

Urinary Tract Infections

Urinary tract infections are a group of common diseases that occur predominantly by ascension of normal enteric flora through the urethra into the bladder. These infections more frequently affect women due to anatomic differences including a shorter urethra. Diagnosis is made by identifying related clinical symptoms in combination with an abnormal urinalysis and growth on urine culture. Antibiotics are often effective therapy, although antibiotic resistance is increasing.

Bacterial pathogens and Pathophysiology

Cystitis

Cystitis is an infection of the bladder. The term “cysto” refers to bladder, and “itis” refers to inflammation. Uncomplicated cystitis is defined as cystitis in otherwise healthy women, whereas complicated cystitis is defined as cystitis in all other groups such as men, pregnant women, diabetics, those with anatomic and neurologic problems, and those with recurrent urinary tract infections.

***Escherichia coli* is by far the most common cause of urinary tract infections, especially cystitis.** Other enteric gram-negative rods such as *Klebsiella* species and *Proteus* species are regular culprits. *Pseudomonas aeruginosa* can cause urinary tract infection, but this is most common in health care–associated infections, patients with anatomic/neurologic abnormalities afflicting their urinary tract, or heavily antibiotic-experienced patients. Gram-positive pathogens include *Enterococcus* species and *Staphylococcus saprophyticus*. *Staphylococcus saprophyticus* is common in young women. *Candida* species can cause infection in patients who have extensive prior antibiotic use and indwelling Foley catheters. Rarely, viruses such as adenovirus, BK virus, and cytomegalovirus can cause a hemorrhagic cystitis. These viruses almost exclusively cause cystitis in immunocompromised hosts such as those who have undergone stem cell transplants.

Bacteria (rarely fungi) reach the bladder via ascension through the urethra. This is much more common in women due to the short urethra and close approximation of the urethra to the vagina and anus. Preceding infection, the vagina, which is normally colonized by *Lactobacillus* species, will become colonized by enteric organisms such as *Escherichia coli* instead. *Escherichia coli* are able to adhere to the urethral and bladder mucosa via pili. Once bacteria enter the bladder, they are able to reproduce and cause an inflammatory response, resulting in the symptoms of infection.

Medical conditions that cause abnormal emptying of bladder increase risk for urinary tract infections. These include anatomic abnormalities such as cystoceles, neurologic disorders such as spinal cord injuries and multiple sclerosis, and the presence of foreign bodies such as indwelling Foley catheters. In infants less than 3 months of age, uncircumcised boys are at higher risk for urinary tract infections than girls. However, after infancy, girls are at higher risk for infection than all boys.

Pyelonephritis

Pyelonephritis is an infection of the kidney(s). “Pyelo” refers to the renal pelvis, and “nephritis” means inflammation of the kidney. Uncomplicated pyelonephritis is defined as pyelonephritis in otherwise healthy women, whereas complicated pyelonephritis is pyelonephritis in all other patients.

Escherichia coli is the most common pathogen causing pyelonephritis. Other enteric gram-negative rods such as *Klebsiella* and *Proteus* species are also involved. *Pseudomonas aeruginosa* can cause pyelonephritis, but this typically occurs in health care–associated infections, patients with anatomic/neurologic abnormalities afflicting their urinary tract, or heavily antibiotic-experienced patients. **Patients with recurrent *Proteus* pyelonephritis should be evaluated for struvite stones.** Infection of the kidney following hematogenous spread of infection can occur with essentially any organism but is seen most commonly with *Staphylococcus aureus*. Hematogenous spread also occurs with *Mycobacterium tuberculosis* and can be seen in disseminated fungal infection as well.

Pyelonephritis may occur either by ascension of bacteria from the urethra to the bladder and then to the kidney(s) or, less commonly, through hematogenous spread from other sites of infection such as endocarditis. Kidney stones predispose to pyelonephritis. Urinary tract infections in children can be associated with anatomic abnormalities, and additional workup for diseases such as vesicoureteral reflex should be considered.

Asymptomatic bacteriuria

Asymptomatic bacteriuria is when bacteria colonize the urinary bladder in the absence of signs or symptoms of upper or lower urinary tract infection. It is defined as the presence of $\geq 1 \times 10^5$ CFU/mL of a single bacterial species on two successive urine cultures in a patient without urinary tract symptoms.

The same organisms that commonly cause cystitis also cause asymptomatic bacteriuria. Asymptomatic candiduria can occur as well.

Asymptomatic bacteriuria is common in many populations including persons with diabetes, patients with anatomic and neurologic abnormalities of the urinary tract, patients with indwelling Foley catheters, and elderly patients. The bacteria reach the bladder via ascension through the urethra, not from hematogenous dissemination.

Clinical Manifestations

The most common clinical manifestations of cystitis include dysuria (pain with urination); frequent, low-volume urination; suprapubic tenderness; and gross hematuria. Men may experience some penile discharge. Most patients with cystitis do not have fever or other systemic symptoms of infection, and when they are present, an upper urinary tract infection (pyelonephritis) should be considered.

Patients with pyelonephritis typically present with fever, flank pain, nausea, and vomiting. They may or may not have signs and symptoms of lower tract infection (dysuria, frequency, hematuria, suprapubic tenderness).

Patients with asymptomatic bacteriuria have no signs or symptoms of upper or lower tract infection.

Diagnostic testing for urinary tract infections

Urine microscopy is the use of a microscope to look at urine. In patients with urinary tract infections, one can often find pyuria (elevated white blood cells [WBCs] in urine) and hematuria (red blood cells in urine), and sometimes bacteria can be seen. The presence of WBC casts indicates

pyelonephritis rather than cystitis. A urine sample that has abundant squamous epithelial cells suggests that it is contaminated and the results of the culture are not reliable.

Urine dipsticks use different chemicals reagents on a strip that is dipped in urine to diagnose urinary tract diseases. Certain dipstick test results are suggestive of infection, namely positive leukocyte esterase, positive nitrite, and positive hemoglobin. The positive nitrite occurs from the conversion of nitrate to nitrite by Enterobacteriaceae.

Urine culture allows identification of the organism causing infection. Urine in the bladder is normally sterile. Because contamination of samples can occur as urine passes through the outer third of the urethra, a numeric threshold of colony-forming units (CFUs) per milliliter has been established to confirm infection. In samples obtained from a midstream void, $\geq 1 \times 10^5$ CFU/mL is consistent with infection. In samples collected via catheterization, $\geq 1 \times 10^2$ CFU/mL is consistent with infection. Either a voided midstream urine specimen or a specimen obtained by bladder catheterization can be used for urine culture.

Antibiotics treatment

Treatment of cystitis requires antibiotic therapy. Empiric therapy is directed against *E. coli* in cases of uncomplicated cystitis and is accomplished with either trimethoprim-sulfamethoxazole or nitrofurantoin. Empiric therapy for complicated cystitis is usually with a fluoroquinolone ([ciprofloxacin](#) or [levofloxacin](#)). Symptomatic relief of the dysuria can be accomplished using [phenazopyridine](#).

Antibiotics that are able to obtain high concentrations in the renal parenchyma and have activity against common pathogens are required to treat pyelonephritis. Empiric regimens for community-onset infection include a fluoroquinolone ([ciprofloxacin](#) or [levofloxacin](#)) or a third-generation cephalosporin such as [ceftriaxone](#). Patients with heavy exposure to prior antibiotics, anatomic abnormalities, or exposure to the health care setting should be treated with antibiotics with reliable activity against *Pseudomonas*, such as cefepime, piperacillin, or [meropenem](#). Antibiotic therapy should be narrowed once antibiotic susceptibilities become available.

Treatment of asymptomatic bacteriuria is indicated in select populations who have been identified to be at risk for subsequent severe infection from presence of bacteriuria. These high-risk groups include (1) pregnant women, (2) adults scheduled to undergo urinary tract procedures that could cause mucosal bleeding and translocation of bacteria into the blood, and (3) neutropenic patients.

References:

Review of Medical Microbiology and Immunology.