Urinary tract infections in infants and children older than one month: Clinical features and diagnosis

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INTRODUCTION — Urinary tract infections (UTI) are a common and important clinical problem in childhood. Upper urinary tract infections (ie, acute pyelonephritis) may lead to renal scarring, hypertension, and end-stage renal disease. Although children with pyelonephritis tend to present with fever, it is often difficult on clinical grounds to distinguish cystitis from pyelonephritis, particularly in young children (those younger than two years) [1]. As a result, we have defined UTI broadly here without attempting to distinguish cystitis from pyelonephritis. Acute cystitis in older children is discussed separately. (See "Acute cystitis: Clinical features and diagnosis in children older than two years and adolescents".)

The clinical features and diagnosis of UTI in children will be discussed here. The epidemiology, risk factors, and management of UTI in children and UTI in newborns (younger than one month of age) are discussed separately. (See "Urinary tract infections in children: Epidemiology and risk factors" and "Urinary tract infections in infants and children older than one month: Acute management, imaging, and prognosis" and "Urinary tract infections in children: Long-term management and prevention" and "Urinary tract infections in neonates".)

CLINICAL PRESENTATION — Urinary tract infections (UTI) may present with nonspecific symptoms and signs, particularly in infants and young children.

Younger children — In a meta-analysis of the diagnostic accuracy of the symptoms and signs of UTI in children younger than two years, the following findings were the most helpful in identifying children with UTI [2]:

- History of UTI (likelihood ratio [LR] 2.3)
- Temperature >40ºC (LR 3.2)
- Suprapubic tenderness (summary LR 4.4)
- Lack of circumcision (summary LR 2.8)
- Fever >24 hours (summary LR 2.0)

Absence of another source for fever (eg, upper respiratory tract infection, otitis media) alone was not particularly helpful in ruling in UTI (summary LR 1.4). Similarly, presence of another source of fever did not rule out UTI (summary LR 0.69). Black children were less likely to have UTI (LR 0.52).

Combinations of signs and symptoms were more useful than individual signs for identifying children with and without UTI [2]:

- Temperature >39ºC for ≥48 hours in absence of another source for fever (LR 4.0)
- Temperature <39ºC and presence of another source for fever (LR 0.37)

Likelihood ratios are discussed separately. (See "Evaluating diagnostic tests", section on 'What are the positive and negative likelihood ratios?'.)

- **Fever** – Several prospective studies have shown that infants and children younger than two years can present with fever as the sole manifestation of UTI [3-5].

  The prevalence of UTI is greater among infants and young children with maximum temperatures ≥39ºC than in those with lesser degrees of fever (16 versus 7 percent for infants ≤60 days, and 4 versus 2 percent for

children <2 years) [4,5]. (See "Urinary tract infections in children: Epidemiology and risk factors", section on 'Prevalence'.)

The presence of another potential source of fever (upper respiratory tract infection, acute otitis media, acute gastroenteritis) does not rule out the possibility of UTI. In studies of UTI in young children who presented to the emergency department with fever, the prevalence of UTI in children with and without another potential source of fever on examination ranged from 2 to 3 percent and 6 to 8 percent, respectively [4,6]. This highlights the importance of obtaining urine cultures in febrile infants and young children without a definite source for fever. (See "Fever without a source in children 3 to 36 months of age" and "Evaluation and management of fever in the neonate and young infant (younger than three months of age)".)

- **Other symptoms** – Less common symptoms of UTI in infants include conjugated hyperbilirubinemia (in those <28 days), irritability, poor feeding, or failure to thrive [7]. (See "Urinary tract infections in neonates".)

  Parental reporting of foul-smelling urine or gastrointestinal symptoms (vomiting, diarrhea, and poor feeding) is generally not helpful in diagnosing UTI [2,8,9].

Older children — Symptoms of UTI in older children may include fever, urinary symptoms (dysuria, urgency, frequency, incontinence, macroscopic hematuria), and abdominal pain [10-12]. The constellation of fever, chills, and flank pain is suggestive of pyelonephritis in older children [7].

Occasionally, older children may present with short stature, poor weight gain, or hypertension (calculator 1 and calculator 2) secondary to renal scarring from unrecognized UTI earlier in childhood [13]. Suprapubic tenderness and costovertebral angle tenderness may be present on examination of older children with UTI.

In a meta-analysis of the diagnostic accuracy of the symptoms and signs of UTI in verbal children, the following symptoms and signs were the most helpful in identifying children with UTI [2]:

- Abdominal pain (LR 6.3)
- Back pain (LR 3.6)
- Dysuria, frequency, or both (LR 2.2)
- New-onset urinary incontinence (LR 4.6)

Likelihood ratios are discussed separately. (See "Evaluating diagnostic tests", section on 'What are the positive and negative likelihood ratios?'.)

CLINICAL EVALUATION — Children with urinary tract infection (UTI) symptoms should be evaluated promptly. Prompt recognition and treatment of UTI is an important factor in the prevention of renal scarring. (See "Urinary tract infections in children: Epidemiology and risk factors", section on 'Risk factors for renal scarring'.)

History — The history of the acute illness should include documentation of the height and duration of fever, urinary symptoms (dysuria, frequency, urgency, incontinence), abdominal pain, suprapubic discomfort, back pain, vomiting, recent illnesses, antibiotics administered, and, if applicable, sexual activity.

The past medical history should include risk factors for UTI, including:

- Chronic urinary symptoms – Incontinence, lack of proper stream, frequency, urgency, withholding maneuvers (suggestive of bladder dysfunction)
- Chronic constipation
- Previous UTI or previous undiagnosed febrile illnesses in which urine culture was not obtained
- Vesicoureteral reflux (VUR)
- Family history of frequent UTI, VUR, and other genitourinary abnormalities
- Antenatally diagnosed renal abnormality
- In sexually active girls, whether barrier contraception with spermicidal agents is used (such methods predispose to UTI by altering the normal vaginal flora [14])

(See "Urinary tract infections in children: Epidemiology and risk factors", section on 'Host factors'.)

The past medical history should also include information about chronic sequelae of UTI, including:

- Poor growth
- Elevated blood pressure

Physical examination — Important aspects of the physical examination in the child with suspected UTI include [2,15,16]:

- Documentation of blood pressure and temperature; temperature ≥39°C (102.2°F) is associated with renal scarring (odds ratio 2.3, 95% CI 1.6-3.3) [17]; elevated blood pressure may be an indication of chronic or recurrent UTI
- Growth parameters (poor weight gain and/or failure to thrive may be an indication of chronic or recurrent UTI)
- Abdominal examination for tenderness; suprapubic tenderness is associated with UTI
- Abdominal examination for mass (eg, enlarged bladder or enlarged kidney secondary to urinary obstruction, palpable stool in colon) [15]; urinary obstruction and constipation predispose to UTI
- Assessment of suprapubic and costovertebral tenderness, a sign of acute UTI
- Examination of the external genitalia for anatomic abnormalities (eg, phimosis or labial adhesions) and signs of vulvovaginitis, vaginal foreign body, sexually transmitted diseases (STDs), which may predispose to UTI (see "Vulvovaginal complaints in the prepubertal child")
- Evaluation of the lower back for signs of occult myelodysplasia (eg, midline pigmentation, lipoma, vascular lesion, sinus, tuft of hair), which may be associated with a neurogenic bladder and recurrent UTI
- Evaluation for other sources of fever; another source of fever decreases the risk of UTI, but does not eliminate it altogether (see "Fever without a source in children 3 to 36 months of age" and "Evaluation and management of fever in the neonate and young infant (younger than three months of age)")

LABORATORY EVALUATION — The laboratory evaluation for the child with suspected UTI includes obtaining a urine sample for a dipstick and/or microscopic evaluation and urine culture. Pyuria and significant bacteriuria on urine culture are necessary to make the diagnosis. (See 'Diagnosis of UTI' below.)

Urine sample

Decision to obtain — The decision to obtain a urine sample for culture is best made on a case-by-case basis, taking into consideration the age, sex, circumcision status, and the presenting signs and symptoms (table 1 and algorithm 1A-C).

Other considerations include the feasibility of follow-up, parental views toward catheterization (if catheterization is necessary), potential harm of not diagnosing an episode of UTI, harm of incorrectly diagnosing UTI, cost and availability of testing, and benefits of early treatment. (See "Urinary tract infections in infants and children older than one month: Acute management, imaging, and prognosis", section on 'Overview'.)

The clinician can use the patient's demographic and clinical characteristics to estimate the probability of UTI. As an example, consider a nine-month-old, well-appearing white girl with a temperature of 39.2ºC and no definite source. The clinician can inform the parents that their daughter has an approximately 1 in 5 chance of having a serious but treatable infection (table 1), and recommend that a catheterized urine specimen be obtained.

Urine samples for urinalysis (dipstick and microscopic examination) and culture are generally indicated in the following patients [2,18-20]:

- Girls and uncircumcised boys younger than two years with at least one risk factor for UTI (history of UTI,

temperature >39ºC, fever without apparent source [particularly if the child will be treated with antibiotics], ill appearance, suprapubic tenderness, fever >24 hours, or nonblack race)

- Circumcised boys younger than two years with suprapubic tenderness or at least two risk factors for UTI (history of UTI, temperature >39ºC, fever without apparent source [particularly if the child will be treated with antibiotics], ill appearance, suprapubic tenderness, fever >24 hours, or nonblack race)
- Girls and uncircumcised boys older than two years with any of the following urinary symptoms: abdominal pain, back pain, dysuria, frequency, high fever, or new-onset incontinence
- Circumcised boys older than two years with multiple urinary symptoms (abdominal pain, back pain, dysuria, frequency, high fever, or new-onset incontinence)
- Febrile infants and children with abnormalities of the urinary tract or family history of urinary tract disease

How to obtain — Catheterization or suprapubic aspiration is the preferred method of urine collection for dipstick, microscopic examination, and culture of the urine in infants and young children who are not toilet-trained. A clean-voided specimen is the preferred method of collection in toilet-trained children. (See "Urine collection techniques in infants and children with suspected urinary tract infection".)

All urine specimens should be examined as soon as possible after collection. A delay of even a few hours increases both the false-positive and false-negative rates substantially [21].

We generally suggest catheterized urine samples for children who are not toilet-trained; the sensitivity and specificity of catheterized specimens for urine culture are 95 and 99 percent, respectively, when compared with suprapubic specimens [21]. Nonetheless, suprapubic aspiration is a relatively straightforward procedure, and complications are rare [22]. We specifically recommend a suprapubic aspirate when:

- Catheterization is not feasible (eg, severe phimosis or penile adhesions in boys; labial adhesions in girls)
- Results from a catheterized specimen are inconclusive (eg, repeated contaminated specimen or repeated low colony counts)

We recommend that urine obtained in a sterile bag **not** be used for culture. Up to 85 percent of positive cultures from bag urine specimens represent false-positive results [21]; results of urine cultures from bag specimens are useful only if they are negative. The high false-positive rate of bag specimens can lead to unnecessary and even harmful interventions [23]. (See "Urine collection techniques in infants and children with suspected urinary tract infection".)

We also suggest that bag urine specimens not be used for dipstick or microscopic analysis. However, others suggest that bag urine samples can be used as a first step to determine whether a catheterized urine sample should be obtained for culture in young children [18,20,24]. This approach is not recommended in ill-appearing patients or in patients who require antibiotics immediately after the urine specimen is collected [16].

Rapidly available tests — The accuracy of the various diagnostic tests in predicting significant bacteriuria on culture has been the subject of two meta-analyses [25,26]. The sensitivity, specificity, and likelihood ratios of rapidly available tests to diagnose UTI in children are summarized in the table (table 2).

Dipstick analysis — Dipstick tests are convenient, inexpensive, and require little training for proper usage; they may be the only test available in some settings. However, they will likely miss some children with UTI (at best they are 88 percent sensitive) (table 2) [26]. Because the sensitivity of dipstick analysis is less than 100 percent, we suggest that a urine culture be obtained in children with suspected UTI who have a negative dipstick test. (See 'Urine culture' below.)

- Leukocyte esterase – Positive leukocyte esterase on dipstick analysis is suggestive of UTI. However, a positive leukocyte esterase test does not always signal a true UTI because WBCs may be present in the urine in other conditions (eg, Kawasaki disease). (See 'Pyuria' below.). In a two-year-old circumcised boy with

a positive leukocyte esterase test, for example, the probability of UTI is <4 percent, based upon the following calculation:

Post-test probability = Pretest probability x the positive likelihood ratio

In this example, the pretest probability is <1 percent (table 1) and the positive likelihood ratio is 4 (table 2), which results in a post-test probability of <4 percent. Likelihood ratios are discussed separately. (See "Evaluating diagnostic tests", section on 'What are the positive and negative likelihood ratios?'.)

- Nitrite – A child with a positive nitrite test is likely to have a UTI. The nitrite test is highly specific, with a low false-positive rate (table 2). However, false-negative tests are common, because urine needs to remain in the bladder for at least four hours to accumulate a detectable amount of nitrite. Thus, a negative nitrite test does not exclude a UTI (table 2).

Microscopic exam — Microscopic examination requires more equipment and training than dipstick tests. In standard microscopy, a centrifuged sample of unstained urine is examined for white blood cells (WBC) and bacteria. When performed in this way, pyuria is defined as ≥5 WBC/high power field (hpf) and bacteriuria as the presence of any bacteria per hpf. The sensitivity, specificity, and likelihood ratios are summarized in the table (table 2). Because the sensitivity of the standard microscopic examination conducted using a centrifuged urine specimen is at best 81 percent, we suggest that a urine culture be obtained in children with suspected UTI who have a negative standard microscopic examination. (See 'Urine culture' below.)

The accuracy of microscopic analysis is improved by using [25-27]:

- An uncentrifuged specimen
- A hemocytometer (results reported as WBC/mm^3)
- A Gram-stained smear

Examination of a catheterized urine sample using these three techniques, which are available at some academic centers, has been called an "enhanced urinalysis" [27]. When using the enhanced urinalysis, pyuria is defined by ≥10 WBC/mm^3 and bacteriuria by any bacteria per 10 oil immersion fields of a Gram-stained smear.

In young children in whom the prompt diagnosis and treatment of UTI are paramount, the enhanced urinalysis offers the best combination of sensitivity and specificity (table 2) [25,28,29]. However, enhanced urinalysis is not available in many outpatient settings.

Urine culture — Urine culture is the standard test for the diagnosis of UTI. We suggest that urine culture be performed routinely for all children in whom UTI is a diagnostic consideration and in whom a sample for urinalysis or dipstick is collected. Catheterization or suprapubic aspiration is the preferred method of urine collection for culture in infants and children who are not toilet-trained. A clean-voided specimen is the preferred method of collection in toilet-trained children. (See 'Decision to obtain' above and 'How to obtain' above.)

Urine obtained for culture should be processed as soon as possible after collection. A delay of even a few hours increases both the false-positive and false-negative rates substantially [21].

Other laboratory tests — Other laboratory tests are not particularly helpful in the diagnosis of UTI and are not routinely necessary in children with suspected UTI. (See "Evaluation and management of fever in the neonate and young infant (younger than three months of age)" and "Fever without a source in children 3 to 36 months of age".)

- Markers of inflammation – We do not routinely obtain markers of inflammation in the evaluation of children with suspected UTI. Erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and procalcitonin (PCT) are indicators of an acute inflammatory process.

  Although some studies have shown that these markers are associated with upper tract infection, they do not reliably differentiate between children with cystitis and children with pyelonephritis because of their low sensitivity and/or specificity. In a 2015 meta-analysis of studies evaluating the accuracy of PCT, CRP, and

ESR in predicting DMSA-confirmed pyelonephritis in children (0 to 18 years) with culture-confirmed UTI, sensitivity ranged from 86 to 95 percent and specificity from 38 to 71 percent [30]. Although CRP <20 mg/L (2 mg/dL) appeared to be helpful in excluding pyelonephritis and procalcitonin >0.5 ng/mL (0.5 mcg/L) appeared to be helpful in confirming pyelonephritis, methodologic limitations (eg, small number of studies, unexplained heterogeneity) prevented definitive conclusions. Thus, we do not find any compelling evidence to recommend the routine use of any of these tests in clinical practice.

A meta-analysis of individual patient data from nine studies including 1280 children (0 to 18 years) who underwent renal scintigraphy at least five months after their first UTI found that polymorphonuclear count >60 percent and CRP >40 mg/L were associated with increased risk of renal scarring [17]. However, the blood tests contributed only minimally when added to models for predicting renal scarring that included temperature, etiologic agent, and renal bladder ultrasonography and/or VCUG.

- Serum creatinine – Measurement of serum creatinine is not routinely necessary in children with suspected UTI. However, we suggest that serum creatinine be measured in children with a history of multiple UTI and suspected renal involvement.

- Blood culture – Bacteremia occurs in 4 to 9 percent of infants with UTI [13,31-36]. Fever in bacteremic infants with UTI persists, on average, one day longer than in non-bacteremic infants with UTI [37]. However, a positive blood culture does not alter management in the vast majority of children because usually the same organism is isolated from the blood and urine.

  Accordingly, we do not routinely obtain a blood culture in children older than two months of age who have UTI and do not require blood culture for other reasons. (See "Evaluation and management of fever in the neonate and young infant (younger than three months of age)" and "Fever without a source in children 3 to 36 months of age".)

- Lumbar puncture – Lumbar puncture generally is not warranted in infants and children older than one month with UTI. Lumbar puncture in infants younger than one month with UTI is discussed separately. (See "Urinary tract infections in neonates".)

DIAGNOSIS OF UTI

Overview — Quantitative urine culture is the standard test for the diagnosis of UTI. UTI is best defined as **significant bacteriuria** in a patient with **pyuria** (ie, evidence of an inflammatory response).

Significant bacteriuria — What constitutes significant bacteriuria depends upon the method of collection and the identification of the isolated organism [20]. Lactobacillus spp, coagulase-negative staphylococci, and *Corynebacterium* spp are not considered clinically relevant uropathogens [20].

- Clean voided sample – We define significant bacteriuria from a clean voided urine specimen in children as growth of ≥100,000 colony forming units (CFU)/mL of a uropathogenic bacteria. This is the same as the standard definition for significant bacteriuria on clean catch specimens in adults, which is based upon studies from the 1950s [38].

- Catheter sample – We define significant bacteriuria from catheterized specimens in children as growth of ≥50,000 CFU/mL of a uropathogenic bacteria [20]. In a prospective study of febrile children <24 months of age, catheterized urine samples with 10,000 to 50,000 CFU/mL were more likely than specimens with ≥50,000 CFU/mL to yield gram-positive organisms (excluding enterococci) or mixed organisms than those with ≥50,000 CFU/mL (65 versus 17 percent) [39].

  We suggest that children who have growth of 10,000 to 50,000 CFU/mL from an initial catheterized specimen have a repeat urine culture. We consider such children to have UTI if the second culture grows ≥10,000 CFU/mL and pyuria is present on dipstick or microscopic urinalysis.

- Suprapubic sample – We define significant bacteriuria from suprapubic aspiration specimens as the growth of any uropathogenic bacteria (the growth of one colony on the plate is equivalent to 1000 CFU/mL).

False negatives — False-negative results in children with UTI (eg, failure to meet the definitions of significant bacteriuria described above) may occur under the following circumstances [6,39]:

- A bacteriostatic antimicrobial agent is present in the urine
- Rapid rate of urine flow with reduced incubation time
- Obstruction of the ureter that interferes with the discharge of bacteria into the bladder

In such cases, when the urine culture will not provide definitive results, renal scintigraphy may be helpful in establishing the diagnosis of acute pyelonephritis. (See "Urinary tract infections in infants and children older than one month: Acute management, imaging, and prognosis", section on 'Renal scintigraphy'.)

Pyuria — The presence of WBC in the urine is not specific for UTI. However, true UTI without pyuria (eg, positive leukocyte esterase on dipstick analysis, ≥5 WBC/hpf with standardized microscopy, or ≥10 WBC/mm^3 on a hemocytometer with an enhanced urinalysis) is unusual [16].

The absence of pyuria in the presence of significant bacteriuria may occur under the following circumstances [20,40]:

- Early in the course of UTI (before the local inflammatory response develops)
- Colonization of the urinary tract (eg, asymptomatic bacteriuria)

In children who are suspected of having UTI but in whom pyuria is not detected on dipstick or microscopic analysis, repeating the urinalysis and urine culture can help to distinguish between early infection and colonization (algorithm 2) [6]:

- Pyuria and bacteriuria on the second sample is suggestive of UTI
- The absence of pyuria and bacteriuria on the second sample is suggestive of bacterial contamination of the initial sample
- Bacteriuria without pyuria on the second sample is suggestive of asymptomatic bacteriuria

DIFFERENTIAL DIAGNOSIS

Asymptomatic bacteriuria — Asymptomatic bacteriuria (ie, colonization of the urinary tract with bacteria in the absence of inflammation) occurs in 1 to 3 percent of infants and preschool age children, and approximately 1 percent of older children [41,42]. The bacteria tend to be of low virulence and are easily eliminated by antibiotics. However, in most children, asymptomatic bacteriuria resolves spontaneously without causing renal scarring, decreased filtration rate, or interfering with renal growth [43-45].

We do not recommend antibiotic treatment of asymptomatic bacteria in children. A meta-analysis of three randomized trials found the evidence insufficient to determine the risks and benefits, but concluded that antibiotic therapy is unlikely to benefit children in the long-term [46].

Other considerations — The differential diagnosis in a child with suspected urinary tract infection (UTI) depends upon the presenting symptoms and signs.

- The differential diagnosis of a well-appearing infant who has fever without a definite source is extensive, but most commonly includes UTI and occult bacteremia. In children vaccinated against *Haemophilus influenzae* and *Streptococcus pneumoniae*, the probability of UTI (7 percent) is much higher than the probability of occult bacteremia (<1 percent) [2,47-49]. (See "Fever without a source in children 3 to 36 months of age".)

- Urinary symptoms (eg, urgency, frequency, dysuria) and bacteriuria may be caused by nonspecific vulvovaginitis, irritant (or chemical) urethritis (eg, bubble baths), urinary calculi, urethritis secondary to a sexually transmitted disease (STD) (particularly Chlamydia), and vaginal foreign body. (See "Evaluation of

dysuria in children and adolescents" and "Vulvovaginal complaints in the prepubertal child" and "Clinical features and diagnosis of nephrolithiasis in children".)

- Patients with group A streptococcal infection, appendicitis, and Kawasaki disease may present with fever, abdominal pain, and pyuria. (See "Acute appendicitis in children: Clinical manifestations and diagnosis" and "Kawasaki disease: Clinical features and diagnosis".)
- Bowel and bladder dysfunction is a frequently overlooked diagnosis in children with urinary symptoms and a negative urine culture. (See "Urinary tract infections in children: Epidemiology and risk factors", section on 'Bowel and bladder dysfunction'.)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topic (see "Patient information: Urinary tract infections in children (The Basics)")
- Beyond the Basics topic (see "Patient information: Urinary tract infections in children (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Fever may be the only sign of urinary tract infection (UTI) in infants and young children. Older children may have urinary symptoms (eg, abdominal pain, back pain, dysuria, frequency, new-onset urinary incontinence). (See 'Clinical presentation' above.)
- Important aspects of the history in a child with suspected UTI include features of the acute illness (eg, fever, urinary symptoms) and risk factors for UTI (table 1). (See 'History' above and "Urinary tract infections in children: Epidemiology and risk factors", section on 'Host factors'.)
- The examination of the child with suspected UTI should include measurement of blood pressure, temperature, and growth parameters; abdominal examination for tenderness or mass; assessment of suprapubic and costovertebral tenderness; examination of the external genitalia; evaluation of the lower back for signs of occult myelodysplasia; and a search for other sources of fever. (See 'Physical examination' above.)
- The laboratory evaluation for the child with suspected UTI includes obtaining a urine sample for a dipstick and/or microscopic evaluation and urine culture (table 2). Urine culture is necessary to make the diagnosis. (See 'Laboratory evaluation' above.)
- We suggest that urine samples be obtained for urinalysis and culture in the following patients (algorithm 1A-C) (see 'Decision to obtain' above):
    - Girls and uncircumcised boys younger than two years with at least one risk factor for UTI (history of UTI, temperature >39ºC, fever without apparent source [particularly if the child will be treated with antibiotics], ill appearance, suprapubic tenderness, fever >24 hours, or nonblack race).
    - Circumcised boys younger than two years with suprapubic tenderness or at least two risk factors for UTI (history of UTI, temperature >39ºC, fever without apparent source, ill appearance, suprapubic tenderness, fever >24 hours, or nonblack race).

- Girls and uncircumcised boys older than two years with any of the following urinary or abdominal symptoms (abdominal pain, back pain, dysuria, frequency, high fever, or new-onset incontinence).
- Circumcised boys older than two years with multiple urinary symptoms (abdominal pain, back pain, dysuria, frequency, high fever, or new-onset incontinence).
- Febrile infants and children with abnormalities of the urinary tract or family history of urinary tract disease.

- Catheterization is the preferred method of urine collection for infants and children who are not toilet-trained. Clean catch is the preferred method of collection for toilet-trained children. We recommend that urine obtained in a sterile bag not be used for culture. (See 'How to obtain' above.)
- We suggest that urine culture be performed routinely for all children in whom UTI is a diagnostic consideration and in whom a sample for urinalysis or dipstick is collected. (See 'Urine culture' above.)
- The diagnosis of UTI requires laboratory confirmation. UTI is best defined as significant bacteriuria in a patient with pyuria on dipstick or microscopic urinalysis. We define significant bacteriuria as recovery of ≥100,000 CFU/mL of a uropathogen from a clean catch specimen, ≥50,000 CFU/mL of a uropathogen from a catheterized specimen, and any uropathogenic bacteria from a suprapubic aspirate. (See 'Significant bacteriuria' above.)

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Topic 5990 Version 25.0

GRAPHICS

Prevalence of urinary tract infection in febrile* infants and children by demographic group

Demographic group	Prevalence or pretest probability (95% CI)
0 to 3 months	**7.2 percent (5.8-8.6)**
Girls	7.5 percent (5.1-10)
Circumcised boys	2.4 percent (1.4-3.5)
Uncircumcised boys	20.1 percent (16.8-23.4)
3 to 6 months	**6.6 percent (1.7-11.5)**
Girls	5.7 percent (2.3-9.4)
Boys	3.3 percent (1.3-5.3)
6 to 12 months	**5.4 percent (3.4-7.4)**
Girls	8.3 percent (3.9-12.7)
Boys	1.7 percent (0.5-2.9)
12 to 24 months	**4.5 percent¶**
Girls	2.1 percent (1.2-3.6)
Circumcised boys >1 year	<1 percent¶
<19 years with urinary symptoms and/or fever Δ	**7.8 percent (6.6-8.9)**

* Temperature ≥38°C.

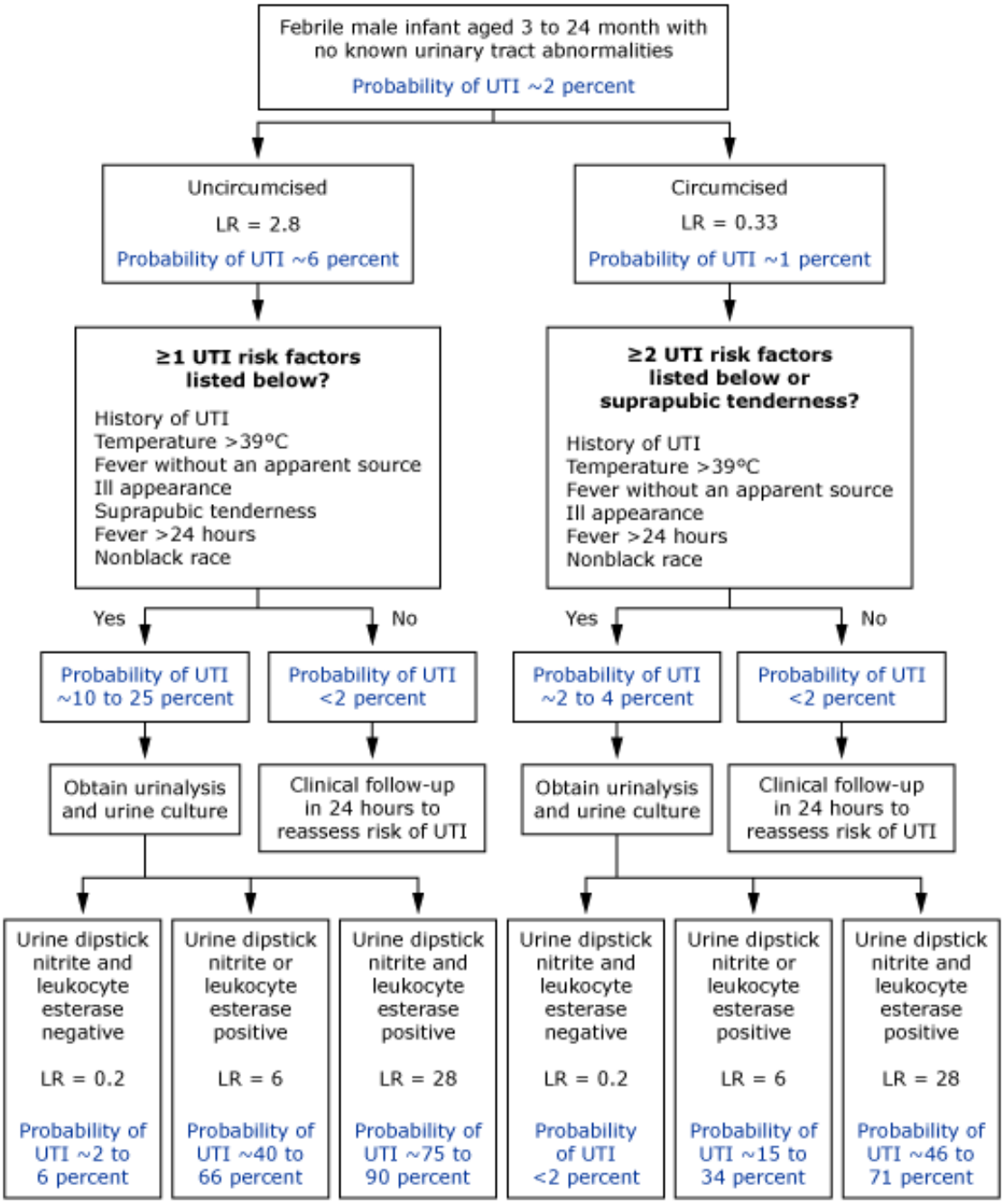
¶ 95% confidence interval not available.

Δ Most of these children were older than two years.

Data from: Shaikh N, Morone NE, Bost JE, Farrell MH. Prevalence of Urinary Tract Infection in Childhood: A Meta-Analysis. Pediatr Infect Dis J 2008; 27:302.

Graphic 76804 Version 6.0

Diagnostic algorithm for febrile male infants aged 3 to 24 months suspected of having a UTI



UTI: urinary tract infection; LR: likelihood ratio.

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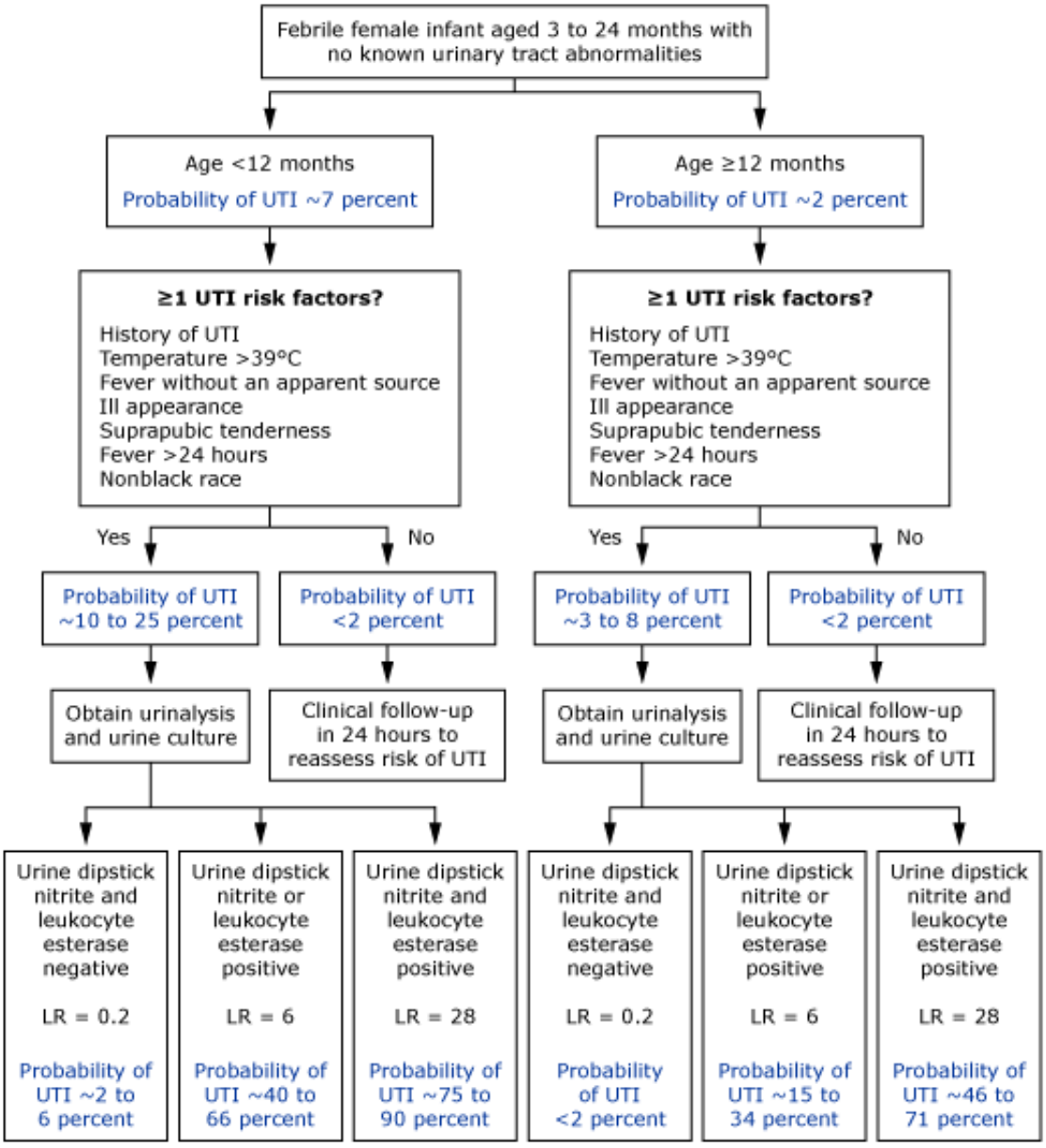
Diagnostic algorithm for febrile female infants aged 3 to 24 months suspected of having a UTI



UTI: urinary tract infection; LR: likelihood ratio.

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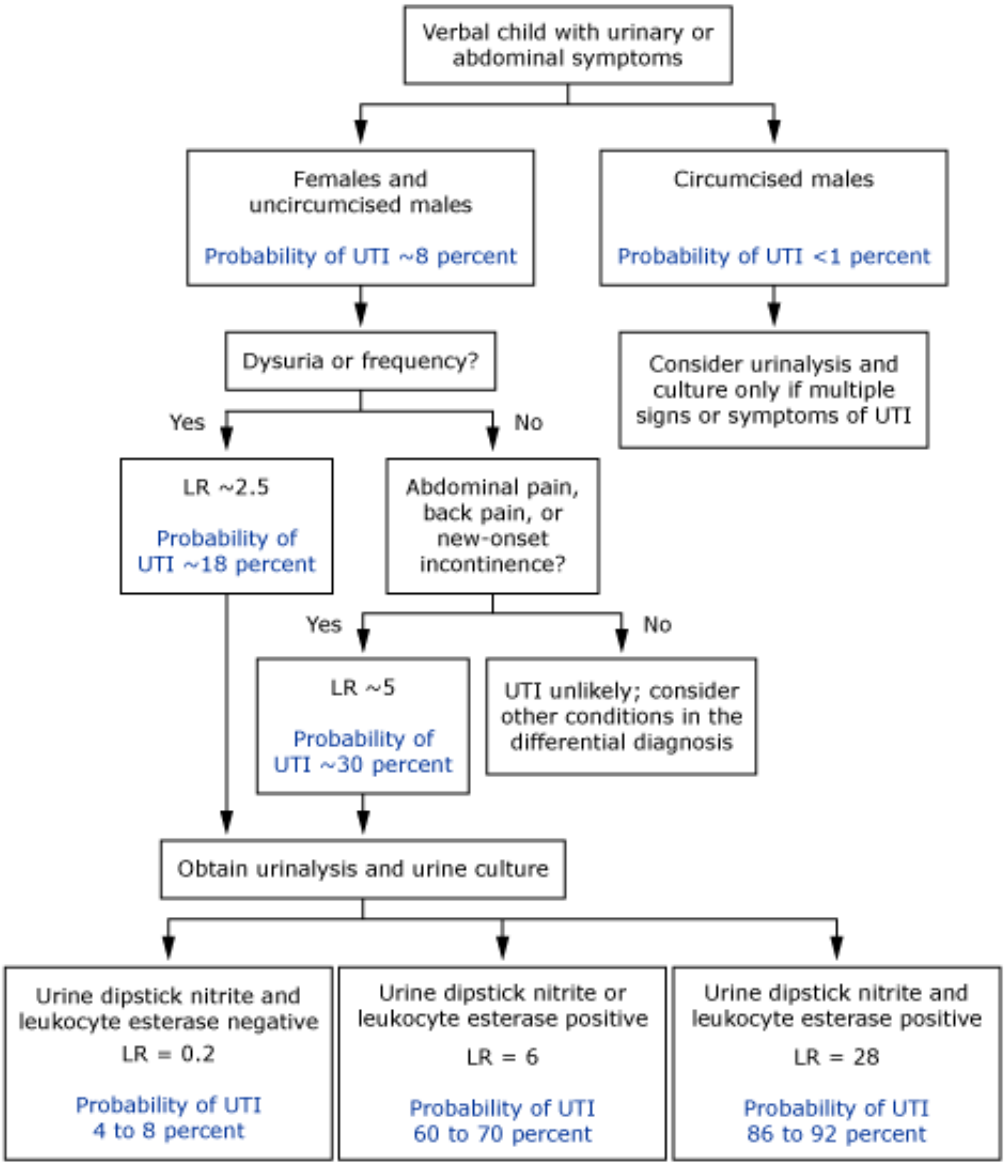
Diagnostic algorithm for verbal children older than 24 months with urinary or abdominal symptoms



UTI: bacterial urinary tract infection; LR: likelihood ratio.

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Test characteristics of tests used to diagnose urinary tract infections in children

	Sensitivity	Specificity	Positive likelihood ratio*	Negative likelihood ratio•
Dipstick				
Leukocyte esterase (LE)	84 percent	78 percent	4	0.2
Nitrite	50 percent	98 percent	25	0.5
Nitrite or LE	88 percent	93 percent	13	0.1
Nitrite and LE	72 percent	96 percent	18	0.3
Microscopy				
Uncentrifuged				
Pyuria (>10/mm^3) (all ages)	77 percent	89 percent	7	0.4
Pyuria (>10/mm^3) (<2 years)	90 percent	95 percent	18	0.1
Bacteriuria (gram stained)	93 percent	95 percent	19	0.1
Overall (P+B) = enhanced	85 percent	99.9 percent	85	0.1
Overall (P or B)	95 percent	89 percent	9	0.1
Centrifuged				
Pyuria (>5/hpf)	67 percent	79 percent	3	0.4
Bacteriuria	81 percent	83 percent	5	0.2
Overall (P+B)	66 percent	99 percent	7	0.4

P: pyuria; B: bacteriuria; hpf: high-power field.

* Positive likelihood ratio: The positive likelihood ratio is the probability that a child with a UTI will have a positive test divided by the probability that a child without a UTI will have a positive test (eg, true positive rate/false positive rate). The higher the positive likelihood ratio, the better the test.

• Negative likelihood ratio: The negative likelihood ratio is the probability that a child with a UTI will have a negative test divided by the probability that a child without a UTI will have a negative test (eg, false negative rate/true negative rate). The lower the negative likelihood ratio, the better the

test (a perfect test has a negative likelihood ratio of zero).

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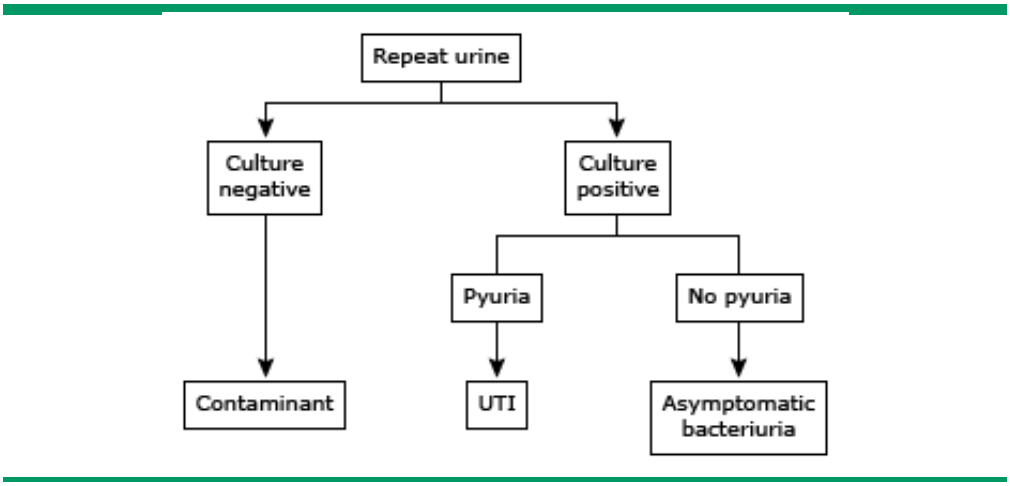
Graphic 82157 Version 6.0

Evaluation of the child with suspected urinary tract infection and initial urine with bacteriuria but no pyuria



Graphic 55592 Version 2.0

Disclosures

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