MERCK MANUAL
Professional Version
The trusted provider of medical information since 1899

Bacterial Urinary Tract Infections (UTIs)

By **Talha H. Imam** , MD, University of Riverside School of Medicine

Bacterial UTIs can involve the urethra, prostate, bladder, or kidneys. Symptoms may be absent or include urinary frequency, urgency, dysuria, lower abdominal pain, and flank pain. Systemic symptoms and even sepsis may occur with kidney infection. Diagnosis is based on analysis and culture of urine. Treatment is with antibiotics and removal of any urinary tract catheters and obstructions.

(See also Introduction to Urinary Tract Infections (UTIs); Gram-Negative Bacilli; Prostatitis; and Urinary Tract Infection in Children.)

Among adults aged 20 to 50 yr, UTIs are about 50-fold more common in women. In women in this age group, most UTIs are cystitis or pyelonephritis. In men of the same age, most UTIs are urethritis or prostatitis. The incidence of UTI increases in patients > 50 yr, but the female:male ratio decreases because of the increasing frequency of prostate enlargement and instrumentation in men.

Pathophysiology

The urinary tract, from the kidneys to the urethral meatus, is normally sterile and resistant to bacterial colonization despite frequent contamination of the distal urethra with colonic bacteria. The major defense against UTI is complete emptying of the bladder during urination. Other mechanisms that maintain the tract's sterility include urine acidity, the vesicoureteral valve, and various immunologic and mucosal barriers.

About 95% of UTIs occur when bacteria ascend the urethra to the bladder and, in the case of pyelonephritis, ascend the ureter to the kidney. The remainder of UTIs are hematogenous. Systemic infection can result from UTI, particularly in the elderly. About 6.5% of cases of hospital-acquired bacteremia are attributable to UTI.

Uncomplicated UTI is usually considered to be cystitis or pyelonephritis that occurs in premenopausal adult women with no structural or functional abnormality of the urinary tract and who are not pregnant and have no significant comorbidity that could lead to more serious outcomes. Also, some experts consider UTIs to be uncomplicated even if they affect postmenopausal women or patients with well-controlled diabetes. In men, most UTIs occur in children or elderly patients, are due to anatomic abnormalities or instrumentation, and are considered complicated.

The rare UTIs that occur in men aged 15 to 50 yr are usually in men who have unprotected anal intercourse or in those who have an uncircumcised penis, and they are generally considered uncomplicated. UTIs in men this age who do not have unprotected anal intercourse or an uncircumcised penis are very rare and, although also considered uncomplicated, warrant evaluation for urologic abnormalities.

Complicated UTI can involve either sex at any age. It is usually considered to be pyelonephritis or cystitis that does not fulfill criteria to be considered uncomplicated. A UTI is considered complicated if the patient is a child, is pregnant, or has any of the following:

- A structural or functional urinary tract abnormality and obstruction of urine flow

- A comorbidity that increases risk of acquiring infection or resistance to treatment, such as poorly controlled diabetes, chronic kidney disease, or immunocompromise

- Recent instrumentation or surgery of the urinary tract

Risk factors

Risk factors for development of UTI in women include the following:

- Sexual intercourse

- Diaphragm and spermicide use

- Antibiotic use

- New sex partner within the past year

- History of UTIs in 1st-degree female relatives

- History of recurrent UTIs

- First UTI at early age

Even use of spermicide-coated condoms increases risk of UTI in women. The increased risk of UTI in women using antibiotics or spermicides probably occurs because of alterations in vaginal flora that allow overgrowth of *Escherichia coli*. In elderly women, soiling of the perineum due to fecal incontinence increases risk.

Anatomic, structural, and functional abnormalities are risk factors for UTI. A common consequence of anatomic abnormality is vesicoureteral reflux (VUR), which is present in 30 to 45% of young children with symptomatic UTI. VUR is usually caused by a congenital defect that results in incompetence of the ureterovesical valve. VUR can also be acquired in patients with a flaccid bladder due to spinal cord injury or after urinary tract surgery. Other anatomic abnormalities predisposing to UTI include urethral valves (a congenital obstructive abnormality), delayed bladder neck maturation, bladder diverticulum, and urethral duplications (see Overview of Congenital Genitourinary Anomalies).

Structural and functional urinary tract abnormalities that predispose to UTI usually involve obstruction of urine flow and poor bladder emptying. Urine flow can be compromised by calculi and tumors. Bladder emptying can be impaired by neurogenic dysfunction (see Neurogenic Bladder), pregnancy, uterine prolapse, cystocele, and prostatic enlargement. UTI caused by congenital factors manifests most commonly during childhood. Most other risk factors are more common in the elderly.

Other risk factors for UTI include instrumentation (eg, bladder catheterization, stent placement, cystoscopy) and recent surgery.

Etiology

The bacteria that most often cause cystitis and pyelonephritis are the following:

- Enteric, usually gram-negative aerobic bacteria (most often)

- Gram-positive bacteria (less often)

In normal GU tracts, strains of *Escherichia coli* with specific attachment factors for transitional epithelium of the bladder and ureters account for 75 to 95% of cases. The remaining gram-negative urinary pathogens are usually other enterobacteria, typically *Klebsiella* or *Proteus mirabilis*, and occasionally *Pseudomonas aeruginosa*. Among gram-positive bacteria, *Staphylococcus saprophyticus* is isolated in 5 to 10% of bacterial UTIs. Less common gram-positive bacterial isolates are *Enterococcus faecalis* (group D streptococci) and *Streptococcus agalactiae* (group B streptococci), which may be contaminants, particularly if they were isolated from patients with uncomplicated cystitis.

In hospitalized patients, *E. coli* accounts for about 50% of cases. The gram-negative species *Klebsiella*, *Proteus*, *Enterobacter*, *Pseudomonas*, and *Serratia* account for about 40%, and the gram-positive bacterial cocci *E. faecalis*, *S. saprophyticus*, and *Staphylococcus aureus* account for the remainder.

Classification

Urethritis

Infection of the urethra with bacteria (or with protozoa, viruses, or fungi) occurs when organisms that gain access to it acutely or chronically colonize the numerous periurethral glands in the bulbous and pendulous portions of the male urethra and in the entire female urethra. The sexually transmitted pathogens *Chlamydia trachomatis* (see Chlamydial, Mycoplasmal, and Ureaplasmal Mucosal Infections), *Neisseria gonorrhoeae* (see Gonorrhea), *Trichomonas vaginalis* (see Trichomoniasis), and herpes simplex virus are common causes in both sexes.

Cystitis

Cystitis is infection of the bladder. It is common in women, in whom cases of uncomplicated cystitis are usually preceded by sexual intercourse (honeymoon cystitis). In men, bacterial infection of the bladder is usually complicated and usually results from ascending infection from the urethra or prostate or is secondary to urethral instrumentation. The most common cause of recurrent cystitis in men is chronic bacterial prostatitis.

Acute urethral syndrome

Acute urethral syndrome, which occurs in women, is a syndrome involving dysuria, frequency, and pyuria (dysuria-pyuria syndrome), which thus resembles cystitis. However, in acute urethral syndrome (unlike in cystitis), routine urine cultures are either negative or show colony counts that are lower than the traditional criteria for diagnosis of bacterial cystitis. Urethritis is a possible cause because causative organisms include *Chlamydia trachomatis* and *Ureaplasma urealyticum*, which are not detected on routine urine culture.

Noninfectious causes have been proposed, but supporting evidence is not conclusive, and most noninfectious causes usually cause little or no pyuria. Possible noninfectious causes include anatomic abnormalities (eg, urethral stenosis), physiologic abnormalities (eg, pelvic floor muscle dysfunction), hormonal imbalances (eg, atrophic urethritis), localized trauma, GI system symptoms, and inflammation.

Asymptomatic bacteriuria

Asymptomatic bacteriuria is absence of UTI signs or symptoms in a patient whose urine culture satisfies criteria for UTI. Pyuria may or may not be present. Because it is asymptomatic, such bacteriuria is found mainly when high-risk patients are screened or when urine culture is done for other reasons.

Screening patients for asymptomatic bacteriuria is indicated for those at risk of complications if the bacteriuria is untreated. Such patients include

- Pregnant women at 12 to 16 wks' gestation or at the first prenatal visit, if later (because of the risk of symptomatic UTI, including pyelonephritis, during pregnancy; and adverse pregnancy outcomes, including low-birth-weight neonate and premature delivery) (See the US Preventive Services Task Force Reaffirmation Recommendation Statement.)

- Patients who have had a kidney transplant within the previous 6 mo

- Young children with gross VUR

- Before certain invasive GU procedures that can cause mucosal bleeding (eg, transurethral resection of the prostate)

Certain patients (eg, postmenopausal women; patients with controlled diabetes; patients with ongoing use of urinary tract foreign objects such as stents, nephrostomy tubes, and indwelling catheters) often have persistent asymptomatic bacteriuria and sometimes pyuria. If they are asymptomatic, these patients should not be screened routinely, because they are at low risk. In patients with indwelling catheters, treatment of asymptomatic bacteriuria often fails to clear the bacteriuria and only leads to development of antibiotic-resistant organisms.

Acute pyelonephritis

Pyelonephritis is bacterial infection of the kidney parenchyma. The term should not be used to describe tubulointerstitial nephropathy unless infection is documented. In women, about 20% of community-acquired bacteremias are due to pyelonephritis. Pyelonephritis is uncommon in men with a normal urinary tract.

In 95% of cases of pyelonephritis, the cause is ascension of bacteria through the urinary tract. Although obstruction (eg, strictures, calculi, tumors, neurogenic bladder, VUR) predisposes to pyelonephritis, most women with pyelonephritis have no demonstrable functional or anatomic defects. In men, pyelonephritis is always due to some functional or anatomic defect. Cystitis alone or anatomic defects may cause reflux. The risk of bacterial ascension is greatly enhanced when ureteral peristalsis is inhibited (eg, during pregnancy, by obstruction, by endotoxins of gram-negative bacteria).

Pyelonephritis is common in young girls and in pregnant women after bladder catheterization.

Pyelonephritis not caused by bacterial ascension is caused by hematogenous spread, which is particularly characteristic of virulent organisms such as *S. aureus*, *P. aeruginosa*, *Salmonella* species, and *Candida* species.

The affected kidney is usually enlarged because of inflammatory PMNs and edema. Infection is focal and patchy, beginning in the pelvis and medulla and extending into the cortex as an enlarging wedge. Cells mediating chronic inflammation appear within a few days, and medullary and subcortical abscesses may develop. Normal parenchymal tissue between foci of infection is common.

Papillary necrosis may be evident in acute pyelonephritis associated with diabetes, obstruction, sickle cell disease, pyelonephritis in renal transplants, pyelonephritis due to candidiasis, or analgesic nephropathy.

Although acute pyelonephritis is frequently associated with renal scarring in children, similar scarring in adults is not detectable in the absence of reflux or obstruction.

Symptoms and Signs

Elderly patients and patients with a neurogenic bladder or an indwelling catheter may present with sepsis and delirium but without symptoms referable to the urinary tract.

When symptoms are present, they may not correlate with the location of the infection within the urinary tract because there is considerable overlap; however, some generalizations are useful.

In **urethritis**, the main symptoms are dysuria and, primarily in men, urethral discharge. Discharge can be purulent, whitish, or mucoid. Characteristics of the discharge, such as the amount of purulence, do not reliably differentiate gonococcal from nongonococcal urethritis.

Cystitis onset is usually sudden, typically with frequency, urgency, and burning or painful voiding of small volumes of urine. Nocturia, with suprapubic pain and often low back pain, is common. The urine is often turbid, and microscopic (or rarely gross) hematuria can occur. A low-grade fever may develop. Pneumaturia (passage of air in the urine) can occur when infection results from a vesicoenteric or vesicovaginal fistula or from emphysematous cystitis.

In **acute pyelonephritis**, symptoms may be the same as those of cystitis. One third of patients have frequency and dysuria. However, with pyelonephritis, symptoms typically include chills, fever, flank pain, colicky abdominal pain, nausea, and vomiting. If abdominal rigidity is absent or slight, a tender, enlarged kidney is sometimes palpable. Costovertebral angle percussion tenderness is generally present on the infected side. In urinary tract infection in children, symptoms often are meager and less characteristic.

Diagnosis

- Urinalysis

- Sometimes urine culture

Diagnosis by culture is not always necessary. If done, diagnosis by culture requires demonstration of significant bacteriuria in properly collected urine.

Urine collection

If a sexually transmitted disease (STD) is suspected, a urethral swab for STD testing is obtained prior to voiding. Urine collection is then by clean-catch or catheterization.

To obtain a **clean-catch, midstream specimen**, the urethral opening is washed with a mild, nonfoaming disinfectant and air dried. Contact of the urinary stream with the mucosa should be minimized by spreading the labia in women and by pulling back the foreskin in uncircumcised men. The first 5 mL of urine is not captured; the next 5 to 10 mL is collected in a sterile container.

A **specimen obtained by catheterization** is preferable in older women (who typically have difficulty obtaining a clean-catch specimen) and in women with vaginal bleeding or discharge. Many clinicians also use catheterization to obtain a specimen if evaluation includes a pelvic examination. Diagnosis in patients with indwelling catheters is discussed elsewhere (see Catheter–Associated Urinary Tract Infections (CAUTIs) : Diagnosis).

Testing, particularly culturing, should be done within 2 h of specimen collection; if not, the sample should be refrigerated.

Urine testing

Microscopic examination of urine is useful but not definitive. Pyuria is defined as ≥ 8 WBCs/μL of uncentrifuged urine, which corresponds to 2 to 5 WBCs/high-power field in spun sediment. Most truly infected patients have > 10 WBCs/μL. The presence of bacteria in the absence of pyuria, especially when several strains are found, is usually due to contamination during sampling. Microscopic hematuria occurs in up to 50% of patients, but gross hematuria is uncommon. WBC casts, which may require special stains to differentiate from renal tubular casts, indicate only an inflammatory reaction; they can be present in pyelonephritis, glomerulonephritis, and noninfective tubulointerstitial nephritis.

Pyuria in the absence of bacteriuria and of UTI is possible, for example, if patients have nephrolithiasis, a uroepithelial tumor, appendicitis, or inflammatory bowel disease or if the sample is contaminated by vaginal WBCs. Women who have dysuria and pyuria but without significant bacteriuria have the urethral syndrome or dysuria-pyuria syndrome.

Dipstick tests also are commonly used. A positive nitrite test on a freshly voided specimen (bacterial replication in the container renders results unreliable if the specimen is not tested rapidly) is highly specific for UTI, but the test is not very sensitive. The leukocyte esterase test is very specific for the presence of > 10 WBCs/μL and is fairly sensitive. In adult women with uncomplicated UTI with typical symptoms, most clinicians consider positive microscopic and dipstick tests sufficient; in these cases, given the likely pathogens, cultures are unlikely to change treatment but add significant expense.

Cultures are recommended in patients whose characteristics and symptoms suggest complicated UTI or an indication for treatment of bacteriuria. Common examples include the following:

- Pregnant women

- Postmenopausal women

- Men

- Prepubertal children

- Patients with urinary tract abnormalities or recent instrumentation

- Patients with immunosuppression or significant comorbidities

- Patients whose symptoms suggest pyelonephritis or sepsis

- Patients with recurrent UTIs ($\geq$ 3/yr)

Samples containing large numbers of epithelial cells are contaminated and unlikely to be helpful. An uncontaminated specimen must be obtained for culture. Culture of a morning specimen is most likely to detect UTI. Samples left at room temperature for > 2 h can give falsely high colony counts due to continuing bacterial proliferation. Criteria for culture positivity include isolation of a single bacterial species from a midstream, clean catch, or catheterized urine specimen. For **asymptomatic bacteriuria**, criteria for culture positivity based on the guidelines of the Infectious Diseases Society of America (see Guidelines for the Diagnosis and Treatment of Asymptomatic Bacteriuria in Adults) are

- Two consecutive clean-catch, voided specimens (for men, one specimen) from which the same bacterial strain is isolated in colony counts of >10^5/mL

- Among women or men, in a catheter-obtained specimen, a single bacterial species is isolated in colony counts of > 10^2/mL

For **symptomatic patients**, culture criteria are

- Uncomplicated cystitis in women: > 10^3/mL

- Uncomplicated cystitis in women: > 10^2/mL *(This quantification may be considered to improve sensitivity to E. coli.)*

- Acute, uncomplicated pyelonephritis in women: > 10^4/mL

- Complicated UTI: > 10^5/mL in women; or > 10^4/mL in men or from a catheter-derived specimen in women

- Acute urethral syndrome: > 10^2/mL of a single bacterial species

Any positive culture result, regardless of colony count, in a sample obtained via suprapubic bladder puncture should be considered a true positive.
In midstream urine, *E. coli* in mixed flora may be a true pathogen (1).
Occasionally, UTI is present despite lower colony counts, possibly because of prior antibiotic therapy, very dilute urine (specific gravity < 1.003), or obstruction to the flow of grossly infected urine. Repeating the culture improves the diagnostic accuracy of a positive result, ie, may differentiate between a contaminant and a true positive result.

Infection localization

Clinical differentiation between upper and lower UTI is impossible in many patients, and testing is not usually advisable. When the patient has high fever, costovertebral angle tenderness, and gross pyuria with casts, pyelonephritis is highly likely. The best noninvasive technique for differentiating bladder from kidney infection appears to be the response to a short course of antibiotic therapy. If the urine has not cleared after 3 days of treatment, pyelonephritis should be sought. Symptoms similar to those of cystitis and urethritis can occur in patients with vaginitis, which may cause dysuria due to the passage of urine across inflamed labia. Vaginitis can often be distinguished by the presence of vaginal discharge, vaginal odor, and dyspareunia.
Men with symptoms of cystitis that do not respond to usual antimicrobial therapy may have prostatitis.

Other testing

Seriously ill patients require evaluation for sepsis, typically with CBC, electrolytes, lactate, BUN, creatinine, and blood cultures. Patients with abdominal pain or tenderness are evaluated for other causes of an acute abdomen.
Patients who have dysuria/pyuria but no bacteriuria should have testing for an STD, typically using nucleic acid-based testing of swabs from the urethra and cervix (see Chlamydial, Mycoplasmal, and Ureaplasmal Mucosal Infections : Diagnosis).
Most adults do not require assessment for structural abnormalities unless the following occur:

- The patient has $\geq$ 2 episodes of pyelonephritis.

- Infections are complicated.

- Nephrolithiasis is suspected.

- There is painless gross hematuria or new renal insufficiency.

- Fever persists for ≥ 72 h.

Urinary tract imaging choices include ultrasonography, CT, and IVU. Occasionally, voiding cystourethrography, retrograde urethrography, or cystoscopy is warranted. Urologic investigation is not routinely needed in women with symptomatic cystitis or asymptomatic recurrent cystitis, because findings do not influence therapy. Children with UTI often require imaging.

Diagnosis reference

1. Hooton TM, Roberts PL, Cox ME, Stapleton AE: Voided midstream urine culture and acute cystitis in premenopausal women. N Engl J Med 369(20):1883-1891, 2013.

Treatment

- Antibiotics

- Occasionally surgery (eg, to drain abscesses, correct underlying structural abnormalities, or relieve obstruction)

All forms of symptomatic bacterial UTI require antibiotics. For patients with troublesome dysuria, phenazopyridine may help control symptoms until the antibiotics do (usually within 48 h).
Choice of antibiotic should be based on the patient's allergy and adherence history, local resistance patterns (if known), antibiotic availability and cost, and patient and provider tolerance for risk of treatment failure. Propensity for inducing antibiotic resistance should also be considered. When urine culture is done, choice of antibiotic should be modified when culture and sensitivity results are available to the most narrow-spectrum drug effective against the identified pathogen. Surgical correction is usually required for obstructive uropathy, anatomic abnormalities, and neuropathic urinary tract lesions such as compression of the spinal cord. Catheter drainage of an obstructed urinary tract aids in prompt control of UTI. Occasionally, a renal cortical abscess or perinephric abscess requires surgical drainage. Instrumentation of the lower urinary tract in the presence of infected urine should be deferred if possible. Sterilization of the urine before instrumentation and antibiotic therapy for 3 to 7 days after instrumentation can prevent life-threatening urosepsis.

Urethritis

Sexually active patients with symptoms are usually treated presumptively for STDs pending test results. A typical regimen is ceftriaxone 250 mg IM plus either azithromycin 1 g po once or doxycycline 100 mg po bid for 7 days. All sex partners within 60 days should be evaluated. Men diagnosed with urethritis should be tested for HIV and syphilis in accordance with the Centers for Disease Control and Prevention's 2015 Sexually Transmitted Diseases Treatment Guidelines.

Cystitis

First-line treatment of uncomplicated cystitis is nitrofurantoin 100 mg po bid for 5 days (it is contraindicated if creatinine clearance is < 60 mL/min), trimethoprim/sulfamethoxazole (TMP/SMX) 160/800 mg po bid for 3 days, or fosfomycin 3 g po once. Less desirable choices include a fluoroquinolone or a beta-lactam antibiotic. If cystitis recurs within a week or two, a broader spectrum antibiotic (eg, a fluoroquinolone) can be used and the urine should be cultured.
Complicated cystitis should be treated with empiric broad-spectrum antibiotics chosen based on local pathogens and resistance patterns and adjusted based on culture results. Urinary tract abnormalities must also be managed.

Acute urethral syndrome

Treatment depends on clinical findings and urine culture results:

- Women with dysuria, pyuria, and colony growth of > 10^2/mL of a single bacterial species on urine culture can be treated as for uncomplicated cystitis.

- Women who have dysuria and pyuria with no bacteriuria should be evaluated for an STD (including for *N. gonorrhoeae* and *C. trachomatis*).

- Women who have dysuria but neither pyuria nor bacteriuria do not have the true urethral syndrome. They should be evaluated for noninfectious causes of dysuria. Evaluation may include therapeutic trials, for example, of behavioral treatments (eg, biofeedback and pelvic musculature relaxation), surgery (for urethral stenosis), and drugs (eg, hormone replacement for suspected atrophic urethritis, anesthetics, antispasmodics).

Asymptomatic bacteriuria

Typically, asymptomatic bacteriuria in patients with diabetes, elderly patients, or patients with chronically indwelling bladder catheters should not be treated. However, patients at risk of complications from asymptomatic bacteriuria (see Asymptomatic bacteriuria) should have any treatable causes addressed and be given antibiotics as for cystitis. In pregnant women, only a few antibiotics can be safely used. Oral beta-lactams, sulfonamides, and nitrofurantoin are considered safe in early pregnancy, but trimethoprim should be avoided during the 1st trimester, and sulfamethoxazole should be avoided during the 3rd trimester, particularly near parturition. Patients with untreatable obstructive problems (eg, calculi, reflux) may require long-term suppressive therapy.

Acute pyelonephritis

Antibiotics are required. Outpatient treatment with oral antibiotics is possible if all of the following criteria are satisfied:

- Patients are expected to be adherent

- Patients are immunocompetent

- Patients have no nausea or vomiting or evidence of volume depletion or septicemia

- Patients have no factors suggesting complicated UTI

Ciprofloxacin 500 mg po bid for 7 days and levofloxacin 750 mg po once/day for 5 days are 1st-line antibiotics if < 10% of the uropathogens in the community are resistant. A 2nd option is usually trimethoprim/sulfamethoxazole (TMP/SMX) 160/800 mg po bid for 14 days. However, local sensitivity patterns should be considered because in some parts of the US, > 20% of *E. coli* are resistant to sulfa.

Patients not eligible for outpatient treatment should be hospitalized and given parenteral therapy selected on the basis of local sensitivity patterns. First-line antibiotics are usually renally excreted fluoroquinolones, such as ciprofloxacin and levofloxacin. Other choices, such as ampicillin plus gentamicin, broad-spectrum cephalosporins (eg, ceftriaxone, cefotaxime, cefepime), aztreonam, beta-lactam/beta-lactam inhibitor combinations (ampicillin/sulbactam, ticarcillin/clavulanate, piperacillin/tazobactam), and imipenem/cilastatin, are usually reserved for patients with more complicated pyelonephritis (eg, with obstruction, calculi, resistant bacteria, or a hospital-acquired infection) or recent urinary tract instrumentation.

Parenteral therapy is continued until defervescence and other signs of clinical improvement occur. In > 80% of patients, improvement occurs within 72 h. Oral therapy can then begin, and the patient can be discharged for the remainder of a 7- to14-day treatment course. Complicated cases require longer courses of IV antibiotics with total duration of 2 to 3 wk and urologic correction of anatomic defects.

Outpatient management can be considered in pregnant women with pyelonephritis, but only if symptoms are mild, close follow-up is available, and (preferably) pregnancy is < 24 wk gestation. Outpatient treatment is with cephalosporins (eg, ceftriaxone 1 to 2 g IV or IM, then cephalexin 500 mg po qid for 10 days). Otherwise, 1st-line IV antibiotics include cephalosporins, aztreonam, or ampicillin plus gentamicin. If pyelonephritis is severe, possibilities include piperacillin/tazobactam or meropenem. Fluoroquinolones and TMP/SMX should be avoided. Because recurrence is common, some authorities recommend prophylaxis after the acute infection resolves with nitrofurantoin 100 mg po or cephalexin 250 mg po every night during the remainder of the pregnancy and for 4 to 6 wk after pregnancy.

Prevention

In women who experience ≥ 3 UTIs/yr, behavioral measures are recommended, including increasing fluid intake, avoiding spermicides and diaphragm use, not delaying urination, wiping front to back after defecation, avoiding douching, and urinating immediately after sexual intercourse. Although some evidence shows that cranberry products prevent UTI in women, others do not; the optimal dose is unknown; and they can have high amounts of oxalates (possibly increasing risk of oxalate stones). Thus, most experts do not recommend use of cranberry products for prevention of symptomatic UTI in women. (See the 2012 Cochrane review article by Jepson et al, Cranberries for preventing urinary tract infections, for further details.)

If these techniques are unsuccessful, antibiotic prophylaxis should be considered. Common options are continuous and postcoital prophylaxis.

Continuous prophylaxis commonly begins with a 6-mo trial. If UTI recurs after 6 mo of prophylactic therapy, prophylaxis may be reinstituted for 2 or 3 yr. Choice of antibiotic depends on susceptibility patterns of prior infections. Common options are TMP/SMX 40/200 mg po once/day or 3 times/wk, nitrofurantoin 50 or 100 mg po once/day, cephalexin 125 to 250 mg po once/day, and fosfomycin 3 g po q 10 days. Fluoroquinolones are effective but are not usually recommended because resistance is increasing. Also, fluoroquinolones are contraindicated in pregnant women and children.

Nitrofurantoin is contraindicated if creatinine clearance is < 60 mL/min. Long-term use can rarely cause damage to the lungs, liver, and nervous system.

Postcoital prophylaxis in women may be more effective if UTIs are temporally related to sexual intercourse. Usually, a single dose of one of the drugs used for continuous prophylaxis (other than fosfomycin) is effective.

Contraception is recommended for women using a fluoroquinolone because these drugs can potentially injure a fetus. Although concern exists that antibiotics may decrease the effectiveness of oral contraceptives, pharmacokinetic studies have not shown a significant or consistent effect. Nonetheless, some experts still recommend that women who use oral contraceptives use barrier contraceptives while they are taking antibiotics.

In **pregnant women**, effective prophylaxis of UTI is similar to that in nonpregnant women, including use of postcoital prophylaxis. Appropriate patients include those with acute pyelonephritis during a pregnancy, patients with > 1 episode (despite treatment) of UTI or bacteriuria during pregnancy, and patients who required prophylaxis for recurrent UTI before pregnancy.

In **postmenopausal women**, antibiotic prophylaxis is similar to that described previously. Additionally, topical estrogen therapy markedly reduces the incidence of recurrent UTI in women with atrophic vaginitis or atrophic urethritis.

Key Points

- The most common causes of bacterial UTI and UTI overall are *E. coli* and other gram-negative enteric bacteria.

- Do not test for or treat asymptomatic bacteriuria except in pregnant women, immunocompromised patients, or before an invasive urologic procedure.

- In general, culture urine in suspected complicated UTI but not in uncomplicated cystitis.

- Test patients for structural abnormalities if infections recur or are complicated, nephrolithiasis is suspected, there is painless hematuria or new renal insufficiency, or fever persists for ≥ 72 h.

- If available, consider local resistance patterns when choosing antibiotic therapy for UTI.

- For women with ≥ 3 UTIs/yr despite behavioral prophylactic measures, consider continuous or postcoital antibiotic prophylaxis.

Drugs Mentioned In This Article

Drug Name	Select Trade
piperacillin/tazobactam	ZOSYN
imipenem/cilastatin	PRIMAXIN
phenazopyridine	No US brand name
nitrofurantoin	FURADANTIN, MACROBID, MACRODANTIN
Ciprofloxacin	CILOXAN, CIPRO
levofloxacin	IQUIX, LEVAQUIN, QUIXIN
azithromycin	ZITHROMAX

Drug Name	Select Trade
ceftriaxone	ROCEPHIN
doxycycline	PERIOSTAT, VIBRAMYCIN
cefotaxime	CLAFORAN
cephalexin	KEFLEX
gentamicin	GENOPTIC
fosfomycin	MONUROL
aztreonam	AZACTAM
meropenem	MERREM
cefepime	MAXIPIME

Last full review/revision June 2018 by Talha H. Imam, MD

MERCK