

Urinary Tract Infections

Key Points

- Urine culture should always be collected when a urinary tract infection (UTI) is suspected. Appropriate collection methods include catheterization for incontinent children and clean-catch urine for continent children. Bagged urine specimens should not be used to make the diagnosis of a bacterial (UTI).
- The diagnosis of UTI is based on the presence of bacteria or pyuria AND a positive urine culture.
- Empiric antibiotics should be used in children with increased probability of UTI based on urinalysis findings.
- Children under <24 months should have a renal bladder ultrasound after a first febrile UTI. Children \geq 24 months should have a renal bladder ultrasound if they have recurrent febrile UTI or complicated UTI. Voiding cystourethrogram should be obtained if the renal bladder ultrasound is abnormal.

Abbreviations

C, Celsius. Cfu, colony-forming units. Hpf, high-powered field. IV, intravenous. Kg, kilogram. Mg, milligram. mL, milliliter. RBUS, renal bladder ultrasound. UA, urinalysis. UTI, urinary tract infection. VCUG, voiding cystourethrogram. WBC, white blood cell.

I. Definition, Assessment, Diagnosis

A. Definitions

1. Cystitis: Bacterial infection of the urine isolated to the bladder.
2. Pyelonephritis: Bacterial infection of the urine involving the renal parenchyma; typically associated with fever.
 1. Complicated UTI: Febrile UTI with systemic symptoms, or with secondary complications of UTI, such as renal or perinephric abscess, urosepsis, or UTI in the presence of medical devices (e.g., ureteral stent, Foley catheter, nephrostomy tube).
3. Asymptomatic bacteriuria or colonization: Presence of bacterial growth in the urine without signs or symptoms of inflammation such as pyuria. This is most commonly seen in children who chronically catheterize or those with urinary tract abnormalities.

B. Risk Factors

1. Neonates (<2 months)
 1. Urinary tract abnormalities
 2. Prematurity
 3. Indwelling catheter
2. Infants (2-24 months)
 1. Urinary tract abnormalities
 2. Female

3. Uncircumcised male
4. White race
5. Age <12 months
6. Fever $\geq 39^{\circ}\text{C}$ with no other apparent fever source
3. Children (≥ 2 years)
 1. Female
 2. Toilet training
 3. Voiding dysfunction or constipation
 4. Spinal cord disorders
 5. Urinary tract abnormalities
4. Adolescents
 1. Sexual activity

C. Assessment

1. Neonates: All febrile neonates should be evaluated for UTI
2. Infants
 1. The overall risk of UTI in a febrile infant is 5%. This is reduced by half in the presence of another apparent source of fever.
 2. Febrile infants should be screened for UTI in the presence of any of the above risk factors.
 3. UTI pretest probability calculators are available online to assist in the assessment of risk factors for UTI. For example, the University of Pittsburgh UTICalc for children 2-23 months of age is available at <https://uticalc.pitt.edu/>.
 4. Children and Adolescents
 - a. Screening for UTI is based on symptoms including dysuria, urinary frequency, new urinary incontinence, abdominal or flank pain, prolonged fever, or hematuria.

D. Diagnosis

1. The diagnosis of UTI is made based on the presence of bacteriuria or pyuria ($>5\text{WBC/hpf}$ on microscopy or leukocyte esterase on urine dipstick) in addition to a urine culture with growth of a single uropathogen – $>50,000$ cfu/mL on specimens obtained by catheterization or suprapubic aspiration, or $>100,000$ cfu/mL on clean-catch, midstream specimens.
 1. The presence of leukocyte esterase and nitrites on UA is highly sensitive for UTI.
 2. Urine culture should always be sent when UA is suspicious for UTI.
 3. Diagnosis of UTI can be made from bacterial growth $<50,000$ cfu/mL if there is low suspicion for contamination and/or clinical suspicion for UTI is very high.
2. Neonates and Infants
 1. Urine should, ideally, be collected by bladder catheterization or suprapubic aspiration. Bag specimens should never be sent for urine culture to confirm UTI.
 - a. A bag specimen may be appropriate to screen for UA abnormalities. If UA is abnormal, a catheterized specimen must be collected for confirmation and culture.
 2. Children and Adolescents

- a. In continent children, a midstream, clean-catch specimen is appropriate for diagnosis.
3. Special Populations (children who chronically catheterize such as spina bifida or other neurogenic bladder)
 - a. UA with leukocyte esterase or >10 WBC/hpf AND $\geq 100,000$ cfu/mL of a single uropathogen AND ≥ 2 new symptoms
 - i. Symptoms include fever $\geq 38^{\circ}\text{C}$, new abdominal or back pain, new or worse incontinence, pain with catheterization or urination, or malodorous/cloudy urine.

II. Management and Treatment Recommendations

A. Treatment

1. Empiric antibiotic treatment should be initiated in infants and children with UA suspicious for UTI.
 1. Empiric antibiotic therapy should be tailored to local susceptibility patterns. Among most uropathogens, there are increasing rates of resistance to most commonly used antibiotics. For example, most centers have a high rate (up to 30%) of sulfamethoxazole-trimethoprim resistance for *E. coli*. Therefore, local susceptibility patterns should be used.
 2. IV antibiotics should be considered if an infant or child is ill-appearing, unable to tolerate oral fluids or medications, or if past cultures have grown bacteria resistant to enteral antibiotics.
 3. Antibiotic therapy should be tailored to culture and sensitivities, once available.
2. Neonates (<2 months): Coverage should be IV and should cover most gram-negative organisms.
 1. Cefotaxime 200 mg/kg/day IV divided every 4-6 hours, Ceftazidime 50 mg/kg/dose every 8 hours, or cefepime 50 mg/kg/dose every 8 hours.
 2. Ceftriaxone 100 mg/kg/day in 1 to 2 divided doses can be used in infants >1 month.
 3. In preterm infants, the dosing for all medications will depend upon the child's gestational age, weight, and day of life.
3. Infants (2-24 months): Enteral antibiotics are recommended in children who are stable and not ill-appearing.
4. Duration of therapy
 1. Uncomplicated cystitis: 7 days of enteral therapy.
 2. Complicated cystitis: 10-14 days of enteral therapy.
 - a. Includes children who chronically catheterize, have known urologic hardware (e.g., ureteral stents, indwelling catheters, nephrostomy tubes).
 3. Pyelonephritis: 14 days of enteral therapy
 4. Complicated pyelonephritis (e.g. renal or perinephric abscess, urosepsis) may require prolonged IV therapy and subspecialty consultation.

B. Management

1. Neonates: Infants age <2 months with a first febrile UTI are at significantly higher risk for having a urologic abnormality.
 1. All neonates with first febrile UTI should have a RBUS and VUCG.
 - a. Ideally, VUCG should be performed after completion of antibiotic therapy. However, if it must be completed while

inpatient, it is recommended to perform once the patient is afebrile.

2. Infants 2-24 months
 1. RBUS should be completed after the first febrile UTI.
 - a. Ideally, RBUS should be performed after treatment of UTI to limit false positive findings.
 2. VCUG should be completed if RBUS is abnormal.
 - a. Abnormal RBUS findings include hydronephrosis, hydroureter, abnormal bladder, or abnormal kidneys.
 - b. VCUG should be performed after second febrile UTI if the initial RBUS was abnormal.
3. Children and adolescents: There are no standard national or international guidelines in the follow-up management of UTI in children 2 years of age or older.
 1. Consider RBUS if a child has recurrent UTIs, UTI with atypical organisms, or does not respond as expected to appropriate therapy.
 2. VCUG should be considered in children with abnormal RBUS and/or recurrent febrile UTIs refractory to management of voiding dysfunction.

III. Prevention and Education

- A. Voiding dysfunction (bowel and bladder dysfunction) is the most common cause of recurrent UTIs. It is most common in children undergoing toilet-training and school-aged children.
 1. Voiding dysfunction is the state of incomplete bladder emptying, often related to the presence of constipation and/or prolonged urinary withholding.
 2. Children should be screened for infrequent voiding, constipation, encopresis, enuresis, or difficulty with toilet training.
 3. Treatment is centered on frequent, timed voiding every 2-3 hours while awake, focus on complete bladder emptying, and aggressive constipation management.
 4. In severe cases, pelvic floor physical therapy can be employed with good effect.
- B. Prophylactic antibiotics are recommended to be used selectively in children with UTI. The use of antibiotic prophylaxis carries a risk of the development of resistant organisms. It has been shown to reduce the number of recurrent febrile UTIs, but may not reduce the risk of renal scarring.
 1. Children who may benefit from antibiotic prophylaxis
 1. Children with high-grade vesicoureteral reflux (grade 4-5)
 2. Infants with urinary tract abnormalities and a history of complicated UTI
 3. Recurrent febrile UTI with evidence of renal scarring
 2. Choice of prophylactic antibiotics should be based on history of organisms and sensitivities
 1. Neonates: Amoxicillin or cephalixin
 2. Infants and children: Sulfamethoxazole-trimethoprim, amoxicillin, cephalixin, nitrofurantoin
- C. Indications for subspecialty referral (e.g. nephrology, urology)
 1. Children with urinary tract or renal abnormalities on imaging
 2. Presence of renal dysfunction
 3. Complicated UTI
 4. Ongoing recurrent UTI despite aggressive management of voiding dysfunction in toilet-trained children

References

- AAP Subcommittee on Urinary Tract Infection. Urinary Tract Infection: Clinical Practice Guideline for the Diagnosis and Management of the Initial UTI in Febrile Infants and Children 2 to 24 Months. *Pediatrics*. 2011;128(3):595-610.
- AAP Subcommittee on Urinary Tract Infection. Reaffirmation of AAP Clinical Practice Guideline: The Diagnosis and Management of the Initial Urinary Tract Infection in Febrile Infants and Young Children 2–24 Months of Age. *Pediatrics*. 2016;138(6):e20163026.
- Farhat W, Bagli DJ, Capolicchio G, et al. The dysfunctional voiding scoring system: quantitative standardization of dysfunctional voiding symptoms in children. *J Urol* 2000;164(3 Pt 2):1011-5
- Keren R, Shaikh N, et al. Risk factors for recurrent urinary tract infection and renal scarring. *Pediatrics* 2015; 136(1).
- Korbel L, Howell M, Spencer JD. The Clinical Diagnosis and Management of Urinary Tract Infections in Children and Adolescents. *Paediatrics and International Child Health*. 2017;37(4):273-279.
- Mattoo TK, Chesney RW, et al. Renal scarring in the randomized intervention for children with vesicoureteral reflux (RIVUR) trial. *Clin J Am Soc Nephrol* 2016; 11(1):54-61.
- North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS). 2008 Annual report: Renal transplantation, dialysis, chronic renal insufficiency.
- North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS). 2011 Annual report: Renal transplantation.
- RIVUR Trial investigators. Antimicrobial prophylaxis for children with vesicoureteral reflux. *N Engl J Med* 2014; 370(25): 2367-2376.
- Shaikh N et al. Development and Validation of a Calculator for Estimating the Probability of Urinary Tract Infection in Young Febrile Children. *JAMA Pediatrics*. 2018;172(6):550-556.
- Subcommittee on UTI, steering committee on quality improvement and management, Roberts KB. Urinary tract infection: Clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2-24 months. *Pediatrics* 2011; 128(3):595-610.
- Shaikh N, et al. Recurrent urinary tract infections in children with bladder and bowel dysfunction. *Pediatrics* 2016; 137(1).