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If one were to personify pediatric urinary tract infections, two words come to mind, "sneaky and sly." Doesn't it always seem to be the urinary tract infection (UTI) that catches us by surprise when evaluating febrile infants and children? At one time or another all of us have breathed a sigh of relief that we followed our clinical conscience while evaluating that febrile child with an equivocal presentation. Our diagnostic dilemmas are understandable when one considers that under the age of three years, symptoms of UTI include irritability (80%), poor feeding (65%), vomiting (40%), diarrhea (30%), and upper respiratory symptoms in up to 15% of children.[1] Furthermore, Hoberman found that symptoms were not very helpful at differentiating between children with fever who did and did not have a UTI.[1]

As if its commonly subtle clinical presentation is not vexing enough, the management and follow-up of pediatric UTI can be equally demanding. Additionally, there is always the threat of permanent damage to the child's renal parenchyma hanging over the head of the clinician. In this issue, the authors provide an in-depth and cutting-edge review of the evaluation and management of pediatric UTIs.

—The Editor

Pediatric Urinary Tract Infections

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Introduction

The diagnosis of a UTI should be considered in all febrile infants and children presenting to the ED. To date, however, there is no consensus on the optimal approach to evaluating a child for a UTI, the proper interpretation of laboratory data, and the most efficient and effective treatment and follow up. The significance of UTIs as an important cause of acute febrile illness has been recently reaffirmed.[1] In this study, febrile infants aged one year and younger underwent bladder catheterization and urine culture. Of all febrile infants evaluated, 5.3% were suffering from a UTI. Among white female infants in this study, 16.9% had a UTI. Of particular interest, approximately one out of three infected infants had an initial diagnosis other than a UTI. These results suggest that UTIs may be underdiagnosed in febrile infants and suggests difficulty in the clinical diagnosis of UTIs in young children. Thus, when the source of fever is equivocal, UTI should always be included in the differential diagnosis, particularly infants during the first two years of life. The information that follows can be used to formulate a rational basis for the selection of children for UTI evaluation and treatment.

Epidemiology and Infection Etiology

Age and gender are major determinants of prevalence rates of UTI in children. UTIs will occur in up to 1% of full-term infants and in as many as 3% of premature infants. During infancy, males and females have comparable risks for UTI. Thereafter, females comprise the major risk group. Symptomatic UTIs will develop in about 2% of children ranging in age from 1 to 5 years, and in 2.5% of school aged females.[2] Accurate diagnosis is complicated by the fact that 1.2-1.8% of school-aged girls may have asymptomatic bacteriuria.[3]

The importance of UTI as a cause of infectious illness in infants and young children goes beyond the risks of severe local or systemic bacterial infection. Many of these children also suffer permanent injury to renal parenchyma. Those at particularly high risk for kidney injury include children with systemic or immunologic disease and those with a variety of structural urinary tract abnormalities. *(See Table 1.)* For instance, kidney stones or urolithiasis is a relatively uncommon condition in the pediatric patient, but it does occur. In a study by Gearhart et al, 47% of 54 children (birth to 17 years) with urolithiasis had concomitant UTIs.[4] Several of these patients, however, had prior urinary tract surgery and had other risk factors for UTI. The most common infecting organisms were *E. coli, Pseudomonas aeruginosa, Proteus mirabilis, Klebsiella,* and *Proteus vulgaris*.

Additional risk factors include, urethral foreign bodies, phimosis, sexual activity, neurogenic bladders, voiding dysfunction, a family history of UTI, and constipation. Blethyn et al showed an association between fecal loading (on x-ray) and a significant increase in UTI, mainly in females.[5] Vesicoureteral reflux (VUR) may be found in 30-50% of children with UTIs, but is rarely found in normal children.[6] Additionally, a number of studies have demonstrated the significantly increased risk of UTI among uncircumcised male children when compared to those who were circumcised.[7,8] Despite this observation, there remains a degree of controversy over whether the increased

Table 1. Children at Risk for UTI

- Premature infants
- Children with immunologic or systemic disease
- Children with anatomic urinary tract abnormalities
  - Ureterpelvic junction obstruction
  - Congenital megaureter
  - Ectopic ureters
  - Ureterocele
  - Ureteral polyps
  - Extrinsic ureteral compression
    - Neoplasms
    - Inflammatory diseases (Crohn's disease)
    - Hematomas
  - Bladder outlet and ureteral obstructions
    - Posterior urethral valves
    - Bladder diverticula
    - Urethral strictures
    - Urethral atresia
    - Meatal stenosis
    - Renal calculi
    - Urethral foreign bodies
    - Phimosis
- Sexual activity
- Neurogenic bladder
- Voiding dysfunction
- Constipation
- Family history of UTI
- Lack of circumcision
- Voluntary retention

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risk of UTIs in uncircumcised males is sufficient alone to justify circumcision.

Host susceptibility and virulence factors of the invading pathogen are important variables in the pathogenesis of UTIs. Recently improved understanding of factors enhancing bacterial virulence in UTI show promise for the prevention of UTI in the future. However, at the present time, host immunity and structural/functional aspects of the urinary tract remain the factors of greatest importance.

During the neonatal period, UTIs are presumed to originate via hematogenous spread. In most cases beyond the neonatal period, bacteria are presumed to ascend the urinary tract following perineal colonization. In the female, the short urethra and its proximity to the anal opening explains at least in part the predominance of UTIs in females. Commonly occurring functional and behavioral factors also increase the risk of UTI in females. These include wiping forward after bowel movements, voluntary deferral of micturition, incomplete bladder emptying, and the failure of voiding promptly after coitus. The presence of foreign bodies in the introitus, frequent masturbation, and pinworm infection are also factors that promote UTIs.[13]

Gram-negative enteric bacteria are the most common organisms that cause UTIs.[3,14] *(See Table 2.) E. coli* accounts for the vast majority (80%) of cases of UTI, particularly first infections. Other organisms that must be considered include *Proteus mirabilis*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Enterobacteraciae*, *Streptococcus viridans*, and *Candida albicans*. Coagulase-negative staphylococcus UTI occurs in teens and young adults. Acute cystitis may also be caused by adenovirus, occurring more commonly in young male children. These patients often have fever, intense dysuria, and gross hematuria.

Isolated urethritis can also cause symptoms of a UTI such as dysuria. In clinical urethritis, colony counts in urine culture may be as low as 10^2 CFU/mL of a single organism, which is considerably lower than the conventional threshold of 5×10^4 to 1×10^5 CFU/mL for cystitis. Other etiologies of urethritis that must be considered, particularly in adolescents, are *Chlamydia trachomatous*, *Neisseria gonorrhoeae*, *Ureaplasm urealyticum*, and Herpes simplex viruses.

Types of Urinary Tract Infections

It is useful to consider UTI in two categories: uncomplicated lower tract infections and upper tract infections. From a practical standpoint, upper tract infections are distinguished as those in which kidney parenchymal injury can be demonstrated. Lower UTIs include cystitis and urethritis. While symptoms of lower UTI among older children are more specific, clinical findings in younger children are often vague. After infancy, cystitis occurs 3-5 times more frequently in females than in males and is the most common primary infection in healthy individuals. Among females, the incidence of first time cystitis gradually diminishes during the first decade of life and then increases during the second decade, correlating with the onset of sexual activity. Recurrent lower tract infections occur in nearly 30% of affected females but are rare in males.

Upper UTIs involve infection of the renal parenchyma (pyelonephritis). Pyelonephritis in children is often associated with VUR voiding dysfunction, or other of the risk factors listed above. In most cases the renal parenchyma is infected by bacterial pathogens ascending the urinary tract rather than dissemination via the hematogenous route. Several anatomic factors associated with the growing kidneys places the younger child at particularly high risk for penetration of bacterial pathogens into renal parenchyma, thereby increasing the risk of renal injury. As with lower UTI, pediatric patients experiencing an episode of pyelonephritis are at increased risk for subsequent episodes, particularly during the ensuing two years.

Asymptomatic bacteriuria may confound an evaluation for possible UTI. Although asymptomatic bacteriuria during infancy and in males beyond infancy is associated with a high incidence of urinary tract abnormalities and necessitates prompt diagnosis and treatment,[9] asymptomatic bacteriuria occurs in nearly all age groups and is found predominately in females. The prevalence of asymptomatic bacteriuria in children differs with age. In premature infants, the prevalence is approximately 3%, while in full-term infants it is less than 1%. In preschool females, the incidence is 0.08%, while nearly negligible in males. School-age females have a prevalence of 2%, and approximately 5% of females will have asymptomatic bacteriuria prior to finishing high school. While these patients generally have no abnormalities on urinalysis, many have associated voiding behavioral disturbances. There is often no history of preceding UTI, and usually there is no evidence of anatomic abnormalities or renal parenchymal scarring by radiographic studies. This condition will resolve in approximately half of all patients without treatment. Nevertheless, identification of prepubertal children with asymptomatic bacteriuria is of importance since some may have VUR and an increased risk of recurrent symptomatic infections.[10,11] Although controversial, the routine treatment of asymptomatic bacteriuria in non-pregnant females appears to be of little benefit. Most prospective studies of girls older than 5 with asymptomatic bacteriuria have failed to demonstrate decreased glomerular filtration rates, impaired renal growth, or progressive parenchymal damage in kidneys that are normal at the time of initial evaluation.[12]

Clinical Aspects of UTI

The diagnosis of a UTI often presents a challenge to ED physicians, especially in infants and children. Accompanying this challenge is the urgency that a delay in diagnosis and treatment increases the risk of parenchymal damage.[16,17] Few symptoms, other than fever, are consistently found in infants and young children who are ultimately diagnosed with UTI.[15] Instead, they present with nonspecific signs and symptoms that often refer to other organ systems. Neonates with UTIs commonly present with jaundice, poor feeding, irritability, and lethargy. Infants and young children may demonstrate gastrointestinal signs and symptoms such as abdominal pain, vomiting, change in appetite, and behavioral changes such as unexplained bouts of crying or new onset bed wetting. The diagnosis, on the other hand, is frequently more obvious in older children and adolescents with uncomplicated UTIs who present with the classic signs of dysuria, urinary frequency, urgency, and/or hesitancy. Nevertheless, because of clear vulnerability, particular attention should be given to neonates with a history of prematurity, infants and children with functional or anatom-

Table 2. Organisms Responsible for Pediatric UTI

E. coli
Proteus mirabilis
Klebsiella pneumoniae
Pseudomonas aeruginosa
Enterobacter species
Streptococcus viridans
Coagulase-negative staphylococci
Candida albicans
Chlamydia trachomatous
Neisseria gonorrhoeae

Table 3. Interpretation of Positive Urine Culture

Method of Collection	Quantitative Culture: UTI Present
Suprapubic aspiration	Growth of urinary pathogens in any number (exception of up to 2-3 $\times 10^3$ coagulase-negative staphylococci)
Catheterization	Febrile infants or children with $\geq 5 \times 10^4$ CFU/mL of single pathogen*
Midstream clean-void	Symptomatic patients with $\geq 10^5$ CFU/mL of a single urinary pathogen
Midstream clean-void	Asymptomatic patients with two specimens on different days with $\geq 10^5$ CFU/mL of the same organism

* Infection may be present with counts as low as 10-50 $\times 10^3$ CFU/mL

Adapted from: Hellerstein S. Urinary tract: Infections old and new concepts. *Ped Clin North Am* 1995;42:1433-1459.

ic urinary tract abnormalities, those with previous UTIs, and children with a history of immunologic deficiencies.

Even more challenging is differentiation between lower (uncomplicated) and upper tract (complicated) infections, especially in the younger age groups. The distinction is specifically relevant when considering treatment options, long-term sequelae, and recommendations for follow up. Both lower and upper tract infections are more easily understood as clinical syndromes which, in general, encompass a constellation of signs and symptoms.

Unfortunately, the symptoms of infection anywhere along the urinary tract may be nonspecific or overlapping. Thus, symptoms of cystitis (dysuria, frequency, hesitancy, and urgency) also occur in other lower tract syndromes. For example, urethritis and vulvovaginitis are relatively common conditions in younger children. A history of trauma, masturbation, poor hygiene, foreign bodies, bubble bath, or other perineal irritants is helpful in differentiating the diagnosis. A careful history should include queries about behavioral and voiding disturbances including infrequent voiding, daytime enuresis, squirming, and urinary frequency. Close physical examination of the perineum and external genitalia may reveal irritation or vaginal discharge. Urethral discharges are rare in children. When they are observed, sexual abuse should be considered, and various sexually transmitted diseases should be considered as the possible idealogy. In these cases, cultures for gonorrhea, chlamydia, and other sexually transmitted organisms should be obtained. Urethral discharge in the adolescent should also prompt the consideration of a sexually transmitted disease. Bladder irritation due to cystitis will usually produce more intense symptoms of urethral irritation as well as symptoms of bladder spasm such as urgency and frequency. Other signs and symptoms of cystitis may include abdominal pain, low back pain, and fever. Parenthetically, viral hemorrhagic cystitis may present with symptoms indistinguishable from bacterial lower UTI. Upper urinary tract syndromes (complicated UTI, pyelonephritis) imply some degree of renal parenchymal involvement and may or may not demonstrate symptoms of cystitis. The clinical syndrome of upper tract disease often includes more systemic symptoms that may or may not be proceeded by lower tract symptoms. Upper tract infections may consist of fever, chills, nausea, vomiting, and a toxic appearance. The inherent difficulty in distinguishing between upper and lower UTIs is the subjectivity of interpreting clinical indicators of severity. Consequently, it is important to pay close attention to history and clinical symptoms, as well as maintaining a high index of suspicion.

Laboratory Evaluation

The most important reason, obviously, for accurate and timely identification of a UTI in the ED is to allow for immediate implementation of appropriate treatment. Concurrently, accurate diagnosis is necessary for other reasons. For patients without primary care physicians, appropriate counseling and referral can be initiated. Additionally, proper confirmation supports the subsequent work-up by primary care providers and specialists looking for underlying structural and functional abnormalities that may lead to renal scarring, hypertension, and possible end-stage renal disease.[18,19]

While urine culture is the gold standard in the diagnosis of UTIs, culture results are rarely, if ever, available to the physicians in the ED. Therefore, the emergency physician must rely on clinical data and other laboratory tests while obtaining a urine culture to subsequently confirm the diagnosis. On occasion for the very young infant, a leukocyte response is limited, and the microscopic examination of the urine is not diagnostic. In this setting, only the urine culture establishes the diagnosis.

A specimen for urinalysis and culture should be obtained through direct bladder sampling (catheterization, suprapubic

sampling) or through a cleanly voided specimen in males and older female patients. Bagged urine specimens are not acceptable. Besides being difficult to obtain because of the time waiting for the child to void, bag specimens have an unacceptably high rate of contamination. If treatment with antibiotics is to commence prior to the availability of culture results, diagnostic uncertainty exists when contaminated specimens produce growth of multiple organisms on culture.[14] In general, children who do not yet have voiding control (< 2 years) should undergo sterile in-and-out catheterization or, when necessary, suprapubic aspiration. Urine specimens from older children with voiding control should be obtained from a cleanly voided mid-stream clean catch. Parents should be instructed on proper technique to avoid contaminated specimens. Periurethral contamination of specimens can be avoided by having the female child sit backwards (facing the rear) on the toilet. This position favors labial retraction and better exposure of the urethral meatus.

Unfortunately, bacterial contaminates grow rapidly at room temperature. When urine samples cannot be cultured immediately, spurious culture results are diminished considerably by maintaining the specimen on ice or at 4°C.

The urinalysis (UA) is by far the most frequently used adjunctive diagnostic test for possible UTI. While the UA frequently identifies urinary abnormalities, an understanding of the proper interpretation of these abnormalities is essential to avoid under- or over-diagnosis of UTI. Urine chemical test strips are a quick means of initial urine screening for the detection of leukocyte esterase and urinary nitrites. Esterases are released into the urine after the breakdown of white blood cells. Nitrates are converted to nitrites by gram-negative urinary pathogens. Both tests provide indirect evidence of pyuria and bacteriuria, respectively. Hematuria, proteinuria, and pyuria are commonly associated with UTI but are nonspecific and occur in the absence of infection. The presence of bacteria in catheterized urinary sediment has also been used as laboratory support for the presence of a UTI. In reality, all of these UA findings have limitations in the diagnosis of a UTI. In most studies, the sensitivities of a positive test for urinary leukocyte esterase or nitrate for a positive urine culture are less than 50%. The combined presence of pyuria (> 5 WBC/HPF) and bacteriuria on urine microanalysis improves the sensitivity to approximately 65%, and other approaches to urinary microscopic interpretation have been reported to yield better results. Nonetheless, the relatively poor sensitivity and positive-predictive value of the UA make it difficult to use alone as a presumptive test for UTI. By contrast, however, the specificity and negative-predictive values of the UA for both the dipstick indices and microscopic findings are consistently in the greater than 95% range. Hoberman et al has described the use of an "enhanced" urinalysis that uses a hemocytometer in the evaluation of uncentrifuged urine.[20] This method reduces the variability of results caused by centrifugation and resuspension, it enables evaluation of a fixed volume of urine, and it facilitates accurate counting by providing a marked visual field with uniform illumination. The centrifuged specimen is also Gram-stained under conditions that standardize the number of drops in urine. A positive-enhanced urinalysis is defined as 10 or more white blood cells per cubic millimeter and bacteriuria is defined as the presence of any bacteria per 10 oil immersion fields on the Gram-stained smear. The sensitivity of the enhanced urinalysis to predict a positive urine culture was 84.5%, compared to 65.6% with the standard urinalysis. The positive-predicted value of enhanced urinalysis was 93.1%, compared with only 80.8% in the standard urinalysis. Although one can reasonably conclude that febrile infants older than 3-6 months of age and older children without symptoms referable to the urinary system with a normal urinalysis are likely to have UTIs, routinely obtaining a urine culture can arguably be cost-effective in nearly all cases. Hoberman describes three scenarios in which urine cultures should be obtained regardless of the results of urinalysis.[20] The scenarios are: children with previous UTIs, children with abnormal urinary tracts, and those who will be treated empirically with antibiotics. The reality of pediatric emergency practice, however, with its inherit difficulties in patient compliance and patient follow up, seems to dictate a more universal approach to culturing the urine in the workup of the febrile child.

A positive urine culture obtained by mid-stream clean catch is defined by greater than 1×10^5 CFU/mL of a single organism. *(See Table 3.)* Catheterized specimens yielding greater than 5×10^4 CFU/mL should also be considered significant. Additionally, growth of a single gram-negative organism in any amount from a suprapubic aspiration should also be considered diagnostic of UTI. While these values are useful, it should be remembered that the urine bacterial concentration may be altered by urine volume, the duration of

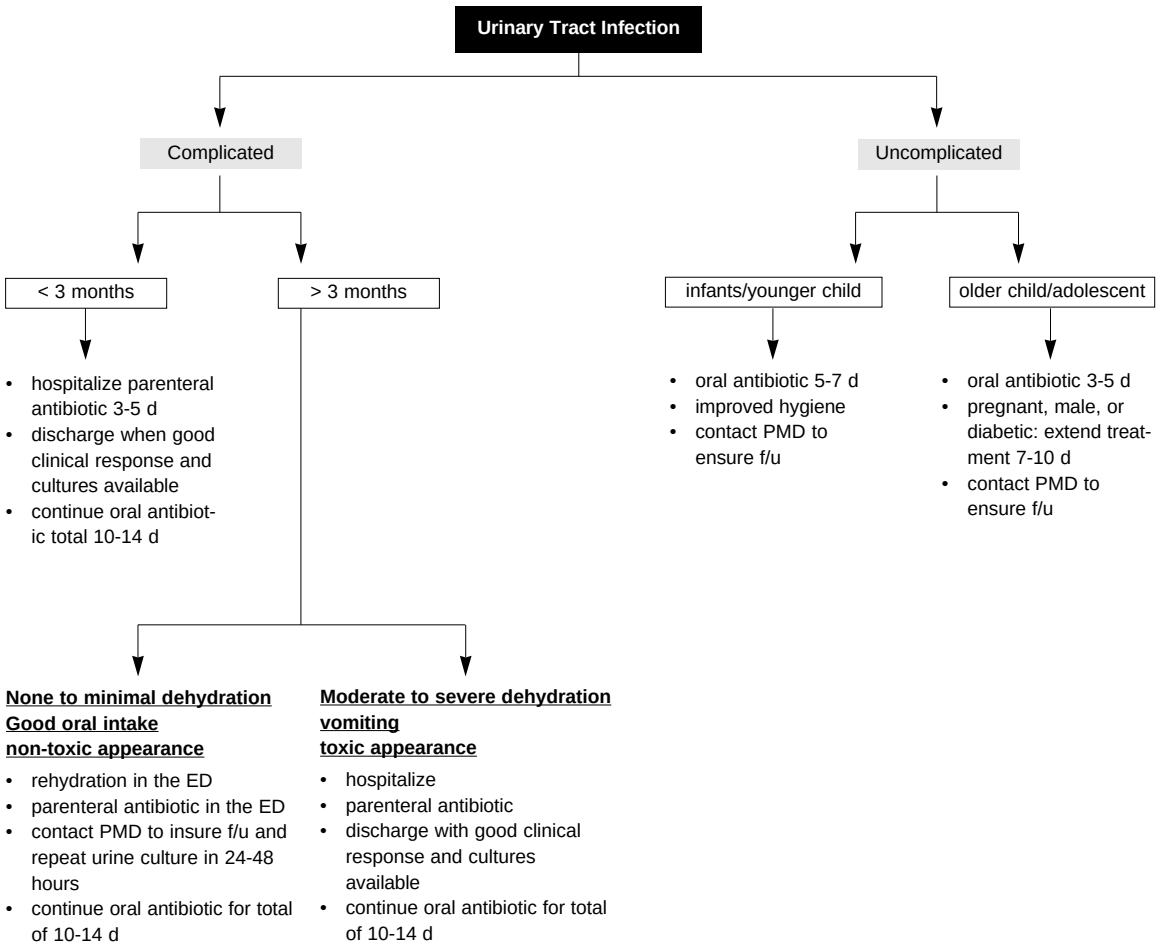
Table 4. Common Antimicrobial Drugs Used in Pediatric Urinary Tract Infections

Drug	Dosage and Interval
Parenteral Therapy	
Ampicillin	100 mg/kg/d 12 h (< 1 week) q 6-8 h (> 1 week)
Ceftriaxone*	75 mg/kg/d q 12-24 h
Cefotaxime	150 mg/kg/d q 6-8 h
Gentamicin	5 mg/kg/d q 12 h (< 1 week) 7.5 mg/kg/d q 8 h (> 1 week)
Oral Therapy	
Amoxicillin†	20-40 mg/kg/d q 8 h
Augmentin	50 mg/kg/d q 8 h
Trimethoprim/ Sulfamethoxazole	6-12 mg/kg/d TMP, 30-60 mg/kg/d SMX q 12 h
Cephalexin	25-50 mg/kg/d q 6 h
Cefixime	8 mg/kg/d q 12 h

* Should not be used in neonates because of potential biliary sludge pseudolithiasis. If cocci are present in urinary sediment, ampicillin should be added until culture and sensitivities are available.

† *E. coli* resistance should be considered

Figure 1. Treatment Algorithm for Pediatric Urinary Tract Infections



urine storage in the bladder, and the site of infection. Peripheral white blood cell counts and erythrocyte sedimentation rates are nonspecific tests that should only be interpreted in conjunction with the urinalysis and urine culture.

Treatment Options

As mentioned, early treatment of UTIs especially in infants and young children decrease the risk of kidney damage. Inpatient management should be instituted for any child less than 3 months of age with a febrile UTI, for those children who have significant dehydration or appear toxic, or when outpatient compliance and follow-up is questionable. In general, children older than 3 months with febrile UTIs who appear only mildly dehydrated and do not have persistent vomiting may be rehydrated in the ED and have antibiotic therapy begun through the parenteral route. *(See Figure 1.)* Prior to discharge, however, patients should demonstrate adequate oral intake with arrangement for appropriate follow-up. Contact with a primary care physician should be obtained and documented to assure follow-up of urine culture and sensitivities and further treatment and evaluation. Long acting, broad spectrum antibiotic coverage with a third-generation cephalosporin, such as ceftriaxone 50-75 mg/kg IV or IM, is an appropriate choice for most patients clinically considered to have upper tract infection who can be managed as outpatients. However, recent preliminary data suggest satisfactory outcomes in non-toxic infants older than 2 months of age treated with oral cefixime alone.[21] Ampicillin 100 mg/kg should be added if gram-positive cocci are noted in urinary sediment or gram stain. Nitrofurantoin therapy is inadequate if parenchymal infection is considered. Children allergic to cephalosporins should receive a single dose of gentamicin 2.5 mg/kg IV or IM prior to discharge while ensuring that oral therapy is initiated with an appropriate antibiotic such as TMP/SMX or a third-generation cephalosporin. *(See Table 4.)* For patients requiring inpatient management, parenteral antibiotic therapy should be initiated in the ED. Older children should receive broad-spectrum antibiotic coverage with a third-generation cephalosporin, while neonates should receive gentamicin and ampicillin to cover the usual neonatal pathogens and other *Enterobacteraciae*. Ceftriaxone should be avoided in this age group due to the displacement of bilirubin from albumin and biliary pseudolithiasis.[22] The total duration of therapy for upper UTI for optimal clinical response is generally 14 days.

Considerable amount of controversy remains concerning the duration of outpatient oral therapy. Generally, in the older child, a three- to five-day course of trimethoprim, trimethoprim-sulfamethoxazole, or a third-generation cephalosporin is effective treatment for uncomplicated lower UTIs. Short-course or single-day therapy has been advocated in adult patients; however, the infection recurrence rate in pediatric patients precludes its use.[23]

Follow Up Considerations

Numerous clinical investigators and clinicians have discussed and debated in recent years the most appropriate radiologic studies for follow-up of children with UTI and various algorithms have been proposed.[24-26] Although imaging studies for UTI are rarely indicated as part of the diagnostic work-up of UTI in the ED (except in the case of a palpable mass), it is important to arrange follow-up for all children with UTI. In general, radiographic evaluation for functional and/or structural causes of UTI begin with voiding cystourethrogram (VCUG) to demonstrate reflux and a renal ultrasound to show anatomic abnormalities. Renal cortical scans with dimercaptosuccinic acid (DMSA) have been used with increasing frequency over recent years.[27] DMSA scans are very useful in detecting evidence of pyelonephritis and focal renal scarring. A primary care provider should be notified to ensure that those patients at highest risk for developing renal parenchymal scarring and its related sequelae are identified early and managed appropriately.

Morbidity and Mortality Associated with UTI

Sepsis is common in infants and the elderly with UTI, especially with urinary tract obstruction; as with the elderly, urosepsis can be fatal. In general, the long-term prognosis for children who experience a UTI is excellent provided there is prompt and adequate treatment instituted at the time of diagnosis. Prompt treatment has been shown to minimize the risk of renal scarring. Renal scarring is also the consequence of recurrent UTI and some at-risk children may require antibiotic prophylaxis for extended periods of time.

The main clinical consequences of recurring renal damage caused by pyelonephritis are arterial hypertension and renal insufficiency. Reflux nephropathy, renal injury attributed to the combination of VUR, and recurring infection, is responsible for up to 15% of the cases of end stage renal failure in children in the United States. Because of these potentially serious consequences, it is imperative for the emergency physician to consider the UTI as a cause of fever in the young child, to perform the appropriate diagnostic studies, and to render adequate therapy.

Summary

The diagnosis of a urinary tract infection should be considered in all febrile children, especially when the diagnosis is unclear. The spectrum of infection signs and symptoms is broad because potential sites of infection span the entire urinary tract. Additionally, the differentiation between upper versus lower urinary tract locations is a recognized challenge; and treatment decisions are dependent on the child's condition and presenting signs and symptoms. The decision to admit or to treat as an outpatient requires careful consideration of the child's overall appearance, oral intake and adequacy of hydration. Urinalysis and culture results must be evaluated carefully as potential errors in collection and sample management can result in spurious results. Finally, because of the potential sequelae of pediatric urinary tract infections appropriate and timely patient follow-up by a primary care provider is a necessity.

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Physician CME Questions

1. Significant risk factors for development of UTI include all of the following *except*:
   A. family history of UTI.
   B. premature birth.
   C. bladder outlet obstruction.
   D. circumcision.
   E. constipation.

2. UTI occurs in 1% of full-term infants. In premature infants, UTI occurs in:
   A. 0.5%.
   B. 1.0%.
   C. 3.0%.
   D. 5.0%.
   E. 10.0%.

3. An indication for admission in pediatric patients with UTI includes:
   A. fever.
   B. elevated white count.
   C. age younger than three months.
   D. first time UTI.
   E. family history of UTI.

4. Symptoms of upper UTI include:
   A. dysuria.
   B. fever.
   C. vomiting.
   D. fever and vomiting.
   E. All of above.

5. All of the following are approved treatment options for UTI in young children *except*:
   A. cefixime.
   B. ciprofloxacin.
   C. TMP/SMX.
   D. amoxicillin.
   E. ceftriaxone.

6. Vesicoureteral reflux occurs in approximately what percentage of children with UTI?
   A. 10%
   B. 20%
   C. 40%
   D. 75%
   E. 90%

7. According to the article, which of the following may present with symptoms identical to lower bacterial UTI?
   A. Chlamydia
   B. Urethritis
   C. Viral hemorrhagic cystitis
   D. None of the above.

8. On standard UA, which of the following findings is most specific and sensitive for establishing a diagnosis of UTI?
   A. Presence of hematuria on chemical strip test
   B. Presence of pyuria on chemical strip test
   C. Combined presence of pyuria and bacteriuria on urine microanalysis
   D. None of the above

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