Urinary Tract Infections in Children

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Educational Gaps

Consideration of risk factors for urinary tract infections (UTIs) in young children with fever is critical for accurate diagnosis, as well as prevention of overtesting. The use of perineal bags to collect urine from young children should be limited to specific indications in the diagnosis of UTIs. Screening for and managing bowel and bladder dysfunction reduces the risk of UTIs in older children.

Objectives

After completing this article, readers should be able to:

1. Recognize the risk factors for urinary tract infections (UTIs) in children.
2. Review the interpretation of urinalysis and urine cultures.
3. Review antibiotic therapy choices for UTIs.
4. Describe which children need imaging after febrile UTIs.
5. Discuss prevention strategies to discuss with families.

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ABBREVIATIONS

AAP	American Academy of Pediatrics
CFU	colony-forming unit
DMSA	dimercaptosuccinic acid
IV	intravenous
UTI	urinary tract infection
VCUG	voiding cystourethrogram
WBC	white blood cell

CASE STUDY

Charlotte is a 13-month-old girl with a history of 2 febrile urinary tract infections (UTIs) 4 and 6 months ago. She had normal renal and bladder ultrasonographic findings 6 months ago. She presents with a fever that began yesterday. She has no other new symptoms. Her 4-year-old brother had a self-limited febrile illness 1 week ago, which resolved. At examination, she is fussy but consolable and alert. She is non–toxic appearing. Her physical examination findings show tachycardia with a heart rate of 130 beats/min, without murmur. Her respiratory rate is 28 breaths/min, without distress or retractions. Her lungs are clear bilaterally. Her tympanic membranes appear normal. Her abdomen is soft and nontender. Her genital examination findings appear normal, without erythema or labial adhesions. Her temperature is 102.5°F (39.2°C). A bag is placed to collect a urine sample. The urinalysis from the bag sample has 5 to 10 white blood cells (WBCs) per high-power field, a 1+ leukocyte esterase result, and a 1+ ketone result. Should a bag have been placed to collect urine? Does Charlotte have a UTI? How should she be treated at this point?

EPIDEMIOLOGY

UTIs are one of the most common bacterial infections in childhood, accounting for 5% to 14% of pediatric emergency department visits. (1) The prevalence of

UTIs and their effect on the health of children are substantial throughout childhood, from the neonatal period to late adolescence (2). Infants and toddlers cannot localize UTI symptoms, cannot submit spontaneous urine samples, and have other distinct characteristics when compared to children over 24 months of age; therefore, we will simplify this review of UTIs into 2 age groups: children less than 24 months of age (whom we will define as *infants and toddlers* in this review) and children 2 years of age and older.

Infants and Toddlers under 24 Months of Age

Roughly 7% of infants and toddlers who present with fever have a UTI. (1) Race, age, sex, circumcision status in male infants and toddlers, and other factors alter the prevalence. Knowledge of how these risk factors affect the likelihood of a UTI in a particular child is critical when assessing whether the child should ultimately undergo urine testing. When considering race, 10% of white febrile infants and toddlers without focal findings to suggest another source of infection will have a UTI, while 2% of black febrile infants and toddlers will have a UTI. (3) When considering sex and age, female febrile infants 12 months of age or less have a 6% to 8% prevalence of UTI, while febrile girls older than 12 months have a prevalence of 2%. The prevalence of UTI in febrile male infants is markedly affected by the circumcision status of the infant. Uncircumcised febrile male infants less than 3 months of age have a 20% risk of UTI, compared with a 2.4% risk in similar but circumcised male infants. In both circumcised and uncircumcised male patients, the prevalence of UTIs decreases with age. For example, circumcised febrile boys older than 12 months have a less than 1% risk of UTI. Additional factors, such as duration of fever, previous history of UTIs, and congenital anomalies of the urinary tract, alter the likelihood of UTI.

Children 2 Years of Age and Older

Children 2 years of age and older who present with urinary symptoms (dysuria, urinary hesitancy) have an overall 8% risk of UTI. (1) However, as in infants, important factors should be considered that modify risk. After 2 years of age, children are more able to report and localize specific symptoms, such as dysuria. The prevalence of UTI in boys 2 years of age and older is low, especially in circumcised boys. Important factors that affect prevalence in this age group include bladder- or bowel-withholding behaviors, congenital anomalies of the urinary tract, and previous history of UTI.

PATHOGENESIS

UTIs are usually caused when bacteria invade and ascend up the urinary tract from the urethra and into the bladder. Cystitis, a lower UTI, occurs when the infection and inflammatory response are localized to the bladder. Pyelonephritis is an upper UTI in which the bacteria and subsequent inflammatory response further ascend to the ureters and kidneys. Colonic bacteria are typically the culprits. *Escherichia coli* is the most common bacteria that causes UTIs in all ages, accounting for 54% to 67% of UTIs in children. *Klebsiella* (6%–7%), *Proteus* (5%–12%), *Enterococcus* (3%–9%), and *Pseudomonas* (2%–6%) are other common causative organisms. (4)

Hematogenous spread to the urinary system is a rare cause of UTI that can occur in neonates and children with immunodeficiency. Group B *Streptococcus, Staphylococcus aureus*, *Candida*, and *Salmonella* can cause pyelonephritis through the hematogenous route.

Mouse models have demonstrated that *E coli* attach to the superficial cells of the bladder lining, then invade the cells and multiply. These cells are shed in defense, which exposes lower layers of cells for bacterial invasion. These lower-layer cells that have bacteria could be the source of recurrent UTIs. Toll-like receptors are an important component of the host defense of UTIs. These toll-like receptors are on the surface of the bladder and activate the host inflammatory response by attracting WBCs to the surface of the bladder. (5)

CLINICAL PRESENTATION AND ESTIMATING RISK OF UTI

The clinical presentation of UTI varies with age. Infants generally present late in the course of infection because of initial nonspecific signs, such as fever, and the inability to express symptoms or localize pain. Older children can usually localize early symptoms of UTI, such as dysuria or abdominal pain, and therefore present earlier in the clinical course.

Infants and Toddlers under 24 Months of Age

Infants and toddlers under 24 months of age who have a UTI most often present with fever. Fever is a common and nonspecific symptom for which clinicians should consider UTI as an etiologic origin, especially when there are no other obvious signs or symptoms to suggest another diagnosis. Obvious signs such as a new rash may suggest a viral syndrome. Recent new respiratory symptoms, such as cough and congestion, suggest a respiratory infection. In the absence of other obvious symptoms, clinicians should be vigilant when assessing risk factors because about 7% of febrile infants and toddlers without an obvious source have a UTI. Clinicians should use the American Academy of

Pediatrics (AAP) Clinical Practice Guideline for the Diagnosis and Management of the Initial UTI in Febrile Infants and Children 2 to 24 months of age when assessing risk of UTI in this age group. (6) The risk factors in Table 1 from the 2011 AAP Clinical Practice Guideline allow the clinician to evaluate the likelihood that a febrile infant has a UTI.

The guidelines use both a probability of UTI of up to 1% and up to 2% to allow clinicians to use their judgment in what is considered low risk and therefore to determine which children need to be further tested for UTIs. The probability of a UTI increases as the number of risk factors increases. The guidelines allow clinicians to calculate a pretest probability of UTI to make an informed decision

TABLE 1. Probability of Urinary Tract Infection Among Febrile Infant Girls and Boys According to Number of Findings Present

PARAMETER	VALUE
Girls	
Individual risk factors	White race Age <12 mo Temperature ≥102.2°F (39°C) Fever ≥2 d Absence of another source of infection
Probability of urinary tract infection	
≤1%	No. of risk factors present: No more than 1
≤2%	No. of risk factors present: No more than 2
Boys	
Individual risk factors	Nonblack race Temperature ≥102.2°F (39°C) Fever ≥24 h Absence of another source of infection
Probability of urinary tract infection	
≤1%	No. of risk factors present: For circumcised boys, no more than 2.*
≤2%	No. of risk factors present: For circumcised boys, no more than 3. For uncircumcised boys: No additional risk factors.

**For uncircumcised febrile boys, probability of UTI exceeds 1% even with no risk factors other than being uncircumcised*

about which children require further evaluation for UTI. Clinicians should also take into account other factors, such as ability to follow up and previous history of UTI, and include the family in the decision-making. If the decision is made to forego testing for UTI, follow-up is crucial, as risk factors such as severity and duration of fever may change.

Risk factors for UTIs in female infants of this age group include white race, age less than 12 months, temperature greater than or equal to 102.2°F (39°C), and absence of another source of infection. The probability of UTI for male patients is most influenced by circumcision status. In febrile, uncircumcised male infants and toddlers under 24 months of age, the risk of UTI exceeds 1% without any additional risk factors.

Ill-appearing children who present with nonspecific symptoms such as fever have important additional diagnostic considerations that include bacteremia and sepsis. Ill-appearing children who warrant antibiotics because of the concern for a serious infection, such as sepsis, should be tested for a UTI. Urine specimens should be collected for urinalysis and culture because the antibiotics may treat an otherwise unknown UTI, masking the diagnosis from the clinician. Even though antibiotics for sepsis or bacteremia may adequately treat UTI, it is important to establish the diagnosis to determine antibiotic duration and choice, future risk of UTI, and possible preventative measures, as discussed in the management section.

Differentiating a lower UTI from an upper tract infection in infants on the basis of signs and symptoms is difficult, but if fever is present, most consider the infant to have upper tract involvement and therefore pyelonephritis. Laboratory values such as procalcitonin and C-reactive protein, when increased, have been shown to be helpful in assessing infants for renal involvement during an infection. (7) If further clarification is necessary, a dimercaptosuccinic acid (DMSA) scan can be performed. In a DMSA scan, DMSA is combined with a radionuclide to image the kidneys by using gamma cameras. A DMSA scan provides the best means of definitively identifying upper UTI but should not be routinely performed because typically, the management will not be altered on the basis of the results and because of radiation exposure related to DMSA. (8)

Infants less than 2 months of age are not included in the AAP guidelines. UTI should be considered for every febrile infant less than 2 months of age. Clinicians should be vigilant in assessing febrile infants less than 2 months of age for UTIs, even those with obvious respiratory symptoms. Infants in this age group with respiratory symptoms have an appreciable risk of UTI, with 1 study showing respiratory syncytial virus–positive febrile infants having a UTI risk of 7%. (9) In infants who present with symptoms of bronchiolitis or respiratory syncytial virus–positive bronchiolitis, 1 systematic review showed that the risk of UTI was 3.3%. (10)

Children 2 Years of Age and Older

In older children, symptoms such as dysuria, urinary frequency, and/or suprapubic discomfort are common with cystitis. These symptoms should prompt testing for UTI. However, when evaluating children for UTI, other diagnoses should be considered. Patients should be evaluated for non-UTI causes of dysuria, such as obstruction, *Candida* infection, and vulvovaginitis in female patients, by compiling a history and performing a physical examination. (11)

Dysuria and urinary symptoms, along with more systemic symptoms, such as flank pain, costovertebral pain, abdominal pain, and/or fever, are suggestive of upper urinary tract involvement and thus pyelonephritis. However, older children with UTI may present with systemic symptoms without dysuria or urinary symptoms. The differential diagnosis for symptoms of pyelonephritis includes appendicitis, viral gastroenteritis, bacterial enteritis, renal stones, and, in the female adolescent, pelvic infections.

DIAGNOSIS

Accurately diagnosing UTIs is critical. Establishing the diagnosis is important to be able to treat and resolve the infection with appropriate antibiotics, prevent further ascension of the infection to the kidneys, determine future risk of UTI, and avoid long-term renal disease. However, overtesting and overtreating expose children to painful procedures, unnecessary antibiotics, and worry. Therefore, careful assessment of the diagnostic test results is important.

The diagnosis of UTI in children is based on the results of urinalysis and urine culture. (6) Demonstration of both inflammation in the urine (WBCs, leukocyte esterase) and bacteria growing in the culture is critical. There are diseases that cause urinary inflammation without bacteria (sterile pyuria) in the urine. Examples include Kawasaki disease and infections outside the urinary system, such as viral infections or pneumonia. Also, bacteria may be present in the urinary tract without causing inflammation and infection (asymptomatic bacteriuria).

Compiling a history and performing a physical examination are important in establishing the diagnosis in all ages. Clinicians should screen for conditions that predispose the patient to or mimic UTIs, such as labial adhesions, *Candida* infection, and vulvovaginitis in female patients. In male patients, an obstructed urinary stream (such as dribbling of urine from the urethra) may suggest posterior urethral valves or phimosis.

Infants and Toddlers under 24 Months of Age

Urine Collection. Infants are generally not able to submit a clean-caught, voided specimen; therefore, catheterization is often performed to collect a urine sample for urinalysis and culture. Urine collection with a bag is also an option with special considerations, but the urine collected should only be analyzed for urinalysis and not culture. Bacteria growing on the skin in the genital area and not in the urinary tract could contaminate the bag specimen. When evaluating infants for UTIs, the clinician can review with the family the advantages and disadvantages of urine collection through catheterization or by using a bag, as reviewed in Table 2.

In 1 study, a pediatric emergency department was able to reduce the use of urinary catheterizations by one-half in infants and toddlers 6 months to 24 months of age, without missing UTIs by obtaining urine from bag specimens that were placed by the nurse early in the visit. (12) Patients with

TABLE 2. **Advantages and Disadvantages of Urine Collection via Bag versus Catheterization**

	ADVANTAGES	DISADVANTAGES
Catheterization	Quick Urine culture can be sent initially	Pain and discomfort
Bag specimen	May prevent the pain and discomfort from catheterization if urinalysis findings are normal	If urinalysis findings are abnormal (increased white blood cell count or leukocyte esterase) then would proceed to catheterization to confirm May take a substantial amount of time for an infant to void in the bag

bag urine specimens with evidence of inflammation (moderate or large leukocyte esterase or nitrites) underwent catheterization for culture and had antibiotics started while culture results were pending.

Suprapubic needle aspiration of urine from the bladder is also an option for obtaining urine specimens but is less commonly used because the procedure is more painful than catheterization and the success rate is low, being 53% in 1 study. (13)(14) A newer approach for urine collection in neonates and infants is the bladder stimulation technique first described in 2013. (15) The technique requires 3 trained providers and involves holding the infant upright while alternating between tapping the bladder and massaging the lower back. During this process, the third clinician waits, ready to collect the urine specimen midstream into a sterile container. Further studies are required to validate this technique before widespread use.

Interpretation of the Urinalysis Results. Once a urinalysis is obtained, the clinician must interpret the results carefully. Urine dipsticks can be used to analyze the presence of leukocyte esterase (a marker of WBCs) and nitrites (a marker of some gram-negative bacteria) among other things; however, urine dipsticks cannot be used to detect the concentration of WBCs. Microscopy of the urine allows WBC concentration data to be collected, which, together with leukocyte esterase and nitrite data, improve the sensitivity for UTIs, as shown in Table 3.

The nitrite test has poor sensitivity in infants because infants empty their bladders frequently, often before the 4 hours required for gram-negative bacteria to form nitrites. As such, absence of urinary nitrites does not rule out a UTI. However, with specificity of 98%, presence of nitrites is highly suggestive of UTI. Generally, 5 or more WBCs per high-power field or 25 WBCs per microliter is considered pyuria and increases the likelihood of UTI. (6)

Interpretation of the Urine Culture Results. Urine culture results also need to be carefully interpreted. The number of colony-forming units (CFUs) per milliliter, the number and types of species of bacteria identified, and the time elapsed in processing of the urine sample should all be considered. Generally, 50,000 CFU/mL and higher represents considerable urine bacterial growth and is clinically significant. (6) However, 10,000 to 50,000 CFU/mL may represent UTI, especially in neonates, children with immunodeficiency, children with urinary tract abnormalities, or children already taking antimicrobial therapy.

Even if a clinically significant amount of bacteria grows in the urine culture, this does not always represent UTI. Bacterial species, such as coagulase-negative staphylococci and *Corynebacterium,* are generally noninvasive in healthy children and could be contaminants or bacterial colonizers not causing infection.

Other Studies. Additional studies, such as blood culture and serum chemistry levels in infants suspected of having a UTI, are sometimes obtained in the initial workup of the fever. Assessing which infants with a UTI also have bacteremia is difficult and, in infants older than 2 months, is often not necessary, especially if the infant is well appearing. (16) The prevalence of bacteremia in infants less than 12 months of age with a UTI is about 4% and as high as 17% in infants less than 2 months of age. (16)(17)

Children 2 Years of Age and Older

Older children are more able to voluntarily submit a clean-caught voided urine specimen for analysis, making the need for catheterization or bag collection usually

TABLE 3. **Sensitivity and Specificity of Components on the Urinalysis, Alone and in Combination**

PARAMETER	SENSITIVITY (RANGE), %	SPECIFICITY (RANGE), %
Leukocyte esterase test	83 (67–94)	78 (64–92)
Nitrite test	53 (15–82)	98 (90–100)
Leukocyte esterase or nitrite test, positive findings	93 (90–100)	72 (58–91)
Microscopy, white blood cells	73 (32–100)	81 (45–98)
Microscopy, bacteria	81 (16–99)	83 (11–100)
Leukocyte esterase test, nitrite test, or microscopy, positive findings	99.8 (99–100)	70 (60–92)

From the AAP urinary tract infection guidelines. (6)

unnecessary. A clean-catch midstream void technique is recommended. (18)

Urinalysis and culture results should be interpreted similarly and carefully, as in infants. When interpreting the urinalysis results with clean-caught voided samples, clinicians should consider the number of squamous epithelial cells at microscopy. Squamous epithelial cells are predictive of a poor urine sample, and thus a poor performance of the urinalysis, because these cells suggest local genital skin contamination. (19) One should consider repeating the sample collection if there is a clinically significant concentration of squamous epithelial cells (5 cells per high-power field or higher). Sterile pyuria in older children may be caused by Kawasaki disease, non-UTIs, sexually transmitted infections, pelvic inflammatory disease, and appendicitis (if the inflamed appendix is close to the bladder).

Children with Neurogenic Bladder Dysfunction. Children with neurogenic bladder dysfunction deserve special consideration because these children are not able to empty the bladder normally and require clean, intermittent catheterization to prevent chronic renal disease, from both high urinary pressures and chronic UTIs. Examples include children with spina bifida and spinal cord injury. Children with neurogenic bladder dysfunction have a high prevalence of asymptomatic bacteriuria; therefore, the presence of bacteria at culture alone should not suggest a UTI. The definition of a UTI in this population has not been widely established, but most agree that all of the following should be established to assign a diagnosis: presence of symptoms (fever, pain, incontinence, or cloudy urine), inflammation at urinalysis, and clinically significant growth of a single bacterial species in the urine culture. (20)

MANAGEMENT

The care of children with UTIs requires consideration of the child's age, medical history, risk factors, degree of current illness, and other unique circumstances. Besides resolving the acute infection, management is important to prevent renal injury and subsequent long-term renal insufficiency.

Antibiotics

Many antibiotics, both oral and intravenous (IV), treat the bacteria responsible for UTIs. Oral antibiotics alone are as effective as IV antibiotics for UTIs, including pyelonephritis. (21)(22) However, IV antibiotics should be administered when a child is clinically toxic appearing and may also have bacteremia and/or sepsis or when the child cannot tolerate oral antibiotics. If IV antibiotics are warranted, the child should be transitioned to oral antibiotics when the clinical condition improves and when the patient can tolerate medications by mouth.

Culture results typically take 12 to 24 hours before bacterial growth is detected, 1 to 2 days before the specific bacterium is identified, and 2 to 3 days before susceptibilities are available. In infants and often in older children, antibiotics should be empirically initiated in suspected UTI after urinalysis but before culture results are interpreted to resolve the infection in a timely manner. However, in older children with mild symptoms, waiting for culture results can minimize unnecessary use or ineffective use of antibiotics.

The choice of the empirical antibiotic should be tailored to local bacterial susceptibility data, patient compliance, medication cost, and, if the patient has a history of prior UTI, the individual susceptibility pattern in prior infections. Antibiograms from local hospitals provide local susceptibility patterns of infectious organisms and are crucial because of varying geographic patterns. (6) See Table 4 for specific oral antibiotic choices. Table 5 depicts parental treatment options for UTIs.

A first-generation cephalosporin, like cephalexin, typically provides good coverage of uropathogens and is well tolerated, widely available, and cheap but must be taken at least 3 times per day. Trimethoprim-sulfamethoxazole is also tolerated well, is inexpensive, and requires twice-per-day dosing but has had increased resistance in past years

TABLE 4. **Some Empirical Antimicrobial Agents for Oral Treatment of UTI**

ANTIMICROBIAL AGENT	DOSAGE
Amoxicillin clavulanate	20–40 mg/kg per d in 3 doses
Sulfonamides	
Trimethoprim-sulfamethoxazole (should not be used in infants less than 2 mo of age)	6–12 mg/kg trimethoprim and 30–60 mg/kg sulfamethoxazole per d in 2 doses
Sulfisoxazole	120–150 mg/kg per d in 4 doses
Cephalosporins	
Cefixime	8 mg/kg per d in 1 dose
Cefpodoxime	10 mg/kg per d in 2 doses
Cefprozil	30 mg/kg per d in 2 doses
Cefuroxime axetil	20–30 mg/kg per d in 2 doses
Cephalexin	50–100 mg/kg per d in 4 doses

From the AAP urinary tract infection guidelines. (6)

TABLE 5. Some Empirical Antimicrobial Agents for Parenteral Treatment of UTI

ANTIMICROBIAL AGENT	DOSAGE
Ceftriaxone	50 mg/kg, every 24 h
Cefotaxime	150 mg/kg per d, divided every 6–8 h
Ceftazidime	100–150 mg/kg per d, divided every 8 h
Gentamicin	7.5 mg/kg per d, divided every 8 h
Tobramycin	5 mg/kg per d, divided every 8 h
Piperacillin	300 mg/kg per d, divided every 6–8 h

in some localities. Nitrofurantoin has good coverage of uropathogens but should not be used in pyelonephritis (and therefore younger children) because this drug does not penetrate renal tissue or blood well.

The duration of antibiotic therapy should depend on the age of the child and the degree of illness, such as lower versus upper tract involvement. For infants and toddlers less than 24 months of age or for older children with pyelonephritis, 7 to 14 days of antibiotics is recommended. (6) For older children with cystitis, a 3- to 7-day course may be adequate. Asymptomatic bacteriuria should not be treated except in pregnancy. Asymptomatic bacteriuria in pregnancy should be treated for 3 to 7 days. (23)

Imaging

Renal and bladder ultrasonography is recommended for infants and toddlers less than 24 months of age after a febrile UTI to detect anatomic abnormalities, such as an obstructive process. (6) The timing of the ultrasonographic examination depends on the clinical situation. Children who are very ill or who do not improve as expected (generally within 12–36 hours) should undergo ultrasonography within the first couple of days to assess them for an obstructive anatomic abnormality or renal abscess. Children with nonsevere infection can undergo ultrasonography after the acute phase of the infection has passed to reduce false-positive findings from renal inflammation 1 to 2 weeks later.

A voiding cystourethrogram (VCUG) should not be routinely performed in children after a first UTI. (6) A VCUG is used to evaluate the patient for vesicoureteral reflux (abnormal reflux of urine from the bladder into the ureters). Vesicoureteral reflux is graded from grade I (reflux into only the ureter) to grade V (clinically significant reflux to the kidney, with dilated ureters and calyces). Vesicoureteral reflux may predispose the child to upper urinary tract involvement and thus possible renal damage and, ultimately, long-term renal insufficiency. However, the cost, discomfort, and radiation from routine VCUGs after a first febrile UTI offset the potential benefit of identifying clinically relevant vesicoureteral reflux in every child with UTI. VCUG is, however, recommended in children less than 24 months of age who have had a febrile UTI and who had an abnormal renal and bladder ultrasonographic finding because these children are at higher risk of grade V vesicoureteral reflux.

Prophylaxis

Antibiotic prophylaxis with trimethoprim-sulfamethaxole for children with vesicoureteral reflux reduces the risk of UTI occurrence by one-half. (24) However, more than 5,500 doses of antibiotic are needed to prevent 1 UTI. (25) Antibiotic prophylaxis has not been shown to reduce renal scarring. (24) Twice-daily administration of an antibiotic may also lead to antibiotic resistance. The decision to routinely start antibiotic prophylaxis in children with vesicoureteral reflux remains controversial. When considering this option, the clinician should take into account each child's unique characteristics and involve the family in the decision. Children with grade V reflux have been excluded from most studies of this subject. These children should receive special attention and referral to a specialist, as most treat these children with antibiotic prophylaxis and sometimes surgical correction.

Prevention by Recognizing Bowel and Bladder Dysfunction

Preventing UTIs by screening for, identifying, and treating bowel and bladder dysfunction is not controversial and is underrecognized, effective, and safe. Inquiring about constipation symptoms, daytime wetting, and withholding behaviors will help identify children with bowel or bladder dysfunction. Bowel and bladder dysfunction occurs in 20% of all children and 50% of children with a history of UTI. (26) Constipation should be treated and managed. Among children with chronic constipation, 33% of girls and 3% of boys have UTIs. (27) One study showed that in children who had relief from their chronic constipation, UTIs were eliminated in those without anatomic abnormalities. (27) Bladder dysfunction can be treated by recommending scheduled voiding, such as every 3 to 4 hours, thereby preventing the child from voluntarily withholding urine until the last minute.

Children with a history of UTIs are at higher risk of developing subsequent UTIs than are healthy children. Families of these children should be educated to seek medical evaluation early for symptoms of a UTI—especially fever. (6)

CASE STUDY CONTINUED

Thirteen-month-old Charlotte's risk factors for UTI include a febrile illness without a clear source, a history of prior UTIs, a temperature over or equal to 102.2°F (39°C), and fever duration of 2 days. She is definitely not considered low risk (≤2%) per the AAP UTI guidelines for infants and toddlers less than 24 months of age. A urine specimen should be collected to evaluate Charlotte for a UTI. She had urine collected from a bag that showed an increased WBC count and the presence of leukocyte esterase. The urine collected from a bag should not be sent for culture because of a substantial contamination rate; therefore, a catheterization should be performed to obtain a urine specimen for culture. Catheterization-obtained urine for culture and repeat urinalysis still demonstrated 5 to 10 WBCs per high-power field. The patient was started on cephalexin because local susceptibility patterns show that more than 90% of *E coli* are susceptible to this antibiotic. Charlotte's fever resolves in 2 days, and her culture result shows 50,000 CFU/mL of pan-sensitive *E coli*. After discussion with the family, it is decided to perform a VCUG to evaluate Charlotte for vesicoureteral reflux and, if present, administer possible antibiotic prophylaxis.

Summary

1. On the basis of strong research evidence, clinicians treating young children with fever without an apparent source should include UTI as part of the differential diagnosis. Clinicians should evaluate risk factors for UTI, including age, race, temperature, fever duration, and, in male patients, circumcision status.
2. On the basis of strong research evidence, young children with symptoms who are not low risk for UTI should undergo urinalysis. The urine specimen for urinalysis can be obtained via either bag or catheterization. Urine specimens obtained from bags can be helpful to rule out UTI if the results of the urinalysis are normal. However, if the urinalysis from the bag specimen has evidence of inflammation, catheterization is necessary for culture and repeat urinalysis. A culture should not be performed on a bag specimen.
3. On the basis of some research evidence, as well as consensus, the diagnosis of a UTI should include clinical symptoms, urinalysis with evidence of inflammation (leukocyte esterase and/or at least 5 WBCs per high-power field), and culture results of at least 50,000 CFU/mL of a typical uropathogen.
4. On the basis of strong research evidence, the choice of antibiotic therapy should take into account local susceptibility data, cost of the antibiotic, and patient compliance issues. Typical good choices, depending on local susceptibility, include cephalexin and trimethoprim-sulfamethoxazole. Trimethoprim-sulfamethoxazole should not be used in infants less than 2 months of age.
5. On the basis of some research evidence, as well as consensus, young children with a febrile UTI should undergo renal and bladder ultrasonography to rule out anatomic abnormalities or signs of obstruction. VCUG should not be performed routinely after the first febrile UTI.
6. On the basis of some research evidence, as well as consensus, clinicians should screen for and manage bowel and bladder dysfunction in older children. Appropriately managing bowel and bladder dysfunction reduces the development of UTIs.

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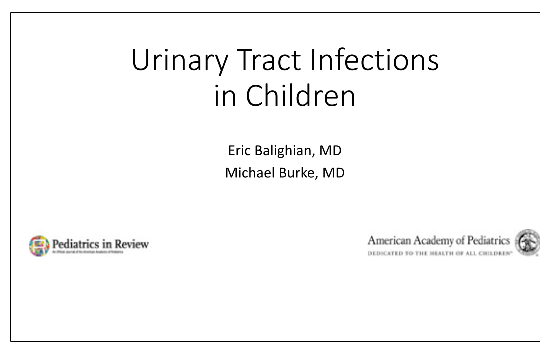

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Additional Resources for Pediatricians

AAP Textbook of Pediatric Care, 2nd Edition

- Chapter 344: Urinary Tract Infections - https://pediatriccare.solutions.aap.org/chapter.aspx?sectionId=125490707&bookId=1626

Point-of-Care Quick Reference

- Urinary Tract Infections - https://pediatriccare.solutions.aap.org/content.aspx?gbosid=165581

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1. A previously healthy 9-month-old African American uncircumcised male infant is brought to the clinic by his parents with a 12-hour history of fever. He has not had nasal congestion, cough, or diarrhea. He had 1 episode of emesis when he was given acetaminophen. He has continued to breastfeed and has had a normal number of wet diapers. His tympanic temperature is 101.1°F (38.4°C). He is mildly ill appearing. There is no discernible focus of infection on examination. Which of the following factors is most strongly associated with an increased probability for this infant having a urinary tract infection (UTI)?

   A. African American race.
   B. Duration of fever.
   C. Episode of vomiting.
   D. Temperature of 101.1°F (38.4°C).
   E. Being uncircumcised.

2. A previously healthy 6-month-old female infant is brought to the emergency department with a 2-day history of fever. She has not had vomiting, diarrhea, cough, or nasal congestion. There has been no known contact with ill persons. She has continued to breastfeed and has not had a decrease in the number wet diapers. Her temperature is 102.4°F (39.1°C). She is mildly ill appearing but alert and interactive. Examination shows no focus of infection. A bag urine sample is collected and sent for urinalysis. The urinalysis shows a specific gravity of 1.015, trace protein levels, 1+ leukocyte esterase result, positive nitrite result, and 10 to 12 white blood cells (WBCs) per high-power field. Which of the following results from her urinalysis has the highest specificity for having a UTI?

   A. Leukocyte esterase.
   B. Nitrite.
   C. Protein level.
   D. Specific gravity.
   E. WBC microscopy.

3. For the same 6-month-old female infant in question 2, a urine culture is performed via catheterization. After catheterization, she is noted to breastfeed normally. She is not allergic to any medications. Pending the urine culture result, which of the following is the most appropriate empirical therapy?

   A. Oral azithromycin.
   B. Oral cephalexin.
   C. Oral nitrofurantoin.
   D. Intravenous ceftriaxone.
   E. Intravenous cefepime.

4. A 4-month-old male infant presents with a 2-day history of fever. He is not vomiting and is alert and interactive. There is no focus of infection on examination. He is circumcised. A bladder catheterization is performed. The urinalysis shows a 2+ leukocyte esterase result, negative nitrite result, and 20 to 30 WBCs per high-power field. He has no allergies and is started on oral trimethoprim-sulfamethoxazole. The urine culture grows 50,000 colony-forming units (CFU) per milliliter of *Escherichia coli* that is susceptible to trimethoprim-sulfamethoxazole. After being sent home, his mother is called and states that he is acting well and has not had a fever in the past day. The mother is advised to have him complete the 10-day course of trimethoprim-sulfamethoxazole. Which of the following is the most appropriate next step in management?

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A. Dimercaptosuccinic acid renal scan.
B. No further testing or treatment indicated.
C. Renal and bladder ultrasonography.
D. Renal and bladder ultrasonography and voiding cystourethrogram.
E. Voiding cystourethrogram.

5. A 34-month-old girl is brought to the office with a 1-day history of dysuria and urinary urgency. She has not had a fever. She received a diagnosis of a febrile UTI at 20 months of age and had a normal renal bladder ultrasonographic finding. She had a second febrile UTI at 23 months of age, and a voiding cystourethrogram result was normal. She had a third UTI at 30 months of age and was afebrile. She has a history of chronic functional constipation with associated fecal incontinence. On examination, there is no costovertebral tenderness, and the vulvar area has some mild erythema. A clean-catch urinalysis is positive for leukocyte esterase and nitrite, with very few epithelial cells. The urine culture grows 100,000 CFU/mL of *Klebsiella oxytoca*. In addition to 7 days of antibiotic treatment, which of the following is the most appropriate next step in management?

A. Cefdinir prophylaxis.
B. Constipation management.
C. Cranberry juice daily.
D. Decreased dietary calcium intake.
E. Intravenous pyelogram.