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Current Status of the Diagnosis and Treatment of Pediatric Urinary Tract Infections

Urinary tract infections (UTIs) are a potential cause of fever in the pediatric patient. Early testing and a timely diagnosis are critical to avert complications and potential scarring of the kidneys. Complication rates in children younger than 90 days of age are 7% and include bacteremia, meningitis, and urosepsis, although a well-appearing infant with a CRP of < 4 mg/dL is significantly less likely to develop complications. The authors present a concise review of the current status of the diagnosis and management of pediatric UTIs.

— Ann M. Dietrich, MD, Editor

Epidemiology

Fever is the most common presenting symptom to pediatric emergency departments, comprising 10%-20% of visits.[1–4] Of these, 2-7% have a final diagnosis of urinary tract infection (UTI), which is an infection anywhere from the tip of the urethra to the renal parenchyma.[5–8] Table 1 shows the prevalence of urinary tract infections in various age groups.[9,10] As can be seen, the prevalence of UTIs is much higher in females. The only time in which males have a significantly higher prevalence of UTI than females is in the 0-1 month age group, with circumcision status being the single largest risk factor.[10,11] Additionally, the prevalence of UTI was significantly higher among whites than among African Americans.[6]

In older verbal children who are able to describe genitourinary (GU) symptoms, the prevalence of a UTI was 7.8%, in contrast to adults, of whom 50% with GU symptoms are ultimately diagnosed with a UTI.[6,12] In addition to the more than 1.1 million physician visits annually for pediatric UTIs, the hospitalization costs for UTIs are extensive — $180 million a year.[13]

Etiology

Ninety-five percent of the isolates from urine cultures are from the *Enterobacteriaceae* family, including *Escherichia coli*, *Klebsiella* spp., *Proteus* spp., *Enterobacter,* and *Citrobacter* spp. As expected, the prevalence of UTIs caused by each bacterium changes with age and gender. There is a high prevalence of *Proteus* infections in older males, while older females have higher rates of *Staphylococcus saprophyticus* infections. In neonates, *Escherichia coli* is the most common pathogen, although other bacteria outside the *Enterobacteriaceae* family can cause UTIs, such as group B streptococcus.[11,14,15] In children with urological abnormalities, immunocompromised patients, or those with indwelling catheters, other organisms such as *Pseudomonas aeruginosa*, *Candida albicans*, and *Haemophilus* spp. must be considered.[14,16] Viral cystitis can also be seen in immunocompromised patients, with the most common virus being adenovirus.[17]

Executive Summary

- In neonates, *Escherichia coli* is the most common pathogen, although other bacteria outside the *Enterobacteriaceae* family can cause UTIs, such as group B streptococcus.
- While the history and physical examination are the cornerstone of accurate diagnosis, there are difficulties in diagnosing UTI in nonverbal children due to the nonspecific nature of symptoms.
- Timely diagnosis and treatment of a UTI is important in the pediatric population because there is a strong association with pyelonephritis, as seen on DMSA scans (up to 57% of cases).
- Pyelonephritis leads to scarring of the renal parenchyma in up to 15% of cases and can lead to complications such as uremia, hypertension, and, ultimately, end stage renal disease.
- In children, indications for hospitalization include vomiting or refusal to drink, toxic appearance, congenital or anatomical urological abnormalities, or a previous culture with a pathogen that is not susceptible to oral agents.

Pathophysiology

Almost all instances of UTI are ascending in nature. The infection begins when bacteria from feces or the skin in the perianal region, or beneath the foreskin in uncircumcised boys, adhere to the urethral epithelium and enter the bladder.[18] Uropathogenic bacteria, especially *E. coli,* have cell surface molecules on terminal fimbria that recognize proteins on the uroepithelial surface and help promote attachment and colonization.[15,19] Other bacterial virulence factors include endotoxin, K-capsular antigen, hemolysin, and aerobactin, all of which promote bacterial growth and invasion.[15] From the bladder, the bacteria may ascend to the renal parenchyma, leading to pyelonephritis. Table 2 lists risk factors for children to develop a UTI.[20]

Table 1. Prevalence of UTI in Febrile Young Children[9,10]

Age (mo)	Prevalence	Female (%)	Male (%)
0-1	6.9	5.1	8.5
> 1-3	5.5	5.9	5.3
> 3-6	3.6	5.1	2.5
> 6-9	2.1	3.7	0.8
> 9-12	1.4	2.3	0.7
> 12-18	0.8	1.4	0.4
> 18-24	0.8	1.4	0.3

Clinical Presentation

While the history and physical examination are the cornerstone of accurate diagnosis, there are difficulties in diagnosing UTI in nonverbal children due to the nonspecific nature of symptoms. In the newborn period, a UTI should be considered with any child who presents with a fever, as this may be the only presenting sign. In a recent retrospective chart review of febrile infants, there was a positive urine culture rate of 10.7% in children younger than 28 days, and 8.5% in children from 29 to 60 days.[21] In addition to fever, infants younger than 2 months of age may also present with persistent jaundice, failure to thrive, vomiting, or fulminant sepsis.[5,22] In nonverbal children from 2 to 24 months of age, risk factors include a temperature greater than 39°C for more than 24 hours. Again, diagnosis is difficult because of the vague, nonspecific nature of the presenting complaints. The strongest predictive factors for this age group are a generally unwell appearance, height of fever, urinary symptoms, decreased fluid intake in the previous 24 hours, circumcision status, and increased capillary refill time.[23,24]

It is somewhat easier to diagnose a UTI in the verbal child. In verbal children, there is a high correlation of UTI with the presence of dysuria, urinary frequency or urgency, urinary incontinence, fever, abdominal pain, and lower back pain.[5] In children with pyelonephritis, presentation may include signs such as fever, chills, and flank pain without the classic signs of a lower urinary tract infection such as dysuria, frequency, and urgency. An abdominal mass may be palpated in rare cases that could be indicative of severely infected hydronephrosis or xanthogranulomatous pyelonephritis. Xanthogranulomatous pyelonephritis is a rare type of granulomatous pyelonephritis seen with recurrent *Proteus* or *E. coli* infections.[25,26] The differential diagnosis includes nephrolithiasis, urethritis, sexually transmitted infection, and diabetes.

Diagnosis

Timely diagnosis and treatment of a UTI is important in the pediatric population because there is a strong association with pyelonephritis, as seen on DMSA scans (up to 57% of cases).[5,27] Pyelonephritis leads to

scarring of the renal parenchyma in up to 15% of cases and can lead to complications such as uremia, hypertension, and, ultimately, end stage renal disease.[6,28–30] Prompt administration of antibiotics can lead to a reduction of scar formation.[31] However, a recent prospective cohort study showed that only 63% of patients with a UTI were treated with antibiotics even though they had the appropriate test performed during their emergency department visit. This may be secondary to test misinterpretation, or a decision to wait until urine culture results returned, but it led to a return rate of 30% for the children who had an infection but were not treated with antibiotics.[23]

In the younger than 60 days of age group, because of the high incidence of bacteremia and sepsis, urinalysis and urine culture should be done on all children presenting to the emergency department with either a fever or suspicion of a serious bacterial infection (SBI). The urinalysis and urine culture should be a part of the routine septic workup in all neonates.

Testing for urinary tract infections in children from 2-24 months should be based on known risk factors, as seen in Table 3.[32]

The probability of a UTI in females is ≤ 1% when no more than one factor is present and ≤ 2% when there are no more than two factors present. Because circumcised males are at lower risk, there is a ≤ 1% when no more than two factors are present and ≤ 2% when there are no more than three factors present. Uncircumcised males are at a very high risk, and, therefore, the probability of having a UTI is > 1%, even with no other risk factors present.[5,7,32]

A challenge for the emergency department physician is deciding whether to pursue the diagnosis of a UTI in a febrile child with a diagnosis of a viral upper respiratory tract infection. There have been multiple studies that show that having a documented viral infection does not significantly decrease the chance of having a UTI.[33–35] Specifically, there is a correlation between a febrile young child having a respiratory syncytial virus (RSV) infection and a UTI.[36] A prospective observational study recently found that in the assessment for SBI in febrile young infants younger than 3 months old with and without bronchiolitis, there was an increased incidence of UTI to 12.2% in the bronchiolitis group from 4% in the control group. They additionally showed that in the age group of ≤ 28 days, there is a high incidence (9.7%) of infants with bronchiolitis who concurrently have a UTI.[35] Even with the lower rate of UTI of 4%, most clinicians would still consider this a high enough risk to screen for a UTI in febrile infants with upper respiratory symptoms.[32]

When urine must be collected for urinalysis and urine culture, the clinician must make a decision about which method to use to collect the sample. Methods for collecting urine include urethral catheterization, suprapubic aspiration (SPA), clean catch collection, or sterile urine bag. While the perineum is scrubbed in an attempt to sterilize the area for collection of a specimen by sterile

Table 2. Risk Factors for Developing a UTI

- Female gender
- Uncircumcised male
- Vesicoureteral reflux
- Toilet training
- Voiding dysfunction
- Obstructive uropathy
- Urethral instrumentation
- Pinworm infestation
- Constipation
- Anatomic abnormality (e.g., posterior urethral valves)
- Neuropathic balder
- Sexual activity
- Pregnancy

Adapted from: Elder J. *Nelson Textbook of Pediatrics*. 18th ed. (Kliegman R, Behrman R, Jenson H, Stanton B, eds.). Elsevier Inc; 2007:2223–2228.

Table 3. Risk Factors for Developing a UTI[32]

Risk Factors in Females

- White race
- Age < 12 months
- Temperature 39°C or greater
- Fever for 2 days or more
- Absence of another source of infection

Risk Factors in Males

- Nonblack race
- Temperature 39°C or greater
- Fever for 24 hours or more
- Absence of another source of infection

Table 4. Performance Characteristics of Urine Assays[40,41]

Test	Sensitivity	Specificity
Overall	84	83
Leukocyte esterase	75	84
Nitrites	43	97
Microscopy (> 5 wbc/hpf)	85	79
Cell count (> 10 wbc/mm^3	77	89
Gram stain	93	95

Figure 1. Transverse Image of Bladder, Debris Present

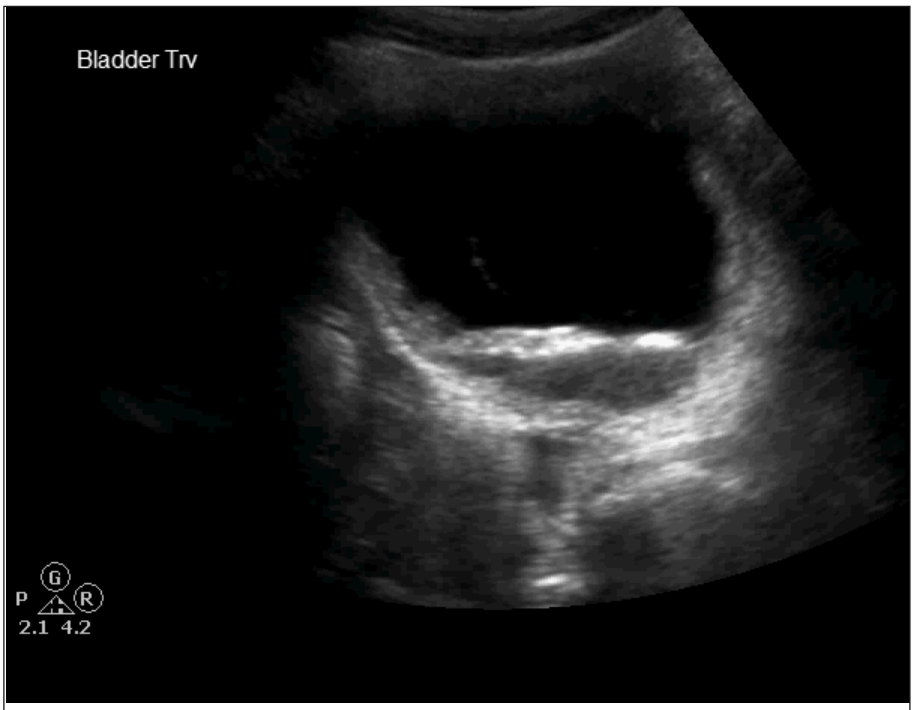

Image courtesy of Dr. Sandra Werner.

urine bag, bacterial growth is often reflective of perianal or anal flora. Contamination rates for bagged specimens are unacceptably high, with some reports as high as 46%. Because of this, a bagged specimen should not be used for diagnosis, although a negative culture in a bag specimen eliminates the possibility of a UTI.[10,37–39] Clean catch urine can be slightly more reliable, especially in older females, circumcised males, or uncircumcised males that can retract the foreskin. Contamination rates in these groups are between 14-26%, which is still significant. The most reliable way of collecting urine is through a catheterization or SPA, with contamination rates of 12-14% and 1-9%, respectively. This is the recommended method of obtaining urine in children younger than 3 years old.[32,38,39] SPA may be the only reliable way of collecting urine in situations such as males with phimosis or females with labial adhesions, although it is often not performed in the emergency department setting, as it is the most technically difficult method as well as the most invasive. A prospective analysis of 3066 febrile infants showed that the most common collection method was catheterization. The use of ultrasound to complete SPA increases accuracy and safety of the procedure. (*See Figure 1.*) In addition, ultrasound may be used to assess the presence and quantity of urine present prior to catheterization or SPA attempts and also identify any debris that may be present. (*See Figure 2.*)

The new AAP definition of a UTI requires both a urinalysis with pyuria or bacteria and a urine culture that is growing > 50,000 colony-forming units/mL of a uropathogen. While the culture may take time to return, the urinalysis is the most readily available and widely used point-of-care test available in the emergency department. The tests that are evaluated for a UTI are nitrites, leukocyte esterase, pyuria, and the presence of bacteria. The sensitivity and specificity of each test can be seen in Table 4.[10,40,41] Nitrites are formed as metabolic breakdown products from many gram-negative bacteria. The nitrite test is the least sensitive test. The problem with this test is that many gram-positive bacteria do not produce nitrites. Additionally, young children who frequently empty their bladder or are receiving large amounts of intravenous fluids may not have enough time for the urine to dwell in the bladder and allow bacteria to form nitrites. While it does have a low sensitivity, the specificity is high and so it is helpful when the test is positive.[42]

Leukocyte esterase is a breakdown product of white blood cells, and has a higher sensitivity than the nitrite test. One advantage of this test is its ability to distinguish between asymptomatic bacteriuria and a true UTI. Given this, a positive leukocyte esterase test must be interpreted with caution, as there is a high false-positive rate. Microscopic

pyuria is a very sensitive test, as it is very rare for a child with a true UTI to have an absence of WBCs. Pyuria is defined as > 5 WBC/high-power field. If there is significant bacteria in the absence of pyuria, the most likely explanation is contamination or asymptomatic bacteria, neither of which needs to be treated with antimicrobials.

A urine dipstick can be used to screen for a UTI and does have a lower cost than a urinalysis, but it does have a lower sensitivity than a urinalysis. A cross-sectional study of 3873 patients was performed and showed that the most cost-effective method for identifying patients with a UTI was to perform a urine dipstick on all patients, start antibiotics, and send a confirmatory culture on all positive urine dipstick results. This method was superior to using an isolated urinalysis because it was more specific and more cost effective.[43]

While the above tests can assist with the diagnosis and can lead to a decision in the emergency department on starting antimicrobials, none of the available tests can allow a practitioner to identify definitively the source of the fever as a UTI.[44] In patients younger than 60 days old, it is imperative that none of the patients with a true UTI are missed; therefore, a test is needed with 100% sensitivity. Given that the gold standard, the urine culture, can take up to 48 hours to identify a positive result, these patients should be admitted while awaiting the results. There are false negatives in both the UA and urine dip, and negative tests do not allow the clinician to exclude a UTI. In children older than 2 months, the finding of any nitrites, greater than "trace" leukocyte esterase, or bacteria on Gram stain of an uncentrifuged sample are very suggestive of a UTI, and antimicrobials should be initiated while awaiting the culture results.[44]

While results will generally not be available during the time that the child is in the emergency department, the urine culture is the gold standard for the diagnosis of a UTI. In children older than 2 months of age, ≥ 50,000 CFU/mL is diagnostic of a UTI.[32,45] Lower CFU counts (< 10,000) may reflect bacteria that are present in distal urethra but not the bladder. That being said, lower counts may be reflective of a true UTI if the sample was gained through SPA or in the setting of an obstructive uropathy.[46] Additionally, the culture is considered to be

Figure 2. Ultrasound of Bladder

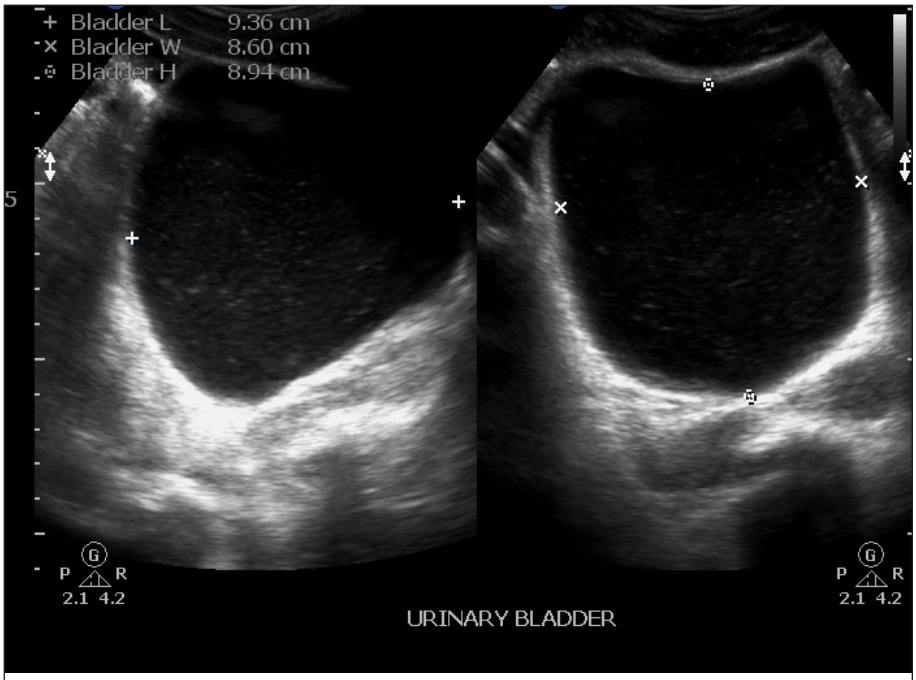

Image courtesy of Dr. Sandra Werner.

Figure 3. Bladder Ultrasound

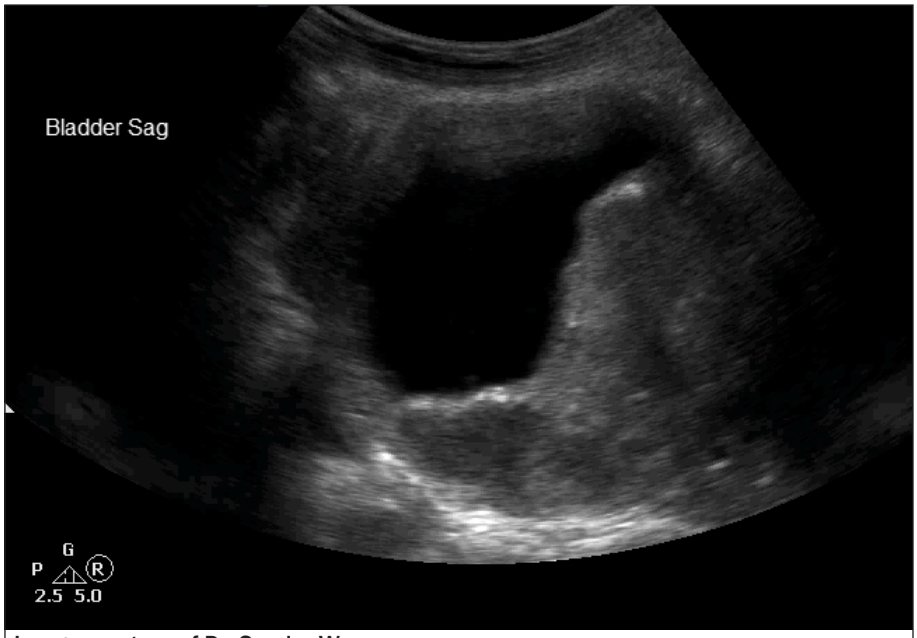

Image courtesy of Dr. Sandra Werner.

Figure 4. Ultrasound of Kidney Showing Hydronephrosis

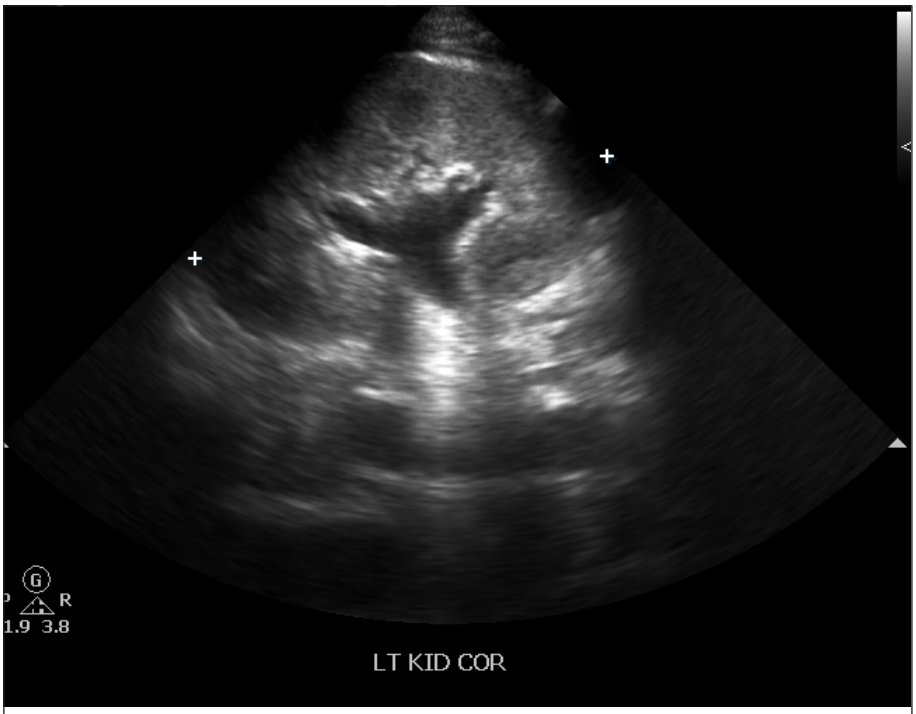

Image courtesy of Dr. Sandra Werner.

Figure 5. Ultrasound of Hydronephrosis

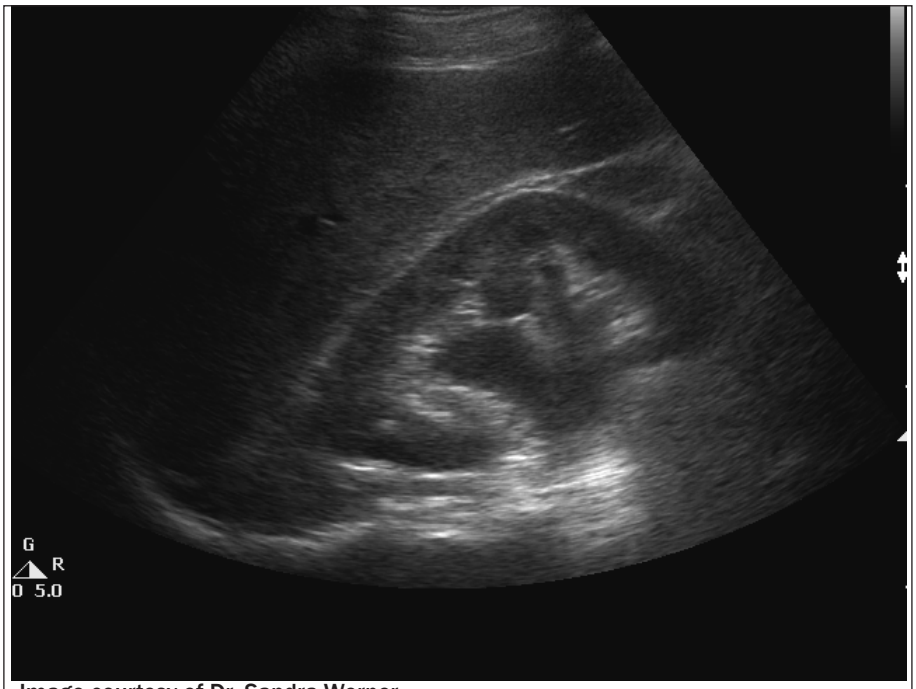

Image courtesy of Dr. Sandra Werner.

positive if it is growing a known uropathogen. Bacteria such as *Lactobacillus* spp., *Corynebacterium* spp., and coagulase-negative staphylococci are considered contaminants for most previously healthy children, as these are not uropathogens.

One group of patients that presents a diagnostic challenge to the emergency medicine physician is patients with neurogenic bladder, such as patients with spina bifida, who require routine frequent catheterizations. These patients suffer from frequent UTIs and are prone to significant renal scarring from recurrent infections. More than half of children with spina bifida will have their first UTI by age 15 months, and 44% will have greater than five episodes by 15 years of age.[47] Because of extensive catheterization, most of these patients have bacterial colonization in their urinary tract, and differentiating this colonization from infection can be difficult. While there is no consensus on the definition of a UTI in this group, a recent meta-analysis made the following recommendation. Their definition is two or more of the following symptoms: fever greater than 38°C, abdominal pain, new back pain, new or worse incontinence, pain with catheterization or urination, or malodorous/cloudy urine *and* greater than 100,000 CFU of a single organism *and* 10 WBC/HPF on urine microscopy.[48]

Imaging can be used at the time of acute infection to evaluate and localize the infection, particularly in the setting of failure of therapy. A simple UTI should begin to respond to appropriate antibiotics within 48 hours. If it does not, then other possibilities should be explored through imaging. In children with a UTI, obstructive lesions can be found in up to 10% of patients, which can lead to a complicated UTI.[49,50]

The recent AAP guidelines recommend that febrile infants should have a renal and bladder ultrasound (*see Figure 3*) at the time of first UTI. This can give an evaluation of the renal parenchyma as well as an assessment of the size of the renal collecting system.[51,52] (*See Figure 4.*) The ultrasound may additionally show signs of acute infection, including a thickening of the renal pelvis, hypoechogenicity, and ureteral dilation.[53] In severe illness or situations

Table 5. Some Common Empiric Parenteral Agents

Agent	Dosage
Ceftriaxone	75 mg/kg
Cefotaxime	150 mg/kg/day
Ceftazidime	100-150 mg/kg/day
Gentamicin	7.5 mg/kg/day
Tobramycin	5 mg/kg/day

in which the expected clinical response is not being achieved, the ultrasound should be done within the first 48 hours after initiation of treatment to identify serious complications such as pyelonephritis or renal or perirenal abscesses.[32] Conversely, in children who are well-appearing and have expected clinical improvement, the ultrasound can be delayed and done as an outpatient. The ultrasound should be done after the child has experienced complete recovery, as there may be misleading ultrasound findings during the acute infection. *E. coli* endotoxin can produce renal dilatation, which can be confused with hydronephrosis, and renal edema from acute infections may alter the echogenicity of the parenchyma.[54] Ultrasound findings during an acute infection may be misleading. A voiding cystourethrogram (VCUG) should not be done routinely, and should be reserved for cases in which the ultrasound shows hydronephrosis (*see Figure 5*), scarring, or findings suggestive of obstruction. This is a change from previous recommendations in which all young children with a first UTI had a VCUG done in order to screen for genitourinary abnormalities. In addition to being an invasive procedure that subjected children to radiation, the recommendation was changed based on increasing evidence that there are large numbers of infants without significant reflux being diagnosed with UTIs, as well as findings questioning the efficacy of antimicrobial prophylaxis in children with documented reflux.

Inflammatory Markers

In addition to the urinalysis and urine culture, serum inflammatory markers have been used as risk stratification tools for children with a possible SBI. Two of the most commonly used markers are C-reactive protein (CRP) and procalcitonin. In febrile young children, a CRP level of > 7 mg/dL has been associated with SBI with a sensitivity 79% and a specificity 91%. A patient with a CRP < 5 mg/dL had a very low likelihood for SBI with a likelihood ratio of 0.087 and post-test probability of SBI of 1.9%.[55] While CRP can be used to assist with the diagnosis of an SBI, procalcitonin appears to be better for differentiating between a simple UTI and pyelonephritis.[56,57] A recent prospective study addressed the use of procalcitonin in differentiating a lower and an upper UTI. The study showed that a procalcitonin value of > 1.0 ng/mL gave the greatest diagnostic efficacy with a sensitivity of 81.6% and a specificity of 91.7%. The procalcitonin level was also shown to correlate with children who went on to develop renal scarring. In the patients who ultimately developed renal scarring, initial procalcitonin levels were elevated, with a mean value of 2.3 ng/mL.[58,59] Finally, a prospective observational study evaluated febrile young children to determine the optimal use of procalcitonin to show renal scarring. They found a value of > 1 ng/mL was optimal, with a sensitivity 78.6% and specificity 63.8%.[60] While there are a large number of inflammatory markers available, most practitioners are using the CRP and procalcitonin for diagnostic purposes.

Treatment

The overall goal of treatment of the UTI is to eliminate the acute infection and reduce the chance of scarring and further complications from occurring. One of the initial decisions that must be made is whether to hospitalize patients with a UTI or manage them as outpatients. Most of the patients who are seen in pediatric emergency departments with a UTI can be treated as outpatients with oral antibiotics without increased incidence of renal parenchymal scarring.[61–64] A recent Cochrane review showed that there were no significant differences in persistent kidney disease at follow-up of 6 to 12 months or in the duration of the fever between treating children with a completely oral course of therapy as compared to three days of IV therapy followed by the remainder of the days as oral therapy.[65]

Because of the serious nature and fast-changing course of their illness, children younger than 90 days of age are generally hospitalized for IV antibiotics. Complication rates in this group are 7% and include bacteremia, meningitis, and urosepsis, although a well-appearing infant with a CRP of < 4 mg/dL is significantly less likely to develop complications.[66] Other indications for hospitalization include vomiting or refusal to drink, toxic appearance, congenital or anatomical urological abnormalities, or a previous culture with a pathogen that is not susceptible to oral agents. These children should be hospitalized until they begin to clinically improve and are able to maintain their hydration orally as well as take medication orally. This will generally take 24-72 hours.

Antibiotic choices should always be guided by the local patterns of susceptibility.[67] Antibiotic choice will also vary by age. In children younger than 1 month of age, antimicrobial coverage is driven by the need to empirically cover for *Listeria monocytogenes* and *Enterococcus.* The common antibiotic combination for this age group is ampicillin

Table 6. Some Common Empiric Oral Agents

Agent	Dosage
Amoxicillin-clavulanate	20-40 mg/kg/day
Trimethoprim-sulfamethoxazole	6-12 mg/kg/day
Sulfisoxazole	120-150 mg/kg/day
Cefixime	8 mg/kg/day
Cefpodoxime	10 mg/kg/day
Cefprozil	30 mg/kg/day

and gentamicin (or ampicillin and cefotaxime). Antibiotics should be adjusted for weight and gestational age.[9,68,69] In older children who are deemed too ill to be discharged home on oral medication, IV medication with an empiric broad-spectrum antimicrobial (aminoglycoside and ampicillin, third-generation cephalosporin, aminoglycoside and cephalosporin, or aminopenicillin/clavulanic acid) should be initiated.[70] If an aminoglycoside is chosen, once daily dosage has been shown to be as safe and effective as TID dosage.[65] Some common antibiotic choices can be seen in Table 5.[32] Treatment should continue for 24-72 hours or until the patient has defervesced and urine culture susceptibilities have returned. At this point, the patient can be transitioned to an oral antibiotic for the remainder of the therapy, a total of 7-14 days.[32]

Historically, an uncomplicated UTI in a school-age child was treated with amoxicillin or trimethoprim-sulfamethoxazole. Recently, resistance to both of these agents is growing in common uropathogens. Empiric choices today for oral therapy for a UTI include either amoxicillin/clavulanate or second- or third-generation cephalosporins. Some commonly used agents are found in Table 6.[22,32,41,71–73] Nitrofurantoin will easily gain adequate urinary concentration, however it will have a low serum concentration. Thus, it can be an appropriate choice for older children with a normal anatomy, but would not be appropriate in children in whom there was a concern of renal or systemic involvement.[14,22,74] Fluoroquinolones are generally avoided in children secondary to concerns for arthrotoxicity, but can be useful in situations in which the UTI is caused by a multi-drug-resistant organism with no safe and effective alternative or coverage is required against *Pseudomonas aeruginosa*, although this is a much less common organism.[75,76]

A recent Cochrane review illustrated that in children with lower UTI, there was not a significant difference in positive cultures after treatment when comparing a short (2-4 day) to a standard (7-14 day) therapy immediately after treatment (eight studies: RR 1.06; 95% CI 0.64 to 1.76) or 15 months after treatment (10 studies: RR 0.95; 95% CI 0.70 to 1.29). Additionally, there was no significant increase in the amount of multi-drug-resistant bacteria that developed with a longer course of antibiotics.[77]

Follow-up, either with a primary physician or in the hospital, if admitted, should be done within 48-72 hours to determine if there has been a clinical response. By that time, the child should have defervesced and should be clinically improving. If no improvements are noted, either complications have developed or the initial antibiotic choice was not appropriate. At this time, the culture susceptibilities should be available and should help to make antibiotic adjustments.

Conclusion

Urinary tract infections are a common diagnosis in the pediatric emergency room, and if missed, can lead to significant morbidity and mortality. UTIs are most common in younger children, with a predominance for females. Diagnosing a UTI in nonverbal children is difficult given the nonspecific nature of the complaints. While no sign or symptom is diagnostic for a UTI, the new AAP guidelines list factors that increase the likelihood that a child has a UTI. The new diagnostic criteria from the AAP include both a positive urinalysis as well as a positive urine culture result. Prompt diagnosis and treatment of a UTI is critical to prevent complications including renal scarring. Most children older than 90 days with no significant comorbidities and a mild clinical course may be treated as an outpatient, but infants younger than 90 days and any child with serious illness or complications should be admitted for further management.

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CME Questions

1. What is the least sensitive test in diagnosing a urinary tract infection?
   A. leukocyte esterase
   B. nitrites
   C. microscopic cell count
   D. Gram stain

2. You are treating a 2-year-old for a urinary tract infection. Because the child appears well and nontoxic, you decide to treat as an outpatient. What type(s) of imaging should you recommend child receive?
   A. renal and bladder ultrasound as soon as possible
   B. renal and bladder ultrasound and voiding cystourethrogram as soon as possible
   C. renal and bladder ultrasound after full resolution of illness
   D. CT scan after full recovery

3. A previously healthy 7-month-old male is being evaluated in the emergency department. He has been febrile (maximum temperature of 103.2°F) for two days, with poor feeding, decreased PO intake, and decreased activity. His vitals are a temperature of 102.5°F, heart rate of 130 beats/min, and blood pressure of 100.65. A urine specimen obtained through catheterization reveals a specific gravity of 1.017, pH 6.5, positive nitrites, positive leukocyte esterase, and 342 while blood cells/HPF. The most appropriate medical management is:
   A. hospital admission and treatment with intravenous ampicillin and a third-generation cephalosporin
   B. outpatient management with a cephalosporin and follow-up with primary care physician
   C. hospital admission and treatment with intravenous gentamicin
   D. outpatient management with amoxicillin-clavulanate and follow-up with primary care physician

4. How many days of antibiotics are necessary for treatment of an uncomplicated urinary tract infection in a school-age child with no significant co-morbidities?
   A. 3-5 days
   B. 7 days
   C. 10 days
   D. 14 days

Pediatric Emergency Medicine Reports

CME Objectives

Upon completion of this educational activity, participants should be able to:

- recognize specific conditions in pediatric patients presenting to the emergency department;
- describe the epidemiology, etiology, pathophysiology, historical and examination findings associated with conditions in pediatric patients presenting to the emergency department;
- formulate a differential diagnosis and perform necessary diagnostic tests;
- apply up-to-date therapeutic techniques to address conditions discussed in the publication;
- discuss any discharge or follow-up instructions with patients.

5. *Escherichia coli* virulence factors that lead to urinary tract infections include all of the following *except*:
   A. endotoxin
   B. K-capsular antigen
   C. staphylokinase
   D. hemolysin

6. What is the most common viral cause of cystitis in immunocompromised patients?
   A. coxsackie A
   B. rotavirus
   C. CMV
   D. adenovirus

7. What is the most significant risk factor for males younger than 3 years of age in developing a urinary tract infection?
   A. race
   B. circumcision status
   C. duration of fever
   D. height of fever

8. A 5-year-old female is presenting to the emergency department for evaluation of fever and back pain. She was diagnosed with a urinary tract infection one week ago based on a positive urine dipstick that was done at her pediatrician's office. Since that time, she has continued to have fever and nonspecific back pain, despite being on oral amoxicillin-clavulanate. The best choice for diagnostic imaging in this case is:
   A. abdominal CT scan
   B. abdominal X-ray
   C. renal ultrasound
   D. abdominal MRI

9. In which situation would treatment with nitrofurantoin be appropriate?
   A. 8-month-male presenting with fever, decreased PO intake, decreased urine output, and tiredness found to have nitrites, leukocyte esterase, and 50 WBC/HPF on urinalysis
   B. 6-week-old female presenting with 1 day of fever and found to have nitrites, leukocyte esterase, and many bacteria on urinalysis
   C. 10-year-old male with spina bifida presenting with 3 days of fever, poor PO intake, with a catheter specimen showing moderate bacteria, no WBC, and no nitrites
   D. 7-year-old female with dysuria for 3 days and urinalysis positive for leukocyte esterase and 140 WBC/HPF

10. What procalcitonin cutoff value will give the best efficacy in determining which children may develop complications from a urinary tract infection?
   A. < 0.1 ng/mL
   B. > 1 ng/mL
   C. < 0.3 ng/mL
   D. < 0.2 ng/mL

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Diagnosis and Treatment of Pediatric Urinary Tract Infections

Prevalence of UTI in Febrile Young Children

Age (mo)	Prevalence	Female (%)	Male (%)
0-1	6.9	5.1	8.5
> 1-3	5.5	5.9	5.3
> 3-6	3.6	5.1	2.5
> 6-9	2.1	3.7	0.8
> 9-12	1.4	2.3	0.7
> 12-18	0.8	1.4	0.4
> 18-24	0.8	1.4	0.3

Risk Factors for Developing a UTI

- Female gender
- Uncircumcised male
- Vesicoureteral reflux
- Toilet training
- Voiding dysfunction
- Obstructive uropathy
- Urethral instrumentation
- Pinworm infestation
- Constipation
- Anatomic abnormality (e.g., posterior urethral valves)
- Neuropathic balder
- Sexual activity
- Pregnancy

Adapted from: Elder J. *Nelson Textbook of Pediatrics*. 18th ed. (Kliegman R, Behrman R, Jenson H, Stanton B, eds.). Elsevier Inc; 2007:2223–2228.

Risk Factors for Developing a UTI

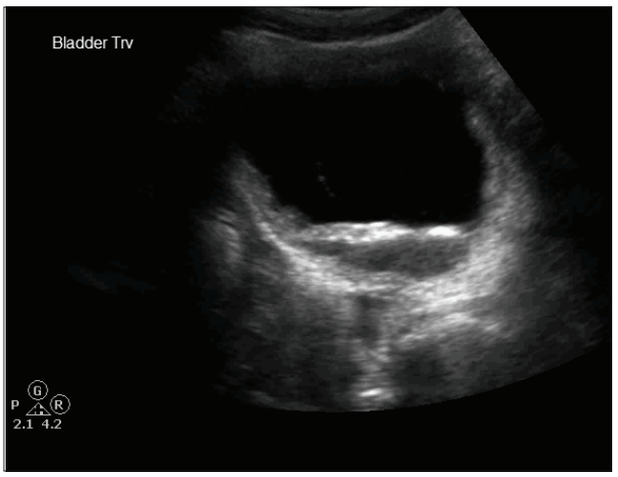
Risk Factors in Females

- White race
- Age < 12 months
- Temperature 39°C or greater
- Fever for 2 days or more
- Absence of another source of infection

Risk Factors in Males

- Nonblack race
- Temperature 39°C or greater
- Fever for 24 hours or more
- Absence of another source of infection

Transverse Image of Bladder, Debris Present



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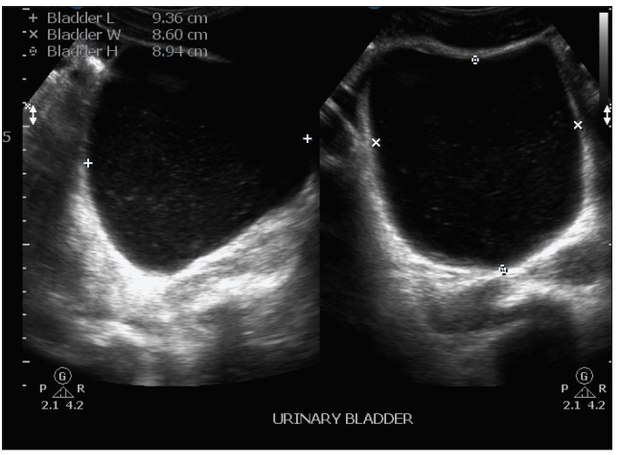
Ultrasound of Bladder



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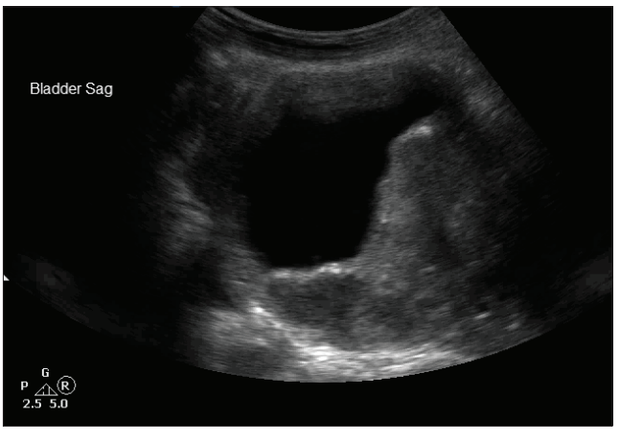
Bladder Ultrasound



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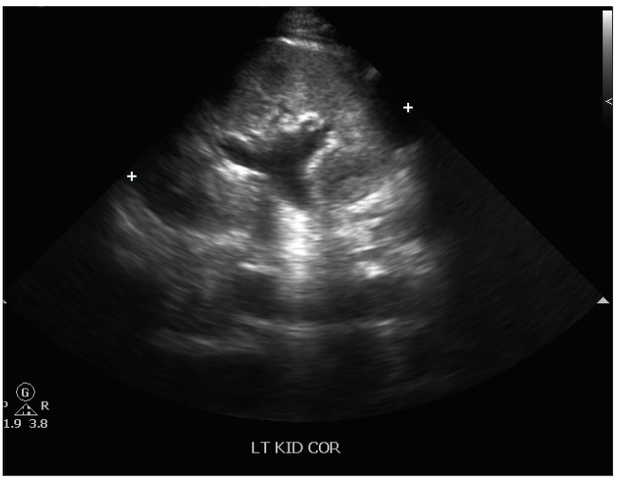
Ultrasound of Kidney Showing Hydronephrosis



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