

Urinary Tract Infection in Children

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Up to 7 percent of girls and 2 percent of boys will have a symptomatic, culture-confirmed urinary tract infection by six years of age. Urinary tract infection may be suspected because of urinary symptoms in older children or because of fever, nonspecific symptoms, or failure to thrive in infants. Urine dipstick analysis is useful for ruling out urinary tract infections in cases with low clinical suspicion. However, urine culture is necessary for diagnosis of urinary tract infections in children if there is high clinical suspicion, cloudy urine, or if urine dipstick testing shows positive leukocyte esterase or nitrite activity. Despite current recommendations, routine imaging studies (e.g., renal ultrasonography, voiding cystourethrography, renal scans) do not appear to improve clinical outcomes in uncomplicated urinary tract infections. Oral antibiotics are as effective as parenteral therapy in randomized trials. The optimal duration of antibiotic therapy has not been established, but one-day therapies have been shown to be inferior to longer treatment courses. (Am Fam Physician 2005;72:2483-8. Copyright © 2005 American Academy of Family Physicians.)



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Until recently, the management of urinary tract infection (UTI) in children has been controversial and based mainly on opinion, but new evidence regarding imaging studies and treatment prompted this review. Although symptomatic UTI and asymptomatic bacteriuria (i.e., positive urine cultures without symptoms or signs of illness) are discussed in the literature, this review focuses on symptomatic UTI.

Epidemiology

Up to 7 percent of girls and 2 percent of boys will have a symptomatic, culture-confirmed UTI by six years of age.¹ The prevalence of UTI in febrile infants is greater with younger age, with a rate of nearly 7 percent among febrile newborns.²

Most UTIs in children result from ascending infections, although hematogenous spread may be more common in the first 12 weeks of life. Most UTIs in children are monomicrobial, often caused by *Escherichia coli* (60 to 80 percent of cases), *Proteus* (more common in boys and in children with renal stones), *Klebsiella*, *Enterococcus*, and coagulase-negative staphylococci.³

Evidence on risk factors for UTI in children is limited. UTIs were associated with constipation, encopresis, bladder instability,

and infrequent voiding in two studies^{4,5} but not in a cohort of febrile children younger than two years.⁶ Bathing and back-to-front wiping have not been demonstrated to be risk factors.

Evaluation

Older children with UTI may have dysuria, frequency, urgency, hesitancy, small-volume voids, or lower abdominal pain. Infants with UTI more commonly present with nonspecific symptoms such as fever, irritability, jaundice, vomiting, or failure to thrive. Unusual odor of the urine is not helpful in predicting UTI.⁷

Other conditions may mimic UTI symptoms. Acute urethritis or vulvovaginitis may be caused by various types of irritants, including chemical (e.g., bubble baths, soaps), physical (e.g., self-exploration), and biologic (e.g., pinworms). Self-infusion of water into the urethra was reported in 10 of 31 boys five to 15 years of age presenting with a first UTI.⁸

URINE CULTURE

Urine culture is required for diagnosis of UTI. The diagnostic threshold depends on the method of urine collection. Compilation of studies comparing counts of colony-forming units from various collection methods with

SORT: KEY RECOMMENDATIONS FOR PRACTICE

<i>Clinical recommendation</i>	<i>Evidence rating</i>	<i>References</i>
Urine culture should be obtained for diagnosis of UTI in children if there is high clinical suspicion, cloudy urine, or positive urine dipstick.	C	13-16
Routine imaging studies (e.g., ultrasonography, VCUG, renal scans) do not appear to improve outcomes in children with a first uncomplicated UTI, but the evidence is weak.	B	24, 26, 27
Oral antibiotics should be used (when tolerated) instead of parenteral antibiotics to manage UTI in children.	A	35, 36
One-day courses of antibiotics should not be used to manage UTI in children.	A	37
Consider that short courses of antibiotics (two to five days) may be as effective as longer courses (seven to 14 days).	B	37-39
Prophylactic antibiotics may be used to reduce the risk of recurrent UTI.	B	42, 43

UTI = urinary tract infection; VCUG = voiding cystourethrography.

A = consistent, good quality patient-oriented evidence; B = inconsistent or limited quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For more information about the SORT evidence rating system, see page 2416 or <http://www.aafp.org/afpsort.xml>.

the probability of UTI has established the recommendations listed in Table 1.⁹

For urine collection from infants and young children, suprapubic aspiration or transurethral catheterization generally is recommended. Urethral catheterization is more likely than aspiration to obtain a sufficient sample of urine.¹⁰ Collection from bags or pads leads to high contamination rates.¹¹ Clean-catch urine collection from infants requires more patience and effort than the

use of pads or bags, but this method is reasonably accurate and rates of contamination are low.^{11,12}

RAPID URINE TESTING

Children with a high likelihood of UTI (e.g., older children with classic urinary symptoms) should have a urine culture; rapid urine testing will not change the treatment of these patients. In children with a low likelihood of UTI (e.g., those with vague urinary complaints and an alternative explanation for fever), urine inspection and dipstick testing may reduce the need for urine culture. Urine culture is indicated if the child's urine is cloudy or if the dipstick test shows positive leukocyte esterase or nitrite activity.¹³⁻¹⁶ Urine culture also is recommended for children with recurrent symptoms.

Urine dipstick analysis can rule out UTI if the result is negative (in nondilute urine), but a positive result on dipstick testing is insufficient to diagnose UTI because false-positive results are common. In a cohort study¹³ with 18 percent prevalence of UTI, a negative result on urine dipstick analysis (i.e., negative for leukocyte esterase and nitrites) had a negative predictive value of 96 percent. Urine dipstick analysis appears to be more accurate than microscopic analysis for the detection of pyuria in children,^{13,14} although this has been debated.¹⁷ Urine dipstick analysis may produce false-negative results with dilute urine (i.e., specific gravity less than 1.005). Clear urine (defined as the ability to read text through the urine in a test tube as easily as through water) had 96 to 100 percent negative predictive values in cohort studies,^{13,15,16} but these values may be unreliable in dilute urine.

TABLE 1
Diagnostic Thresholds for UTI in Children

<i>Method of urine collection</i>	<i>Diagnostic threshold</i>
Clean-catch voiding in girls	100,000 CFU per mL Repeat testing if 10,000 to 100,000 CFU per mL
Clean-catch voiding in boys	10,000 CFU per mL
Catheter	10,000 CFU per mL Repeat testing if 1,000 to 10,000 CFU per mL
Suprapubic aspiration	Any number of colonies for gram-negative bacilli, more than a few thousand CFU per mL for gram-positive cocci

UTI = urinary tract infection; CFU = colony-forming units.

Adapted with permission from Hellerstein S. Recurrent urinary tract infections in children. *Pediatr Infect Dis* 1982;1:275.

Some authors recommend urine culture testing for infants with suspected UTI because of lower sensitivities for urine dipstick analysis in infants.^{18,19} However, investigators in several large cohort studies^{2,20} of infants younger than two years with undiagnosed fevers or UTI symptoms have found negative predictive values greater than 98 percent despite sensitivities of 79 percent. Urine dipstick testing achieved these high negative predictive values because of the low likelihood of positive urine cultures (2.8 to 8 percent) in these studies.^{2,20}

ADDITIONAL TESTING

Blood cultures are unnecessary in most children with UTI, but they are more likely to be positive in children younger than two months and in children whose urine cultures grow *Staphylococcus aureus* or group B streptococcus.^{21,22}

Previously, imaging studies were recommended for any child with a UTI. The 1999 clinical practice guideline²³ from the American Academy of Pediatrics (AAP) recommends imaging for children two months to two years of age, noting that the strength of evidence for the recommendation is fair. Recent evidence has suggested that imaging work-ups for children with a first uncomplicated UTI may not improve patient care. In one prospective study,²⁴ renal ultrasonography did not change the management of UTI in any of 255 children younger than five years who were admitted with a first uncomplicated febrile UTI. An earlier systematic review²⁵ of 63 descriptive studies found no evidence of the impact of routine imaging on clinical outcomes in children with a first UTI.

In a randomized trial,²⁶ 150 children two to 10 years of age with a first UTI were assigned to routine imaging (i.e., ultrasonography and voiding cystourethrography [VCUG]) or to selective imaging (only if recurrent UTI or persistent problems were present). Approximately one in five children (21 percent) in the selective imaging group had imaging performed. Routine imaging increased the use of prophylactic antibiotics (28 versus 5 percent) but did not reduce the rate of recurrent UTIs (26 versus 21 percent) or renal scarring at two years (9 versus 9 percent). These results suggest that imaging is not useful in determining which children might benefit from prophylactic antibiotics.

Extensive imaging work-up (i.e., ultrasonography and renal scan within 72 hours, VCUG at one month, and repeat renal scan at six months) was evaluated in a prospective study²⁷ of 309 children one to 24 months of age with a first febrile UTI. Results of ultrasonography were normal in 88 percent, and abnormalities did not change

management (i.e., no obstructive lesions were found). Initial renal scans suggested acute pyelonephritis in 61 percent of patients, but febrile UTI in infants is managed with the presumption of pyelonephritis. VCUG and repeat renal scans showed vesicoureteral reflux (VUR) and renal scarring in 39 and 9.5 percent of infants, respectively. However, the manner in which VUR or renal scarring should alter the course of management is controversial. In some reviews,^{28,29} authors have suggested that VUR predisposes children to recurrent pyelonephritis and renal scarring. Although some children with renal scarring develop hypertension and renal insufficiency in adulthood, this association appears limited to those with extensive renal scarring or hypertension in childhood.²⁸ Recommendations have been made to identify VUR early to stop this cascade of events, despite a lack of studies showing that interventions along this pathway prevent renal scarring, hypertension, and renal insufficiency. Severe VUR has been associated with recurrent UTI³⁰ and recurrent pyelonephritis,³¹ but the association of VUR with renal scarring has been inconsistent.^{32,33} Renal scarring is associated with recurrent UTI³² and recurrent pyelonephritis,³⁴ but a causal relationship has not been established.²⁵

Although imaging traditionally has been recommended in children with recurrent UTI, no randomized trials are available to support or refute these recommendations. Bladder ultrasonography to determine postvoid residual volume may identify urinary obstruction, and children with renal scarring may benefit from follow-up for early detection of hypertension or renal insufficiency, but data supporting these approaches are sparse.

Treatment

Empiric antibiotic therapy (Table 2²³) is reasonable while awaiting culture results if there is a high clinical suspicion of UTI.²³ Subsequently changing antibiotics based on reported sensitivities may be unnecessary if clinical resolution occurs. According to the AAP, the child should be reevaluated with a repeat urine culture and renal/bladder ultrasonography if clinical improvement does not occur within two days.²³

The authors of randomized trials^{35,36} comparing oral and parenteral regimens in children with fever and

Surgical and medical management for vesicoureteral reflux do not appear to differ in urinary tract infection recurrence rates, renal function, renal scarring, hypertension, or end-stage renal disease.

UTI in Children

positive urine cultures did not find differences in cure rates or speed of improvement. Parenteral antibiotics may be necessary if vomiting precludes oral administration.

The optimal duration of antibiotic therapy has not been established. One-day courses of antibiotics are less effective than longer courses.³⁷ Systematic reviews³⁷⁻³⁹ of randomized trials comparing shorter and longer courses of antibiotics have had varying results, based in part on the inclusion of one-day courses in the analysis. Short courses (three to five days) of antibiotics may be as effective as longer courses (seven to 14 days), but this has not been clearly proved.³⁷⁻³⁹

No evidence was found to support a recommendation for routine posttreatment urine cultures in children with UTIs. In one study⁴⁰ of 364 children hospitalized with UTI, 291 (80 percent) had follow-up urine cultures, none of which was positive.

Prevention

In a one-year longitudinal study,⁴¹ recurrent symptomatic UTI occurred in 12 percent of children younger than five years presenting to an emergency department with a first UTI. Children younger than six months had a higher risk of recurrence (18.6 percent).

Prophylactic antibiotics may reduce the risk of recurrent UTI. Two systematic reviews^{42,43} found weak evidence of benefit with poor quality trials. Table 3²³ describes potential prophylactic regimens in children younger than two years. Only one comparison trial of antibiotic selection was found. In this six-month trial,⁴⁴ nitrofurantoin (Furadantin) was more effective than trimethoprim (Primsol) in preventing UTIs (number needed to treat [NNT] = 5.4) but was more likely to be discontinued

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TABLE 2
Empiric Oral Antibiotic Therapy
for UTI in Children

Antibiotic	Daily dosage
Amoxicillin	20 to 40 mg per kg in three doses*
Cefixime (Suprax)	8 mg per kg in two doses
Cefpodoxime (Vantin)	10 mg per kg in two doses
Cefprozil (Cefzil)	30 mg per kg in two doses
Cephalexin (Keflex)	50 to 100 mg per kg in four doses
Loracarbef (Lorabid)	15 to 30 mg per kg in two doses
Sulfisoxazole (Gantrisin)	120 to 150 mg per kg in four doses
Trimethoprim/sulfamethoxazole (Bactrim, Septra)	6 to 12 mg per kg/30 to 60 mg per kg in two doses

UTI = urinary tract infection.

*—Amoxicillin is the first choice for infants younger than two months.

Adapted with permission from Committee on Quality Improvement, Subcommittee on Urinary Tract Infection. Practice parameter: the diagnosis, treatment, and evaluation of the initial urinary tract infection in febrile infants and young children [published corrections appear in *Pediatrics* 2000;105:141, 1999;103:1052, and 1999;104:118]. *Pediatrics* 1999;103:848.

because of side effects (number needed to treat to harm = 5.3), which were mainly gastrointestinal.

Because VUR has been considered a predisposing factor to UTI and its complications, treatments for children with VUR have been promoted. Medical management often has used prophylactic antibiotics, but the systematic reviews⁴³ suggesting that prophylactic antibiotics prevent recurrent UTI did not include studies of children with VUR. Nonetheless, the AAP recommends prophylaxis until imaging studies are completed and until additional treatment based on the imaging findings is instituted.²³ Two systematic reviews^{45,46} of randomized trials comparing surgical and medical management of VUR found no significant differences in UTI recurrence rates, renal function, renal scarring, hypertension, or end-stage renal disease. In two randomized trials^{47,48} involving more than 400 children younger than 11 years who had grade III or IV VUR and documented UTI, surgery reduced the rate of acute pyelonephritis (21 to 22 percent incidence with surgery versus 8 to 10 percent with antibiotic prophylaxis alone; NNT = 7 to 9), but overall rates of UTI did not differ. A new treatment for children with VUR, dextranomer/hyaluronic acid

TABLE 3
Antibiotic Choices for UTI Prophylaxis in Children

<i>Antibiotic</i>	<i>Dosage</i>
Methenamine mandelate (Mandelamine)	75 mg per kg per day in two doses
Nalidixic acid (NegGram)	30 mg per kg per day in two doses
Nitrofurantoin (Furadantin)	1 to 2 mg per kg once per day
Sulfisoxazole (Gantrisin)	10 to 20 mg per kg per day in two doses
Trimethoprim/sulfamethoxazole (Bactrim, Septra)	2 mg per kg/10 mg per kg nightly or 5 mg per kg/25 mg per kg twice per week

UTI = urinary tract infection.

Adapted with permission from Committee on Quality Improvement, Subcommittee on Urinary Tract Infection. Practice parameter: the diagnosis, treatment, and evaluation of the initial urinary tract infection in febrile infants and young children [published corrections appear in *Pediatrics* 2000;105:141, 1999;103:1052, and 1999;104:118]. *Pediatrics* 1999;103:849.

copolymer (Deflux), is a bulking agent placed endoscopically near the distal ureteral orifice. Deflux was more effective than antibiotic prophylaxis in resolving childhood VUR in one randomized trial⁴⁹ of 61 children but did not prevent UTI. Nine UTIs were recorded in six of the 40 children in the Deflux group, whereas none occurred in the 21 children receiving antibiotics.⁴⁹

Cranberry juice and related products have not been shown to prevent or reduce UTI in children; in a systematic review⁵⁰ of seven trials, the evidence base was too limited to support such conclusions.

Circumcision prevented recurrent symptomatic UTI in one randomized trial.⁵¹ Seventy uncircumcised boys three months to 10 years of age with a first symptomatic culture-confirmed UTI were randomized to immediate circumcision or circumcision after six months. Recurrent symptomatic UTIs developed in three of 35 boys during the six-month delay (8.6 percent) but not in the boys who received immediate circumcision (NNT = 12). Circumcision may provide primary prevention of UTI in boys, based on prospective follow-up of 69,100 boys for two to three years.⁵² However, circumcision may not be warranted for this specific purpose because 195 circumcisions would be needed to prevent one hospital admission for UTI in the first year of life.

Data sources: Online sources including PubMed, The Cochrane Library, Clinical Evidence, DynaMed, and the National Guideline Clearinghouse were searched in April 2003 using "urinary tract infection" and age limitations (younger than 18 years) where applicable. Referencelists of retrieved articles and reviews also were used. The highest level of evidence found for each specific topic was included. This review is based on a more thorough version of this topic that is available in DynaMed (<http://www.DynamicMedical.com>) and is updated as additional relevant information is identified.⁵³

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UTI in Children

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