Acute cystitis: Clinical features and diagnosis in children older than two years and adolescents

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INTRODUCTION — Cystitis is inflammation of the urinary bladder, usually caused by infection, which can occur alone or in conjunction with pyelonephritis.

The clinical features and diagnosis of acute cystitis in children older than two years and adolescents will be reviewed here. The management and prognosis of acute cystitis in children older than two years and adolescents is discussed separately. (See "Acute cystitis: Management and prognosis in children older than two years and adolescents".)

Urinary tract infection (UTI) in newborns and children younger than two years (in whom it is difficult to distinguish cystitis from pyelonephritis on clinical grounds) also is discussed separately.

- (See "Urinary tract infections in neonates".)
- (See "Urinary tract infections in children: Epidemiology and risk factors".)
- (See "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis".)
- (See "Urinary tract infections in infants and children older than one month: Acute management, imaging, and prognosis".)

TERMINOLOGY

Uncomplicated cystitis — Uncomplicated cystitis is limited to the lower urinary tract and typically occurs in children older than two years with no underlying medical problems or anatomic or physiologic abnormalities. Although uncomplicated cystitis may occur in children younger than two years, it is difficult to differentiate upper from lower UTI in such children and they are usually assumed to have upper UTI. Uncomplicated cystitis usually is caused by pathogens that are susceptible to commonly used antimicrobial agents.

Complicated cystitis — Complicated cystitis is defined by coexisting upper UTI, multiple-drug resistant uropathogens, or hosts with special considerations (eg, anatomic or physiologic abnormality of the urinary tract, indwelling bladder catheter, malignancy, diabetes). (See "Etiology and clinical features of bladder dysfunction in children" and "Evaluation and diagnosis of bladder dysfunction in children".)

PATHOGENESIS — In the normal host, most uropathogens originate in the gastrointestinal tract, migrate to the periurethral area and the urethra, and ascend to the bladder, where they stimulate a host response. Bacterial adhesins (pili) and other virulence factors, such as hemolysin and flagellae, provide a selective advantage. Patients who have urodynamic dysfunction, neurogenic bladder, or incomplete bladder emptying may harbor pathogens in residual urine, creating a source for persistent or recurrent infection. (See "Bacterial adherence and other virulence factors for urinary tract infection".)

The pathogenesis of catheter-associated urinary tract infections involves ascension of organisms along a biofilm on intraluminal or extraluminal surface of the catheter. Failure to maintain the integrity of a closed urinary catheter system provides access for organisms to enter the bladder.

EPIDEMIOLOGY — The prevalence of acute cystitis in children is difficult to determine because most epidemiologic studies include children with both upper and lower urinary tract infection (UTI). In pooled analysis of four studies that included children younger than 19 years (most of whom were older than two years) and had urinary

symptoms and/or fever, the prevalence of UTI was 7.8 percent (95% CI 6.6-8.9) [1]; no distinction was made between upper and lower tract disease, and sexual activity was not assessed.

RISK FACTORS — Risk factors for acute cystitis in children and adolescents include:

- Female sex – Urinary tract infections (UTI), including acute cystitis, are more common among girls than boys [2]. The combination of virulence factors and the propensity of bacteria to adhere to the female periurethral mucosa may explain the increased incidence of acute cystitis in females compared to males [3]. Other factors that may contribute to the lower incidence of acute cystitis in males include the antibacterial properties of prostatic fluid, drier periurethral environment, and longer urethra.

- Lack of circumcision is a risk factor for UTI in males, but is most important in infants. (See "Urinary tract infections in children: Epidemiology and risk factors" and "Urinary tract infections in children: Epidemiology and risk factors", section on 'Lack of circumcision'.)

- Sexual activity – Sexual intercourse is one of the most important risk factors for acute cystitis in females. Sexually active young females have approximately 0.5 episodes of acute cystitis per person-year [4]. (See "Acute uncomplicated cystitis and pyelonephritis in women", section on 'Epidemiology'.)

  Unprotected insertive anal intercourse also may increase the risk of acute cystitis in males [5].

- Abnormalities of the urinary system, including:

  - Bladder stones. (See "Clinical features and diagnosis of nephrolithiasis in children", section on 'Dysuria and urgency'.)

  - Indwelling bladder catheter or recent instrumentation of the urinary system [6-9]; the risk of catheter-associated UTI (CAUTI) increases with duration of urinary catheter use, female sex, severity of illness, cardiovascular surgery, multiple trauma, diabetes, and multiple organ failure [7].

  - Bowel and bladder dysfunction. (See "Etiology and clinical features of bladder dysfunction in children", section on 'Urinary tract infection'.)

  - Neurogenic bladder (prolonged stasis of urine in the bladder predisposes to infection) [10,11]. (See 'Pathogenesis' above.)

- Sickle cell disease. (See "Renal manifestations of sickle cell disease", section on 'Urinary tract infection'.)

- Diabetes mellitus. (See "Susceptibility to infections in persons with diabetes mellitus" and "Emphysematous urinary tract infections".)

- Immunodeficiency.

MICROBIOLOGY — Most cases of cystitis in children and adolescents are caused by enteric bacteria. However, cystitis may be caused by any pathogen that colonizes the periurethral area and urinary tract, including nonenteric bacteria, fungi, viruses, and parasites (table 1) [12,13].

The potential pathogens vary according to host characteristics:

- **Normal host** – *Escherichia coli* and other gram-negative organisms account for nearly 90 percent of cases of uncomplicated cystitis in older children, adolescents, and young adults. In a 2009 national surveillance study, *E. coli* accounted for 79 percent of outpatient urinary isolates obtained from children younger than 18 years [2]. *E. coli* was more frequently isolated from girls than boys (83 versus 50 percent). Other pathogens were more frequently isolated from boys than girls: *Enterococcus* (17 versus 5 percent), *P. mirabilis* (11 versus 4 percent), *P. aeruginosa* (7 versus 2 percent), and *Enterobacter* (5 versus 1 percent).

  Adenovirus is an uncommon cause of acute cystitis (usually hemorrhagic) in children without underlying medical problems [14,15]. (See "Epidemiology and clinical manifestations of adenovirus infection", section on

'Genitourinary tract'.)

In Africa and the Middle East, hematuria and cystitis in otherwise healthy children may be due to *Schistosoma haematobium* [16]. (See "Epidemiology, pathogenesis, and clinical manifestations of schistosomiasis", section on 'Genitourinary schistosomiasis'.)

- **Underlying genitourinary abnormality** – Among children with bladder dysfunction, *E. coli* is the most frequently isolated organism, unless there is a history of recent infection or colonization with a gram-negative rod other than *E. coli* or another pathogen.

  Enteric pathogens that are increasingly isolated from children with other underlying genitourinary abnormalities include *Klebsiella* spp, *Enterobacter* spp, and *Pseudomonas aeruginosa* [13].

  P. aeruginosa and *Candida albicans* are the most common pathogens in catheter-associated cystitis. Funguria is particularly common in patients with indwelling urinary catheters who are taking antibiotics or are immunocompromised [17].

- **Sexually active females** – In addition to *E. coli* and other gram-negative organisms, uropathogens that must be considered in sexually active female adolescents and young adults include *Staphylococcus saprophyticus* [18] and *Trichomonas vaginalis.* (See "Bacterial adherence and other virulence factors for urinary tract infection", section on 'Staphylococcus saprophyticus' and "Trichomoniasis", section on 'Consequences'.)

- **Immune compromised child –** During prolonged hospitalization or urinary catheterization, immunocompromised patients are susceptible to healthcare-associated infection, including cystitis caused by enteric pathogens, gram-positive organisms (eg, *Enterococcus*), viruses, and yeast (table 1).

  Patients with impaired T-cell immune function can develop primary or reactivated adenoviral infection, which often presents as hemorrhagic cystitis. (See "Epidemiology and clinical manifestations of adenovirus infection", section on 'Genitourinary tract'.)

  Hematopoietic cell transplant and solid organ transplant recipients are at risk of developing hemorrhagic cystitis due to reactivation of latent adenovirus or polyomaviruses (BK, JC, and SV40) [19-22]. (See "Epidemiology and clinical manifestations of adenovirus infection", section on 'Genitourinary tract' and "Clinical manifestations and diagnosis of JC, BK, and other polyomavirus infections".)

CLINICAL PRESENTATION — Patients with acute cystitis usually present with lower urinary tract symptoms (eg, dysuria, frequency, urgency, new onset incontinence [in toilet trained child], abdominal or suprapubic pain) and/or hematuria [23]. However, lower urinary tract symptoms are not always caused by acute cystitis. (See 'Differential diagnosis' below.)

Children with acute uncomplicated cystitis usually do not have fever or systemic complaints. Fever >38ºC (100.4°F), chills, or flank pain suggest upper tract infection rather than acute cystitis [24], but cannot reliably make this distinction. (See "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Clinical presentation'.)

The clinical manifestations of hemorrhagic cystitis range from microscopic hematuria to extensive bladder hemorrhage with clot formation and obstruction. Adenovirus cystitis is characterized by the acute onset of dysuria and frequency followed by hematuria 12 to 24 hours later [15]; upper respiratory tract infection may precede urinary symptoms. (See "Epidemiology and clinical manifestations of adenovirus infection", section on 'Clinical presentation'.)

Symptoms of dysuria or frequency often are absent in patients with neurogenic bladder. In patients with bladder dysfunction and urinary stasis, cloudiness of urine, a change in the urinary sediment and/or odor, and pathogen colony count ≥100,000 colony forming units (CFU)/mL may help to differentiate between acute cystitis and chronic bacteriuria due to colonization. (See "Urinary tract complications of myelomeningocele (spina bifida)", section on 'Urinary tract infections' and 'Diagnosis' below.)

EVALUATION

History — The history of the acute illness should include:

- Fever (temperature ≥38°C [100.4°F] suggests upper urinary tract infection [UTI] rather than acute cystitis, but cannot reliably make this distinction) (see "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Clinical presentation')
- Vomiting (suggestive of upper urinary tract infection)
- Recent illnesses (may suggest adenovirus infection or acute interstitial nephritis, both of which may be associated with hematuria)
- Recent antibiotics (may be associated with resistant pathogens [25] or acute interstitial nephritis)
- Sexual activity – Sexual activity increases the risk of acute cystitis and expands the list of pathogens to be considered (eg, *S. saprophyticus*, *T. vaginalis*); sexually active girls should be asked about use of barrier contraception with spermicidal agents (which predispose to UTI by altering the normal vaginal flora [26], and may contribute to chemical cystitis [27]) (see 'Microbiology' above)

Information from the past medical history should include (see "Urinary tract infections in children: Epidemiology and risk factors", section on 'Host factors'):

- Chronic urinary symptoms (eg, incontinence, poor stream, frequency, urgency, withholding maneuvers) – May be associated with anatomic or physiologic abnormalities of the urinary tract (eg, bladder dysfunction, posterior urethral valves), increasing the risk of resistant pathogens or recurrent UTI (see "Evaluation and diagnosis of bladder dysfunction in children", section on 'When to suspect bladder dysfunction' and "Clinical presentation and diagnosis of posterior urethral valves", section on 'Presentation')
- Chronic constipation – May be associated with urinary stasis and recurrent UTI (see "Constipation in infants and children: Evaluation", section on 'Constipation and bladder dysfunction')
- Previous UTI or undiagnosed febrile illnesses (which may have been UTI) – Recurrent UTI is associated with progression of renal scarring (see "Urinary tract infections in children: Long-term management and prevention", section on 'Recurrent symptoms')
- Vesicoureteral reflux (VUR) – May be a marker of abnormal renal development and possibly associated with renal scarring (see "Clinical presentation, diagnosis, and course of primary vesicoureteral reflux", section on 'Renal scarring and/or dysplasia')
- Medications – May be associated with interstitial nephritis (see 'Differential diagnosis' below)
- Family history of frequent UTI, VUR, and other genitourinary abnormalities – May be associated with undiagnosed anatomic or physiologic abnormalities of the urinary tract in the patient (see "Clinical presentation, diagnosis, and course of primary vesicoureteral reflux", section on 'Genetics' and "Overview of congenital anomalies of the kidney and urinary tract (CAKUT)", section on 'Epidemiology')

Physical examination — Important aspects of the physical examination in the child with suspected UTI include [12,23,28]:

- Temperature (temperature ≥38°C [100.4°F] suggests upper urinary tract infection rather than acute cystitis, but cannot reliably make this distinction) (see "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Clinical presentation')
- Blood pressure (hypertension may be an early sign of chronic kidney disease) (see "Clinical presentation and evaluation of chronic kidney disease in children", section on 'Hypertension')
- Growth parameters (poor weight gain may be an indication of chronic or recurrent UTI) (see "Clinical

presentation and evaluation of chronic kidney disease in children", section on 'Growth impairment')

- Abdominal palpation for mass (eg, enlarged bladder or enlarged kidney, suggestive of anatomic abnormality)
- Assessment of suprapubic and costovertebral angle tenderness (suprapubic tenderness is suggestive of lower UTI, whereas costovertebral angle tenderness suggests upper UTI)
- Evaluation of the lower back for signs of occult myelodysplasia (eg, midline pigmentation, lipoma, vascular lesion, sinus, tuft of hair), which may be associated with a neurogenic bladder (see "Pathophysiology and clinical manifestations of myelomeningocele (spina bifida)")
- Examination of the external genitalia for anatomic abnormalities that may predispose to UTI (eg, phimosis or labial adhesions) and signs of considerations in the differential diagnosis (eg, vulvovaginitis, vaginal foreign body, sexually transmitted diseases) (see "Care of the uncircumcised penis", section on 'Pathologic phimosis' and "Vulvovaginal complaints in the prepubertal child" and "Sexually transmitted diseases: Overview of issues specific to adolescents", section on 'STD clinical patterns')

Laboratory evaluation — The laboratory evaluation of the child or adolescent with possible cystitis typically includes a urinalysis (dipstick and microscopic examination) and urine culture. (See 'Diagnosis' below.)

Sexually active adolescents with history or examination findings of possible urethritis (urethral discharge); vaginitis or cervicitis (eg, vaginal discharge, intermenstrual or post-coital bleeding, dyspareunia); or epididymitis (urethral discharge, painful or swollen epididymis), should be tested for sexually transmitted infections (with nucleic acid amplification or nucleic acid hybridization tests or culture). (See "Sexually transmitted diseases: Overview of issues specific to adolescents", section on 'STD clinical patterns' and "Clinical manifestations and diagnosis of Neisseria gonorrhoeae infection in adults and adolescents" and "Clinical manifestations and diagnosis of Chlamydia trachomatis infections", section on 'Nucleic acid amplification'.)

DIAGNOSIS — Acute bacterial cystitis is defined as significant bacteriuria in a patient with an inflammatory response and lower urinary tract symptoms (eg, dysuria, frequency, etc). Quantitative urine culture is the standard test for significant bacteriuria. Pyuria on dipstick or microscopic urinalysis confirms the inflammatory response.

Clinical suspicion — Acute cystitis should be suspected in children ≥2 years and adolescents with lower urinary tract symptoms (eg, dysuria, frequency, urgency, new onset incontinence, abdominal or suprapubic pain) and/or hematuria [29].

Urinary tract infection (including complicated cystitis) also should be suspected in children who are immunocompromised, have abnormalities of the urinary tract, family history of urinary tract disease, or history of previous urinary tract infection, if they are febrile (≥38°C [100.4°F]), whether or not they have lower urinary tract symptoms.

Urinalysis — Urinalysis is necessary to assess the inflammatory response (ie, pyuria). Pyuria can be established on dipstick or microscopic urinalysis. Dipstick and microscopic urinalysis also can suggest bacteriuria before the results of the urine culture are available. However, quantitative urine culture is necessary to confirm the diagnosis. (See 'Bacterial culture' below.)

A clean-voided specimen is the preferred method of collection for toilet-trained children. For children who are not toilet trained, we prefer catheterized urine samples to suprapubic aspiration samples given that providers may not be proficient in obtaining suprapubic samples. (See "Urine collection techniques in infants and children with suspected urinary tract infection".)

Pyuria is established by any of the following:

- Positive leukocyte esterase on dipstick analysis
- ≥5 WBC/high power field (hpf) with standard microscopy (centrifuged and unstained)
- ≥10 WBC/mm3 on a hemocytometer with an enhanced urinalysis (which is performed at some centers on

catheterized urine samples that are Gram stained, but not centrifuged) [30]

Bacteriuria is suggested by any of the following:

- Positive nitrites on dipstick analysis; nitrites are produced by *Enterobacteriaceae* (eg, *E. coli*, *Klebsiella*, and *Proteus)*; a negative dipstick nitrite does not exclude a bacteriuria because urine must remain in the bladder for at least four hours to accumulate a detectable amount of nitrite (see "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Dipstick analysis')
- Any bacteria per hpf on standard microscopic analysis (centrifuged and unstained)
- Any bacteria per 10 oil immersion fields on a Gram-stained smear on enhanced urinalysis (which is performed at some centers on catheterized urine samples) [30]

In studies correlating urinalysis results with urine culture, positive leukocyte esterase and/or nitrites on dipstick analysis or white blood cells or bacteria on microscopic examination are highly suggestive of UTI (table 2) [31,32]. (See "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Rapidly available tests'.)

Urine culture

Bacterial culture — Urine culture should be obtained in children in whom acute cystitis is suspected. Urine culture is necessary to determine if the bacteriuria is significant, whether the isolate is a uropathogen, and for susceptibility testing to guide therapy. (See "Acute cystitis: Management and prognosis in children older than two years and adolescents", section on 'Bacterial cystitis'.)

The definition of significant bacteriuria depends upon the method of collection and the identification of the isolated organism (see "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Significant bacteriuria'):

- With midstream (clean catch) samples, significant bacteriuria usually is defined by the growth of ≥100,000 colony-forming units (CFU)/mL [33]. However, we suggest using a threshold of 10,000 CFU/mL for males ≥15 years of age in whom there is an association between UTI and underlying urologic abnormalities (which increases the potential benefit of antibiotic therapy). (See "Acute uncomplicated cystitis, pyelonephritis, and asymptomatic bacteriuria in men", section on 'Urine culture'.)
- With catheterized samples, significant bacteriuria usually is defined by growth of at least 50,000 CFU/mL [34].
- Uropathogens in children and adolescents include organisms such as *E. coli*, *Klebsiella* spp, *Enterobacter* spp, and *Pseudomonas aeruginosa* (table 1).

  Lactobacillus spp, coagulase-negative staphylococci other than *S. saprophyticus*, and *Corynebacterium* spp are **not** considered clinically relevant uropathogens in immune competent children without indwelling bladder catheters.

Viral culture — Viral cultures should be obtained in children and adolescents with hematuria and in immunocompromised children and adolescents if a bacterial pathogen has not been isolated and if another explanation for hematuria (ie, severe thrombocytopenia in an immunocompromised child or vulvovaginitis) has not been identified.

Adenovirus may cause acute cystitis (usually hemorrhagic) in immune competent children without abnormalities of the urinary tract. Adenovirus and polyomaviruses (BK, JC, and SV40) may cause cystitis in children with impaired T-cell function and children who have undergone hematopoietic cell or solid organ transplant. (See 'Microbiology' above and "Epidemiology and clinical manifestations of adenovirus infection", section on 'Genitourinary tract'.)

Viral culture and polymerase chain reaction assays are highly sensitive and specific methods for detecting most

adenoviruses. (See "Diagnosis, treatment, and prevention of adenovirus infection".)

The diagnosis of polyomavirus cystitis is discussed separately. (See "Clinical manifestations and diagnosis of JC, BK, and other polyomavirus infections", section on 'Diagnosis'.)

Fungal culture — The vast majority of fungal urinary tract infections are caused by *Candida* spp, which are easily isolated on routine bacterial media. Specific fungal cultures rarely are warranted in pediatric patients.

DIFFERENTIAL DIAGNOSIS — The differential diagnosis of urinary symptoms (dysuria, frequency, urgency, new onset incontinence, abdominal or suprapubic pain), and/or hematuria in children ≥2 years and adolescents includes the conditions listed below. Detailed approaches to children with dysuria, hematuria, and abdominal pain are provided separately. (See "Evaluation of dysuria in children and adolescents" and "Evaluation of gross hematuria in children" and "Causes of acute abdominal pain in children and adolescents" and "Emergent evaluation of the child with acute abdominal pain".)

Negative urine culture usually distinguishes the conditions listed below from acute cystitis in otherwise healthy children. However, in immunocompromised children, viral and/or fungal cultures may be warranted before excluding infectious cystitis.

- Bladder dysfunction – Frequency, urgency, and incontinence may be symptoms of bladder dysfunction, a diagnosis that is frequently overlooked in children with urinary symptoms and a negative urine culture. (See "Etiology and clinical features of bladder dysfunction in children".)
- Vulvovaginitis, chemical/mechanical cystitis, or vaginal foreign body – Girls with nonspecific vulvovaginitis, chemical/mechanical cystitis or urethritis (eg, related to bath products, migration of pinworms, masturbation), or vaginal foreign body may complain of dysuria and/or bleeding and may have white blood cells in their urine. (See "Vulvovaginal complaints in the prepubertal child".)
- Epididymo-orchitis – Clinical manifestations of epididymo-orchitis may include scrotal swelling, pain, and tenderness with erythema and shininess of the overlying skin, as well as dysuria [35]. Mumps is the most common viral etiology. (See "Causes of scrotal pain in children and adolescents", section on 'Orchitis' and "Epidemiology, clinical manifestations, diagnosis, and management of mumps", section on 'Orchitis'.)
- Nephrolithiasis – Most children with symptomatic nephrolithiasis have flank pain/renal colic in addition to gross or microscopic hematuria. (See "Diagnosis and acute management of suspected nephrolithiasis in adults".)
- Urethral strictures – Symptoms and signs of urethral stricture may difficulty urinating and an abnormal urine stream in addition to lower urinary tract symptoms.
- Systemic diseases that may be associated with urinary symptoms and sterile pyuria include:
    - Kawasaki disease; additional manifestations of Kawasaki disease may include conjunctivitis, cervical lymphadenopathy, rash, oral lesions (injected or fissured lips, injected pharynx, strawberry tongue), extremity changes (erythema or edema of the hands and feet, periungual desquamation). (See "Kawasaki disease: Clinical features and diagnosis", section on 'Clinical manifestations'.)
    - Autoimmune diseases (eg, systemic lupus erythematosus, Sjögren's syndrome) with interstitial nephritis [36]. (See "Diagnosis and classification of renal disease in systemic lupus erythematosus", section on 'Tubulointerstitial nephritis' and "Renal disease in Sjögren's syndrome", section on 'Interstitial nephritis'.)
    - Behçet's disease, a multisystem disorder that may include urogenital involvement (eg, aphthous ulcers, epididymitis, urethritis, recurrent cystitis); recurrent oral ulcers are the cardinal feature. (See "Clinical manifestations and diagnosis of Behçet's disease".)
- Drugs, such as nonsteroidal antiinflammatory agents (eg, ibuprofen), antibiotics (eg, penicillins,

cephalosporins, trimethoprim-sulfamethoxazole), and various chemotherapeutic agents (eg, cyclophosphamide, doxorubicin, methotrexate) may cause interstitial nephritis, which may be associated with hematuria. (See "Clinical manifestations and diagnosis of acute interstitial nephritis", section on 'Drugs'.)

- Neoplasms – Neoplasms, such as neuroblastoma, pelvic teratoma, or Wilms' tumor may cause urinary symptoms secondary to bladder compression. Additional findings in patients with these tumors commonly include a palpable mass on abdominal/pelvic examination, hypertension, and/or neurologic symptoms or signs. (See "Clinical presentation, diagnosis, and staging evaluation of neuroblastoma", section on 'Clinical presentation' and "Presentation, diagnosis, and staging of Wilms tumor", section on 'Clinical presentation'.)

Additional considerations in sexually active patients include:

- Chemical cystitis (eg, related to spermicides) [27].
- Vaginitis – Vaginal odor, discharge, pruritus, or dyspareunia suggests vaginitis. Causes of vaginitis include yeast infection, trichomoniasis, and bacterial vaginosis. (See "Approach to women with symptoms of vaginitis".)
- Cervicitis – Signs and symptoms of cervicitis may include purulent or mucopurulent discharge from the endocervix, intermenstrual or postcoital bleeding, pruritus, dyspareunia, vulvovaginal irritation, cervical motion tenderness, cervical friability, and cervical edema. (See "Acute cervicitis", section on 'Diagnosis'.)
- Pelvic inflammatory disease – In addition to dysuria and abdominal pain, female adolescents with pelvic inflammatory disease may have vaginal discharge, pain with coitus, and constitutional symptoms. (See "Clinical features and diagnosis of pelvic inflammatory disease", section on 'Clinical features'.)
- Urethritis – Urethritis is a consideration in sexually active patients with dysuria, particularly those with pyuria and no bacteriuria. Causes of urethritis include *N. gonorrhoeae*, *C. trachomatis*, *Ureaplasma urealyticum*, or *T. vaginalis* as well as routine uropathogens, such as *E. coli*. Symptoms of urethritis caused by *N. gonorrhoeae* or *C. trachomatis* typically develop gradually over several weeks in an adolescent whose sexual partner may or may not have urethral symptoms. (See "Sexually transmitted diseases: Overview of issues specific to adolescents", section on 'Discharge syndromes'.)

EVALUATION FOR UNDERLYING ABNORMALITIES — Radiologic evaluation (eg, renal ultrasonography, renal scan, voiding cystourethrogram) for underlying abnormalities is not routinely necessary in children and adolescents with uncomplicated cystitis.

The imaging indications and modalities for children with complicated cystitis vary depending upon the clinical scenario; imaging may be indicated for patients with:

- Suspected or confirmed recurrent cystitis
- Cystitis caused by an unusual pathogen
- Family history of renal or urologic disease
- Poor growth
- Hypertension
- Failure to respond as expected to antimicrobial therapy (in children with confirmed bacterial infection)

These clinical features may indicate an underlying anatomic or functional abnormality (eg, renal calculus, cyst, abscess, foreign body, bladder dysfunction) that may require additional intervention.

Guidelines for imaging the urinary tract after UTI in young children and children with upper tract infections are discussed separately. (See "Urinary tract infections in infants and children older than one month: Acute management, imaging, and prognosis", section on 'Imaging'.)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade

reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topic (see "Patient information: Urinary tract infections in children (Beyond the Basics)")
- Beyond the Basics topic (see "Patient information: Urinary tract infections in children (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Risk factors for acute cystitis in children ≥2 years and adolescents include female sex, sexual activity, abnormalities of the urinary system (eg, vesicoureteral reflux, bowel and bladder dysfunction, neurogenic bladder, indwelling bladder catheter, recent instrumentation of the urinary system), certain chronic diseases (eg, sickle cell disease, diabetes mellitus), and immunodeficiency. (See 'Risk factors' above.)
- Acute cystitis is usually caused by *Escherichia coli,* but may be caused by any pathogen that colonizes the periurethral area and urinary tract (table 1), particularly in children with underlying genitourinary abnormalities, or immune compromise. (See 'Microbiology' above.)
- Children with acute cystitis typically present with dysuria, frequency, urgency, new onset incontinence (in toilet trained child), abdominal or suprapubic pain, and/or hematuria. Fever >38°C (100.4°F), chills, or flank pain suggest upper tract infection rather than acute cystitis but cannot reliably make this distinction. (See 'Clinical presentation' above.)
- The history (table 3) and examination (table 4) of children with suspected acute cystitis focus on risk factors for urinary tract infection and evaluation of other conditions in the differential diagnosis. (See 'Evaluation' above and 'Risk factors' above and 'Differential diagnosis' above.)
- Acute cystitis should be suspected in children ≥2 years and adolescents with lower urinary tract symptoms (eg, dysuria, frequency, urgency, new onset incontinence, abdominal or suprapubic pain) and/or hematuria. Urinary tract infection (including complicated cystitis) also should be suspected in children who are immunocompromised, have abnormalities of the urinary tract, family history of urinary tract disease, or history of previous urinary tract infection, if they are febrile (≥38°C [100.4°F]), whether or not they have lower urinary tract symptoms. (See 'Clinical suspicion' above.)
- The diagnosis of acute bacterial cystitis requires isolation of ≥100,000 colony forming units (CFU)/mL of a uropathogen from a clean catch urine sample or ≥50,000 CFU/mL of a uropathogen from a catheterized urine sample in a patient with urinary symptoms and pyuria on dipstick or microscopic urinalysis. (See 'Diagnosis' above and 'Urinalysis' above and 'Bacterial culture' above.)
- The results of the urine culture differentiate acute cystitis from other causes of lower urinary tract symptoms, hematuria, and/or lower abdominal pain in children and adolescents. (See 'Differential diagnosis' above.)

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Topic 6012 Version 22.0

GRAPHICS

Urinary tract pathogens in acute cystitis in children and adolescents

Bacteria
Gram-negative bacilli
Escherichia coli
Pseudomonas aeruginosa
Klebsiella spp
Enterobacter cloacae
Enterobacter aerogenes
Morganella morganii
Proteus mirabilis
Providencia stuartii
Serratia spp
Gram-negative cocci
*Neisseria gonorrhoeae**
Gram-positive cocci
Enterococcus spp
Streptococcus group B
Streptococcus group D
Staphylococcus aureus
Staphylococcus epidermidis
Staphylococcus saprophyticus
Other bacterial pathogens
*Chlamydia trachomatis**

Fungi
Candida spp
Trichosporon spp
Aspergillus spp
Microsporidia spp
Viruses
Adenovirus
Polyomaviruses
BK virus•
JC virus•
SV 40 virus•
Herpes simplex virus*
Parasites
Schistosoma spp
Trichomonas vaginalis

* Associated with sexually transmitted disease.
• Most often in immunocompromised hosts.

Graphic 54955 Version 6.0

Test characteristics of tests used to diagnose urinary tract infections in children

	Sensitivity	Specificity	Positive likelihood ratio*	Negative likelihood ratio•
Dipstick				
Leukocyte esterase (LE)	84 percent	78 percent	4	0.2
Nitrite	50 percent	98 percent	25	0.5
Nitrite or LE	88 percent	93 percent	13	0.1
Nitrite and LE	72 percent	96 percent	18	0.3
Microscopy				
Uncentrifuged				
Pyuria (>10/mm^3) (all ages)	77 percent	89 percent	7	0.4
Pyuria (>10/mm^3) (<2 years)	90 percent	95 percent	18	0.1
Bacteriuria (gram stained)	93 percent	95 percent	19	0.1
Overall (P+B) = enhanced	85 percent	99.9 percent	85	0.1
Overall (P or B)	95 percent	89 percent	9	0.1
Centrifuged				
Pyuria (>5/hpf)	67 percent	79 percent	3	0.4
Bacteriuria	81 percent	83 percent	5	0.2
Overall (P+B)	66 percent	99 percent	7	0.4

P: pyuria; B: bacteriuria; hpf: high-power field.

* Positive likelihood ratio: The positive likelihood ratio is the probability that a child with a UTI will have a positive test divided by the probability that a child without a UTI will have a positive test (eg, true positive rate/false positive rate). The higher the positive likelihood ratio, the better the test.

• Negative likelihood ratio: The negative likelihood ratio is the probability that a child with a UTI will have a negative test divided by the probability that a child without a UTI will have a negative test (eg, false negative rate/true negative rate). The lower the negative likelihood ratio, the better the

test (a perfect test has a negative likelihood ratio of zero).

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Graphic 82157 Version 6.0

Important aspects of the history in child (≥2 years) or adolescent with suspected acute cystitis

Historical feature	Potential significance
History of acute illness	
Fever (temperature ≥38°C [100.4°F])	May suggest upper UTI
Vomiting	Suggests upper UTI or other cause of symptoms
Recent illness	May suggest adenovirus or be associated with interstitial nephritis
Recent antibiotics	May be associated with resistant pathogens or acute interstitial nephritis
Sexual activity	Expands the potential pathogens (eg, *Staphylococcus saprophyticus*, *Trichomonas vaginalis*) and the differential diagnosis (eg, cervicitis, pelvic inflammatory disease)
If sexually active, use of spermicidal agents	Predisposes to urinary tract infection by altering vaginal flora
Past history	
Chronic urinary symptoms (eg, incontinence, poor stream, frequency, urgency, withholding maneuvers)	May be associated with anatomic or physiologic abnormalities of the urinary tract (eg, bladder dysfunction, posterior urethral valves), increasing the risk of resistant pathogens or recurrent UTI
Chronic constipation	May be associated with urinary stasis and recurrent UTI
Previous UTI or undiagnosed febrile illnesses (which may have been UTI)	Recurrent UTI is associated with progression of renal scarring
Vesicoureteral reflux	May be a marker of abnormal renal development and possibly associated with renal scarring
Medications	May be associated with interstitial nephritis or urinary retention
Family history of frequent UTI, VUR, or other genitourinary abnormalities	May be associated with undiagnosed anatomic or physiologic abnormalities of the urinary tract

UTI: urinary tract infection; VUR: vesicoureteral reflux.

Graphic 94623 Version 2.0

Important aspects of the examination in child (≥2 years) or adolescent with suspected acute cystitis

Examination finding	Potential significance
Fever (temperature ≥38°C [100.4°F])	May suggest upper UTI
Blood pressure	Hypertension may be an early sign of chronic kidney disease
Growth parameters	Poor weight gain may be an indication of chronic or recurrent UTI
Abdominal palpation	Enlarged bladder or kidney suggestive of anatomic abnormality
Suprapubic or costovertebral angle tenderness	Suprapubic tenderness is suggestive of lower UTI; costovertebral angle tenderness is suggestive of upper UTI
Lower back for signs of occult myelodysplasia (eg, midline pigmentation, lipoma, vascular lesions, sinus, tuft of hair)	May be associated with neurogenic bladder
External genitalia	May reveal anatomic abnormalities that predispose to UTI (eg, phimosis, labial adhesions) or signs of considerations in the differential diagnosis (eg, vulvovaginitis, vaginal foreign body, sexually transmitted infection)

UTI: urinary tract infection.

Graphic 94622 Version 2.0

Disclosures

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