] 3.6; P = .004), whereas asymptomatic bacteriuria was the only significant association for type 2 diabetes (RR 1.65; 95% CI 1.02, 2.67). Another prospective study enrolling women in a US health maintenance organization reported increased symptomatic urinary infection in postmenopausal women with diabetes (OR 2.2; 95% CI 1.6–3.0) for subjects receiving oral diabetes medication or insulin. A retrospective record review of patients attending primary care practices in the Netherlands reported recurrent urinary infection was increased for women with diabetes (OR 2.0; 95% CI 1.4–2.9). The increased risk was independently associated with type 2 diabetes, diabetes of 5 or more years’ duration, receiving oral or insulin therapy, or retinopathy. Hemoglobin A1c was not a risk factor. Studies that have used administrative databases or retrospective record

<table>
<thead>
<tr>
<th>Table 1 Variables associated with symptomatic urinary tract infection or asymptomatic bacteriuria in women with Type 2 diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Factors for Infection (Ref.)</strong></td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Not diabetes associated</td>
</tr>
<tr>
<td>Diabetes associated</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
review, however, may overestimate the frequency of urinary infection in diabetic women, because these patients are more likely to seek medical care than nondiabetic persons.

Diabetes is a common risk factor associated with more severe presentations of urinary tract infection. A case series of 65 consecutive patients with renal or perinephric abscesses reported 28% of subjects had diabetes mellitus. In other case series, 67% of patients presenting with emphysematous cystitis were diabetic, and 62% presented with emphysematous pyelonephritis. Diabetes mellitus has not, however, been identified as a risk factor for complications of severe sepsis or septic shock in patients with urosepsis.

The prevalence of asymptomatic bacteriuria is increased for diabetic women but not diabetic men, with reported rates of 5% to 25% for women and 3% for men. Asymptomatic bacteriuria correlates with duration of diabetes and long-term complications of diabetes, but not with parameters of current metabolic control (see Table 1).

Management

Diagnosis

The clinical and microbiologic diagnosis of urinary tract infection in diabetic populations is similar to other patients with complicated infection. Patients with neuropathy may have impaired bladder sensation, which obscures some clinical symptoms of lower tract infection. Diabetic women with pyelonephritis are more likely to have bilateral renal involvement and bacteremia. In a group of elderly Greek patients hospitalized with pyelonephritis, bacteremia was identified in 30.7% with and 11% without diabetes. The types of infecting organisms are also similar for diabetic and nondiabetic patients. Escherichia coli is the single most common organism. Strains isolated from women with or without diabetes have similar virulence characteristics.

Treatment

Diabetic women with a functionally normal genitourinary tract are managed similarly to other women with uncomplicated urinary infection. Cystitis should be treated with short-course therapy and pyelonephritis for 7 to 14 days. Complicated infections may require more prolonged antimicrobial therapy. Imaging is indicated for severe clinical presentations, failure to respond to therapy, or early symptomatic recurrence following discontinuation of antimicrobial therapy. Emphysematous pyelonephritis is managed with antimicrobial therapy and initial percutaneous drainage; delayed nephrectomy, where necessary, is performed once the patient is stable. A perinephric abscess usually requires percutaneous or open drainage. Small renal abscesses of less than 3 cm in diameter are treated conservatively with antimicrobial therapy alone and continued until the abscess has resolved on follow-up imaging. This treatment may require prolonged therapy for several weeks to months.

Outcomes

Hospitalized elderly Greek diabetic patients with acute pyelonephritis had a longer duration of fever (median 4.5 vs 2.5 days, *P* < .001), a longer period of hospitalization (median 10 vs 7 days; *P* < .001), and higher mortality (12.5% vs 2.5% *P* < .01). For women enrolled in 2 clinical trials evaluating ciprofloxacin therapy for treatment of acute uncomplicated pyelonephritis, diabetes mellitus was an independent predictor of treatment failure, defined as clinical failure or relapse by 4 to 6 weeks posttherapy (OR 8.3; 95% CI 2.3–30.3). Diabetes is not, however, a reported risk factor for increased mortality for patients with septic shock from a urinary source.

The contribution of symptomatic urinary infection to chronic kidney disease in patients with diabetes has been controversial. In 221 diabetic patients hospitalized...
from 2001 to 2011 for urinary infection complicated by systemic inflammatory response syndrome, evidence of acute kidney injury was present on admission only for subjects with preinfection glomerular filtration rate (GFR) of less than 30 mL/min.¹⁹ In these patients, renal function had returned to baseline by 6 months following successful treatment of infection. The report describing elderly Greek patients with pyelonephritis also reported no significant association of diabetes with acute decline in renal function.¹⁴

**Prevention**

Women with frequent, recurrent cystitis and no evidence of impaired urinary function can be managed with long-term or postcoital antimicrobial prophylaxis strategies, similar to nondiabetic women.¹⁵ Antimicrobial prophylaxis is not indicated for patients with impaired voiding attributable to neuropathy or with other genitourinary abnormalities, as prophylaxis does not decrease the subsequent frequency of symptomatic infection, whereas reinfection with antimicrobial-resistant organisms occurs. Underlying abnormalities should be corrected, if possible. Prevention of neuropathy should also prevent urinary tract infection for some patients. However, there are no studies of long-term diabetes management that specifically address the impact of prevention of long-term complications of diabetes on the frequency or severity of urinary infection. Treatment of asymptomatic bacteriuria in diabetic women does not decrease the frequency of symptomatic infection and, may, in the short term, increase episodes of infection including pyelonephritis.²⁰,²¹ Thus, asymptomatic bacteriuria should not be treated.

**RENA L TRANSPLANT PATIENTS**

**Unique Aspects of Urinary Infection**

Urinary tract infection is the most common infection occurring in renal transplant recipients.²²,²³ Risk factors that promote urinary infection in these patients may predate transplant, be associated with the transplant procedure itself, or follow transplantation (Table 2). Patients with infection of native kidneys before transplant may have persistent infection following transplant because poor perfusion of the end-stage kidney limits antimicrobial access to the infection site and organisms cannot be eradicated. Technical aspects of the transplant procedure such as duration of use of an indwelling urethral catheter or ureteric stent increase the likelihood of infection. These indwelling devices become coated with biofilm, providing a persistent nidus for bacteriuria. Following transplantation, immunosuppressive therapy or persistent urologic abnormalities, such as strictures, stone formation, or hydronephrosis, increase the frequency of infection.

**Epidemiology**

From 25% to 47% of renal transplant patients experience at least one symptomatic urinary infection.²²,²³ The risk of infection is highest in the first year following transplant. During a 10-year period from 1998 to 2008 a cohort of 122 Greek transplant patients experienced 316 episodes of urinary infection in 74 (60.7%) patients, with a mean follow-up of 67.8 months.²⁶ Asymptomatic bacteriuria and symptomatic episodes were not differentiated, but 141 episodes required hospitalization. Infection was diagnosed within 1 month posttransplant in 25% of all infected patients; 45% between 1 month and 1 year, 28% between the first and second year, and 48% after 2 years. There were 35 (29%) patients who experienced 3 or more infections. Urinary infection during the first month posttransplant correlated with recurrent urinary infection during any subsequent time period. Another single-center Polish study described
the 12-month follow-up of all patients who received a transplant in 2009. There were 151 episodes of urinary infection identified in 49 (55%) patients, with 48% diagnosed during the first month posttransplant. The clinical presentations were characterized as asymptomatic bacteriuria in 65%, lower urinary tract infection in 13%, and pyelonephritis in 22%.

Major risk factors for acute pyelonephritis following transplant are female gender (OR 5.14; 95% CI: 1.86, 14.20), experiencing acute rejection episodes (OR 3.84; 95% CI: 1.37, 10.79), number of urinary infections (OR 1.17; 95% CI: 1.06, 1.30), and receiving mycophenolate mofetil (OR 1.9; 95% CI: 1.2, 2.3). In another report, identification of symptomatic or asymptomatic bacteriuria during the first year following transplant was independently associated with age (OR 1.04/year, 95% CI: 1.01, 1.07), female gender (OR 4.3; 95% CI: 2.01, 9.22), days of bladder catheterization posttransplant (OR 1.44/day; 95% CI: 1.05, 1.96), anatomic genitourinary alterations (OR 17.68; 95% CI 4.65, 67.29), and urinary infection during the month before transplantation (OR 4.98; 95% CI: 1.13, 21.96).

### Management

#### Diagnosis

The microbiological and clinical diagnosis of urinary tract infection is similar to other patients with complicated infection. Graft tenderness is a clinical finding consistent with pyelonephritis in the transplanted kidney. A characteristic presentation is relapsing infection with a trimethoprim/sulfamethoxazole (TMP/SMX)-susceptible organism that presents after discontinuation of posttransplant TMP/SMX prophylaxis, suggesting persistent pretransplant infection in native kidneys, which was suppressed by the prophylactic therapy.

The appropriate quantitative count for asymptomatic or symptomatic infection is ≥10^5 cfu/mL. Lower quantitative counts may be present for some symptomatic patients, such as patients undergoing diuresis. However, lower counts should be interpreted critically, particularly when ureteral stents are present, because biofilm

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretransplant</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td></td>
<td>Prolonged dialysis</td>
</tr>
<tr>
<td></td>
<td>Polycystic kidney disease</td>
</tr>
<tr>
<td></td>
<td>Pretransplant urinary infection</td>
</tr>
<tr>
<td>Transplant procedure</td>
<td>Deceased donor</td>
</tr>
<tr>
<td></td>
<td>Allograft trauma</td>
</tr>
<tr>
<td></td>
<td>Microbial contamination of cadaver kidney</td>
</tr>
<tr>
<td></td>
<td>Technical complications with anastomosis</td>
</tr>
<tr>
<td></td>
<td>Indwelling urinary catheter</td>
</tr>
<tr>
<td></td>
<td>Ureteral stent</td>
</tr>
<tr>
<td>Posttransplant</td>
<td>Urinary tract obstruction</td>
</tr>
<tr>
<td></td>
<td>Immunosuppressive therapy</td>
</tr>
<tr>
<td></td>
<td>Vesicoureteral reflux</td>
</tr>
<tr>
<td></td>
<td>Reimplantation</td>
</tr>
<tr>
<td></td>
<td>Acute rejection episodes</td>
</tr>
</tbody>
</table>

Data from Refs.22,24,25
formation on these devices may contaminate voided urine specimens. *E. coli* remains the most common infecting organism. A wide spectrum of other organisms, including yeast, may be isolated depending on prior patient exposures and antimicrobial therapy.\textsuperscript{22,24,27} These patients have frequent and prolonged exposure to health care settings and receive repeated courses of antimicrobials, so antimicrobial-resistant organisms are common.

**Treatment**

Treatment of symptomatic infection should, of course, avoid potential nephrotoxic agents. The selection of an antimicrobial regimen for empiric therapy must consider the likelihood that resistant organisms are present. Individuals developing urinary infection while receiving TMP/SMX will usually have a TMP/SMX-resistant organism isolated. Therapy in patients with renal impairment may need to be more prolonged, although the appropriate duration is not established. For patients who experience recurrent symptomatic infection, a systematic assessment should be undertaken to identify potentially contributing factors. Underlying urologic complications such as stones or strictures should be identified and corrected, if possible.

Prospective randomized clinical trials that address the question of treatment of asymptomatic bacteriuria for renal transplant patients have not been published. However, retrospective studies consistently report no benefits of treatment for preventing either symptomatic infection or poor graft outcomes.\textsuperscript{28,29} In one report, 18.2% of treated patients and 5.6% of untreated patients with asymptomatic bacteriuria during the first posttransplant year had a composite outcome of hospitalization for symptomatic urinary infection or 25% reduction in estimated GFR.\textsuperscript{29} Another report described 334 episodes of asymptomatic *E. coli* or *Enterococcus faecalis* bacteriuria identified at least 1 month posttransplant in 77 patients at a Swiss center.\textsuperscript{26} Symptomatic urinary infection developed following none of the treated episodes and in 1.7% of the untreated patients. These few symptomatic episodes were not complicated by either acute rejection or pyelonephritis. Spontaneous bacterial clearance was observed in 59% of untreated episodes. Recurrence followed 46% of treated episodes, and 78% of these recurrent episodes had more resistant strains isolated.

**Outcomes**

The prognosis of adequately treated symptomatic urinary tract infection is excellent. Transient decline of GFR may occur with acute pyelonephritis. However, symptomatic urinary tract infection is not a risk factor for impaired long-term graft function.\textsuperscript{23,26,30}

**Prevention**

Identification and correction of urologic abnormalities will prevent further infections. Limiting the postoperative duration of an indwelling urethral catheter or ureteric stent decreases the risk for subsequent episodes of bacteriuria or symptomatic urinary tract infection.\textsuperscript{31} A ureteric stent is usually placed routinely at surgery to assist with healing of the anastomosis. In a randomized controlled open-label study that compared ureteric stent removal at 8 or 15 days, asymptomatic or symptomatic urinary infection was significantly lower with early stent removal (40.5% vs 72.9%; *P* = .004).\textsuperscript{31}

Renal transplant patients should receive TMP/SMX prophylaxis for 3 to 6 months following transplant,\textsuperscript{32} decreasing the frequency of urinary tract infection as well as other infections. When recurrent symptomatic urinary infection is attributed to infection in native kidneys, prolonged suppressive antimicrobial therapy may be indicated to prevent symptomatic episodes. The antimicrobial regimen is selected based on tolerance and susceptibility of the infecting organisms and initiated at a full therapeutic dose. If this treatment is effective, the dose is decreased to one-half after 2 to 4 weeks.
There is no standard recommended duration of suppressive therapy. It may need to be continued for years for some patients. Previously, recommendations suggested urine cultures should be collected routinely at follow-up visits, particularly for the first 6 months after transplant. Current guidelines do not recommend routine urine cultures for asymptomatic patients, which reflects the increasing evidence that asymptomatic infection is not harmful and that treatment is not beneficial.

**HIV INFECTION**

*Unique Aspects of Urinary Infection*

The dominant immunologic abnormality of HIV infection is decreased cell-mediated immunity. Symptomatic uncomplicated urinary tract infection, on the other hand, correlates with variations of the innate immune response. It is unknown whether abnormalities of the innate immune system associated with HIV infection contribute to urinary tract infection, or how defects in cell-mediated immunity might promote urinary infection. Evidence is inconsistent in reporting whether there is an increased incidence of urinary tract infection directly attributable to HIV infection. In addition, there are few studies from the era of highly active antiretroviral therapy (HAART) therapy to characterize the current frequency of symptomatic urinary tract infection or bacteriuria in HIV-positive patients. Male patients with HIV infection may have an increased risk for prostatitis, but the contribution of HIV infection rather than other risk factors common in this population has not been determined.

**Epidemiology**

The incidence of symptomatic urinary tract infection in a cohort of primarily male (89%) HIV patients followed between 1988 and 1992 was 1.49/100 patient-years overall, but 18.5/100 patient-years for women. Patients with AIDS or a CD4 lymphocyte count less than 200 cells/mm³ had an incidence of 5.4/100 patient-years compared with 0.5/100 for other HIV patients. In a prospective study of 1310 women, a self-reported history of urinary infection in the previous 6 months was significantly increased in women with HIV infection compared with matched seronegative at-risk women (OR 1.5; 95% CI 1.1–2.1), but infection did not correlate with CD4 cell count. A subsequent report from the same cohort found no association of HIV infection with prevalence or incidence of asymptomatic bacteriuria. HIV-infected women with bacteriuria had an increased viral load (RR 1.3; 95% CI 1.03–1.63), but not a lower CD4 count. In another report, symptomatic urinary infection occurred in 13.3% of men with a diagnosis of AIDS, 3.2% with asymptomatic HIV infection, and 1.8% without HIV infection. However, the AIDS subjects in this report were hospitalized and the control groups were outpatients, so the comparison is subject to bias. An Internet-based survey addressing urinary quality-of-life outcomes for men reported that HIV infection was an independent risk factor for lower urinary tract symptoms consistent with prostatitis. HIV-infected men had a worse total international prostate symptom score for all domains including quality of life, but the study did not differentiate between bacterial or nonbacterial prostatitis. A retrospective review of children aged 0 to 12 years who attended a South African clinic from 1996 to 2001 concluded that the clinical presentations, etiologic agents, response to therapy, and renal function of culture proven urinary tract infection were similar for HIV-infected or uninfected children.

The prevalence of bacteriuria in Kenyan sex workers was reported to be 23% and was similar for women with or without HIV infection. There was no correlation of bacteriuria with CD4 count for HIV-positive women. Of the 222 women enrolled,
19% reported lower tract symptoms or signs of fever and loin tenderness. There was no association between symptoms or signs of infection and HIV status. The prevalence of asymptomatic bacteriuria among pregnant HIV-positive women in Nigeria was 15.5%. Bacteriuric women had significantly lower CD4 counts (250 cells/mm³ vs 356/mm³) and significantly higher viral loads (88,700 copies/mL vs 55,400 copies/mL). In another Nigerian study, 18% of HIV-positive pregnant women had asymptomatic bacteriuria. Bacteriuria was independently associated with a past history of symptomatic urinary infection (OR 4.3; 95% CI 2.1, 7.9), HIV-1 RNA greater than 10,000 copies/mL (OR 3.9; 95% CI 2.7, 9.1), CD4 count less than 200 cells/mm³ (OR 1.4; 95% CI 1.1, 3.3), and maternal hemoglobin less than 11 g/L (OR 1.4; 95% CI 1.3, 2.9). A cohort of HIV-infected men followed prospectively between 1987 and 1990 with urine cultures obtained every 6 months for 2 years identified bacteriuria in 30% of men with CD4 counts less than 200 cells/mm³, 11% with 200 to 500 cells/mm³, and in no subjects with cell counts greater than 500 cells/mm³.

Management
Clinical trials that address the diagnosis or therapy for urinary infection in HIV patients have not been reported. One review reported no significant difference in the frequency of symptomatic urinary tract infection for HIV patients receiving or not receiving TMP/SMX prophylaxis. The frequency of symptomatic urinary tract infection identified in hospitalized Italian HIV patients (76% men) before and after the introduction of HAART was compared. There were 5.6 episodes/100 person-years of urinary infection during the full period of observation. In a time series analysis, the proportion of patients with infection decreased from 9% to 4% (RR 1.94; 95% CI 1.5–2.5) after HAART became the standard of practice. However, the authors did not stratify by potential sources of bias such as duration of hospitalization or indwelling catheter use, so the impact of HAART on frequency of urinary infection is uncertain.

SPINAL CORD INJURY
Unique Aspects of Infection
Spinal cord injury patients experience an increased frequency of urinary tract infection as a consequence of impaired bladder emptying associated with a neurogenic bladder. Urinary tract infection and renal failure were the most common causes of death in these patients before the introduction of current bladder management strategies, which maintain a low-pressure bladder. A high bladder pressure leads to vesicoureteral reflux with hydronephrosis, pyelonephritis, and renal failure. Maintaining a low-pressure bladder in patients who cannot void spontaneously is usually achieved by intermittent catheterization or, for men, sphincterotomy and condom catheter drainage. Surgical procedures such as augmentation cystoplasty, ileal conduits, or other urinary diversions are also used for selected patients. Some patients with high-level cord injury may require management with a chronic urethral or suprapubic urinary catheter.

Epidemiology
The incidence of symptomatic urinary infection in men with spinal cord injury is reported to be 0.41/100 person-days with intermittent catheterization and 0.36/100 person-days when a condom catheter is used. This compares to 2.72/100 person-days with a chronic indwelling catheter. Risks for symptomatic infection include age greater than 40 years, hyperreflexic bladder with detrusor-sphincter dyssynergy, a cervical level of injury, functional status, indwelling catheter, vesicoureteral

Downloaded for Anonymous User (n/a) at University of Wisconsin Madison from ClinicalKey.com by Elsevier on December 04, 2019. For personal use only. No other uses without permission. Copyright ©2019. Elsevier Inc. All rights reserved.
reflux, and invasive procedure. The frequency and risks of infection are reported to be similar for men and women. Urinary infection is the most frequent cause of rehospitalization in the first year following traumatic spinal cord injury.

Asymptomatic bacteriuria is a common finding in spinal cord–injured patients with impaired voiding. The prevalence is 50% for patients with sphincterotomy or intermittent catheterization, and 100% with indwelling urethral or suprapubic catheters. Risk factors for bacteriuria include detrusor sphincter dyssynergy, bladder overdistension, high-pressure voiding, large postvoid residual volume, urolithiasis, and vesicoureteral reflux. Quadriplegia, complete injury, and decreased functional independence are also associated with bacteriuria.

Management

Diagnosis
Some patients will have a clinical presentation of increased lower limb hyperreflexia or increased incontinence associated with bladder spasms. Individuals with high spinal cord lesions may present with autonomic dysreflexia. Clinical symptoms are, however, often nonspecific. Signs of urinary infection correlate poorly with urine cell counts and pyuria. The accuracy and predictive value of signs and symptoms of urinary infection for asymptomatic or symptomatic infection were evaluated for patients using intermittent catheterization. The highest accuracy for identification of a positive urine culture was cloudy urine (83.1%), and the highest specificity was fever (99%). However, fever had a very low sensitivity (6.9%). Subjects were able to predict a positive urine culture with an accuracy of 66.2%; the negative predictive value was 82.8% and positive predictive value was 32.6%. This study concluded that subjects were better at predicting the absence of urinary infection than a positive urine culture, when present.

The appropriate microbiologic quantitative criteria for diagnosis for spinal cord–injured patients using intermittent catheterization is \( \geq 10^2 \) cfu/mL of any organism, as these are catheterized specimens. A wide variety of organisms are isolated, and resistant organisms are common.

Treatment
Antimicrobial selection is similar to other populations with complicated urinary tract infection. In a prospective randomized trial, treatment of symptomatic urinary tract infection was less successful with 3 compared with 14 days of therapy. Some patients experience frequent, recurrent infection with isolation of organisms of increasing antimicrobial resistance. In these patients, the recurrence should be characterized as relapse with the same organism, or reinfection with a new organism. Recurrent relapse following therapy for a susceptible organism suggests urolithiasis or, in men, prostate infection.

Prevention
The most important preventive strategy is to maintain a low-pressure bladder, with a bladder volume of less than 500 mL (Box 1). Chronic indwelling urethral or suprapubic catheters should be avoided, if possible. Prophylactic antimicrobial therapy does not decrease the frequency of symptomatic infection and antimicrobial resistance emerges with reinfection, so prophylaxis is contraindicated. Cranberry products are also not effective in preventing symptomatic infection. In a multicenter study of patients enrolled in the early postinjury period, intermittent catheterization with a hydrophilic-coated catheter was not associated with a decreased incidence of symptomatic infection compared with a standard catheter. However, a systematic review including all spinal cord injury populations concluded there was no difference in symptomatic urinary infection with hydrophilic-coated catheters compared...
with uncoated catheters. A prospective, randomized study compared standard care for management of patients with intermittent catheterization to an educational program of written material, self-administered test, and review by nurse and physician with follow-up telephone calls. After controlling for baseline bacterial counts and differences between groups, patients randomized to the educational program had significantly fewer positive urine cultures, but no significant difference in symptom reports or antimicrobial treatment for urinary infection.

Treatment of asymptomatic bacteriuria does not decrease symptomatic infection and is associated with increased isolation of resistant organisms with reinfection. Thus, treatment of asymptomatic bacteriuria is not indicated. The optimal management of asymptomatic bacteriuria in pregnant women with spinal cord injury is not clear. Current guidelines recommend treatment of asymptomatic bacteriuria, similar to other pregnant women. However, recurrent bacteriuria is common, and resistant strains emerge requiring escalating courses of antimicrobial therapy. A small case series reported pregnant women with spinal cord injury were effectively managed with a weekly oral cyclic antibiotic program. However, appropriate management of these women requires further evaluation.

Some innovative approaches for prevention have also been described. Bacterial interference is a strategy that induces asymptomatic bacteriuria using an avirulent *E. coli* strain with a goal of preventing symptomatic infection with virulent strains. Preliminary studies report a small benefit of this intervention in decreasing symptomatic infection for selected spinal cord–injured patients. In another novel approach, a randomized controlled trial of an aerobic physical training intervention reported a

---

**Box 1**

**Approaches to prevention of urinary infection in spinal cord injured subjects**

**Effective**
- Maintain low-pressure bladder
  - Intermittent catheterization
  - Sphincterotomy/condom
  - Neobladder
- Intermittent catheterization
  - Education program (bacteriuria only)
- Avoid chronic indwelling catheter

**Not effective**
- Antimicrobial prophylaxis
- Cranberry products
- Hydrogel catheter

**Investigational**
- Bacterial interference
- Aerobic physical training

significant decrease in prevalence of chronic asymptomatic bacteriuria, but not symptomatic infection, in a small number of subjects. However, bladder management techniques for this study cohort were not characterized.⁶⁰

REFERENCES

