Urinary Tract Infection (UTI) v10.1: Criteria and Definition

Inclusion Criteria
- Birth to 18 years with a postmenstrual age of at least 40 weeks
- Presumed or definite first-time or recurrent UTI in an otherwise healthy child

Exclusion Criteria
- Chronic kidney disease as defined by estimated glomerular filtration rate (GFR) by the original Schwartz formula < 80 mL/min/1.73m²
- Known OR suspected genitourinary abnormalities, including: previous genitourinary surgery (other than circumcision), neurogenic bladder conditions, obstructive uropathy, vesicoureteral reflux
- Septic shock
- Presumed or definite meningitis
- Conditions requiring Intensive Care Unit care
- Immunocompromised host
- Pregnancy
- Recent history of sexual abuse

Definition of a UTI
- Clinical signs and symptoms
- UA with pyuria and/or bacteriuria
- Growth of a urinary pathogen

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Possible</th>
<th>Definite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheterization</td>
<td>≥ 10,000 cfu/mL</td>
<td>≥ 50,000 cfu/mL</td>
</tr>
<tr>
<td>Clean-catch</td>
<td>≥ 50,000 cfu/mL</td>
<td>≥ 100,000 cfu/mL</td>
</tr>
</tbody>
</table>
Obtain Urinalysis and Urine Culture by the Following Method(s)

- Infants and Non-Toilet Trained Children: Catheterization or if unable to catheterize, consider suprapubic aspiration (SPA)
- Toilet Trained Children: Midstream clean catch
- Adolescents: Midstream clean catch + ‘dirty' urine for Gonococcus (GC) / Chlamydia (Chl)

Additional Studies

- For infants 0-56 days of age
  - See Neonatal Fever pathway
- For adolescents
  - HSV testing: culture visible lesions, or cervical culture as indicated
  - If GC/Chl positive: consider Syphilis Screen
  - Annual HIV testing
  - Consider pregnancy testing in girls
- If ill appearing
  - See Septic Shock pathway

Patients 2 to 23 Months of Age

- Can also use UTICalc tool to help with decision to test
  - [https://uticalc.pitt.edu/](https://uticalc.pitt.edu/)

Risk factors and screening recommendations are adapted from CHOP's UTI pathway ([https://www.chop.edu/clinical-pathway/urinary-tract-infection-uti-febrile-clinical-pathway](https://www.chop.edu/clinical-pathway/urinary-tract-infection-uti-febrile-clinical-pathway)).
Urinary Tract Infection (UTI) v10.1: Outpatient Management

Approval & Citation

Summary of Version Changes

Explanation of Evidence Ratings

Patients 2 to 23 Months of Age
- Can also use UTICalc tool to help with decision to start antibiotics
https://uticalc.pitt.edu/

Admit Criteria

All Age Categories
- Dehydration requiring IV fluids
- Adherence risk as defined by: unable to take previously prescribed regimen, no reliable caregivers at home, inability to follow recommended care plan, or at risk for loss to follow-up
- Failed outpatient therapy as defined by: persistent clinical symptoms beyond 48 hours on appropriate therapy, or inability to maintain hydration status

Infants
- Admit all febrile patients up to 56 days of age with presumed or definite UTI

Adolescents
- Adherence risk is not an admission criteria for adolescents with cystitis

Outpatient Management: Nonfebrile Infants 29-56 days
- Give cephalaxin PO
- Consider ceftriaxone IM if concern for PO tolerance
- Follow up with primary care provider within 24 hours

Outpatient Management: Non-Toilet Trained Children, Toilet Trained Children & Adolescents
- Give cephalaxin PO OR trimethoprim/sulfamethoxazole PO (if cephalaxin allergy concern, see Beta-Lactam Antibiotic Allergy Reference)
- Consider ceftriaxone IM if concern for PO tolerance
- Follow up with primary care provider within 24 hours

Culture results follow-up
- Call family to review culture results
- Narrow coverage when sensitivities return

Criteria for Urology Referral

Go to Inpatient

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Inpatient Management: Infants 0-28 days
- Give IV ampicillin + gentamicin
  
  **If E. coli**
  - Minimum 3 days IV antibiotics
  - Consider switch to PO after 3 days if afebrile and back to baseline ≥24 hours, identification and sensitivities returned
  
  **If Non-E. coli**
  - S. aureus or Pseudomonas: consult ID
  - Other non-E. coli pathogens: consider ID consult to discuss IV duration
  
  Total IV+PO duration: 14 days

Positive Blood Culture
- **If E. coli**
  - Repeat blood culture if not clinically improved within 48 hours of starting antibiotics
  - Consider switch to PO after 3 days if meets criteria above, plus repeat blood culture negative x36 hours (if applicable)
  
  **If Non-E. coli**
  - S. aureus or Pseudomonas: repeat blood culture and consult ID
  - Other non-E. coli pathogens: repeat blood culture and consider ID consult to discuss IV duration

Positive Blood Culture
- **If E. coli**
  - Repeat blood culture if not clinically improved within 48 hours of starting antibiotics
  - Minimum 2 days IV antibiotics
  - Consider switch to PO after 2 days if meets criteria above, plus repeat blood culture negative x36 hours (if applicable)
  
  **If Non-E. coli**
  - S. aureus or Pseudomonas: repeat blood culture and consult ID
  - Other non-E. coli pathogens: repeat blood culture and consider ID consult to discuss IV duration

Discharge Criteria
- **General discharge criteria for all patients**
  - Clinical response to therapy
  - Social risk factors assessed and addressed
  - Family education provided/completed
  - Urine culture is negative on final report OR urine culture is positive and patient is on targeted antibiotics
  - Other studies for bacteremia and meningitis are negative (if applicable), or if bacteremic have completed appropriate course of IV antibiotic therapy
  - If indicated, renal ultrasound completed or scheduled
  - If indicated, VCUG scheduled
  - Consultation (e.g., urology, nephrology, ID) completed if desired

Consultation to discuss IV duration
- Repeat blood culture and consider ID
- Other non
- Total blood culture negative x 1
- Meets criteria above
- Consider switch to PO after antibiotics
- Repeat blood culture if not clinically
- Identification and sensitivities returned
- Total IV+PO duration: 14 days

Summary of Version Changes

Explanation of Evidence Ratings

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Last Updated: April 2020
Next Expected Review: February 2025
Urinary Tract Infection (UTI) v10.1: Imaging

**Patients ≤ 24 Months of Age**
- RBUS if
  - First-time febrile UTI or
  - Recurrent febrile UTI
- If stones are present, refer to Nephrolithiasis pathway

**Patients > 24 Months of Age**
- RBUS if
  - Non-E. coli UTI,
  - Recurrent febrile UTI, or
  - Atypical clinical course
- If stones are present, refer to Nephrolithiasis pathway

**Obtain Renal Bladder Ultrasound (RBUS)**
- Within 1 month or
- During acute infection if severe illness or not improving by 48 hours

**RBUS results**

**Recurrent Febrile UTI**
- Patients ≤ 12 months of age
  - Schedule VCU (regardless of RBUS results)
  - Consider Urology consult
- Patients > 12 months of age
  - Consult Urology for imaging recommendation

**Voiding Cystourethrogram (VCUG)**
- When patient is stable
- ≥ 24 hours afebrile
- Preferably after 4+ days of antibiotics

**VCUG results**

**Urinary Tract Dilation (UTD) Normal**
- No further imaging

**UTD P1**
- Repeat RBUS in 1-6 months
- If abnormalities persist on repeat RBUS, consult Urology

**UTD P2**
- Repeat RBUS in 1-3 months AND consider VCU
- Consult Urology as needed for imaging recommendations or imaging abnormalities

**UTD P3 or Kidney Size Discrepancy**
- Schedule VCU and Urology evaluation
- Start prophylactic antibiotics after acute treatment until VCU performed or Urology evaluation

**Gr I-III vesicoureteral reflux**
- Antibiotic prophylaxis not routinely recommended

**Gr IV-V vesicoureteral reflux**
- Management per Urology
**Urinary Tract Infection (UTI) v10.1: Emergency / Urgent Care**

**UTI Culture Results Decision Tree**

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**Inclusion Criteria**
- Child discharged with presumed UTI
- UCx pending

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**Concerning signs/symptoms**
- Persistent fever
- Persistent vomiting and/or abdominal pain
- Persistent dysuria
- In patients with GU abnormalities or recurrent UTIs – persistence of presenting complaints typical of prior UTIs

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**Urine Culture results**

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**Unlikely UTI**
- Negative
- Mixed flora
- < 50,000 cfu/mL from clean catch

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**Not on antibiotics**
- No call needed

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**On antibiotics**
- Call family with results
- Determine if concerning s/sx

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**Concerning s/sx**
- Stop antibiotics
- “Though the preliminary test showed your child might have a UTI, the confirmatory culture is negative and your child does NOT have a UTI at this time.”
- Continue abx and refer to PCP ASAP
- “The confirmatory culture is negative but your child is still symptomatic so your child needs to be re-evaluated by her/his doctor to make sure s/he is on the right therapy.”

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**Possible UTI**
- Abnormal UA and
- ≥ 10,000 cfu/mL from catheterization
- ≥ 50,000 cfu/mL from clean catch

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**Not on antibiotics**
- No call needed

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**On antibiotics**
- Review original s/sx
- Determine if concerning s/sx
- Discuss with provider on next steps

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**Concerning s/sx**
- On correct abx based on susceptibilities
- Call family with results

---

**Definite UTI**
- Abnormal UA and
- ≥ 50,000 cfu/mL from catheterization
- ≥ 100,000 cfu/mL from clean catch

---

**Review susceptibilities**
- Determine if targeted therapy is needed

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**On incorrect abx based on susceptibilities**
- Call family with results
- Change abx
- “The urine culture grew a bacteria that is not treated by the antibiotic your child is currently receiving. We will change the antibiotic to one that treats this bacteria”

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**No concerning s/sx**
- Stop antibiotics

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**On correct abx based on susceptibilities**
- Call family with results
- If symptoms are improving, consider remaining on original abx and contact PCP
### Urinalysis (UA) Post-Test Probability, Part 1

<table>
<thead>
<tr>
<th>Urinalysis Results (# Studies, n)</th>
<th>Gold Standard: Urine Culture</th>
<th>WBC &gt; or = 5 per HPF</th>
<th>WBC &gt; or = 10 per HPF</th>
<th>&gt; 1 bacteria per HPF</th>
<th>(-) LR Point estimate (95% CI)</th>
<th>(-) LR GRADE</th>
<th>(-) Post --test probability (%) low prevalence estimate of 5%</th>
<th>(-) Post --test probability (%) high prevalence estimate of 25%</th>
<th>(+) LR Point estimate (95% CI)</th>
<th>(+) LR GRADE</th>
<th>(+) Post --test probability (%) low prevalence estimate of 5%</th>
<th>(+) Post --test probability (%) high prevalence estimate of 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) LE Trace or greater</td>
<td>(+) Nitrte</td>
<td>(+) gram stain</td>
<td>WBC &gt; or = 5 per HPF</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>0.06 (0.00-0.08)</td>
<td>+4 High certainty</td>
<td>0 (0-0)</td>
<td>0 (0-3)</td>
<td>12.9 (11.5-14.4)</td>
<td>+4 High certainty</td>
<td>40 (38-43)</td>
<td>81 (79-83)</td>
</tr>
<tr>
<td>(+) Nitrte and WBC &gt; or = 10 per HPF (1 study, n = 4935)</td>
<td>(+) LE Trace or greater</td>
<td>(+) Nitrte</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>0.07 (0.04-0.10)</td>
<td>+4 High certainty</td>
<td>0 (0-1)</td>
<td>2 (1-3)</td>
<td>10.5 (9.4-11.6)</td>
<td>+3 Moderate certainty</td>
<td>36 (33-38)</td>
<td>78 (76-79)</td>
<td></td>
</tr>
<tr>
<td>Nitrite or LE (trace or &gt;) or WBC &gt; 5 per HPF (1 study, n = 3470)</td>
<td>(+) LE Trace or greater</td>
<td>(+) Nitrte</td>
<td>WBC &gt; or = 5 per HPF</td>
<td>0.09 (0.0-0.15)</td>
<td>+4 High certainty</td>
<td>0 (0-1)</td>
<td>3 (0-5)</td>
<td>14.8 (8.7-25.2)</td>
<td>+2 Low certainty</td>
<td>44 (31-57)</td>
<td>83 (74-89)</td>
<td></td>
</tr>
<tr>
<td>(+) Nitrte or LE (trace or &gt;) (2 studies, n = 3814)</td>
<td>(+) LE Trace or greater</td>
<td>(+) Nitrte</td>
<td>WBC &gt; or = 5 per HPF</td>
<td>0.09 (0.0-0.15)</td>
<td>+4 High certainty</td>
<td>0 (0-1)</td>
<td>3 (0-5)</td>
<td>14.8 (8.7-25.2)</td>
<td>+2 Low certainty</td>
<td>44 (31-57)</td>
<td>83 (74-89)</td>
<td></td>
</tr>
</tbody>
</table>

#### Recommended for both thresholds

- **WBC > or = 10 per HPF**
  - (+) LE Trace or greater
  - (+) Nitrte
  - (+) gram stain
  - WBC > or = 10 per HPF
  - 0.00 (0.00-0.1)
  - +4 High certainty
  - 0 (0-1)
  - 0 (0-3)
  - 12.9 (11.5-14.4)
  - +4 High certainty
  - 40 (38-43)
  - 81 (79-83)

#### Recommended based on NPV > 98% threshold:

- (+) LE (trace or >), (+) nitrte and WBC > or = 10 per HPF (1 study, n = 4935)
- Nitrite or LE (trace or >) or WBC > 5 per HPF (1 study, n = 3470)
- (+) Nitrte or LE (trace or >) (2 studies, n = 3814)
### Urinalysis (UA) Post-Test Probability, Part 2

<table>
<thead>
<tr>
<th>Urinalysis Results (# Studies, n)</th>
<th>(+) LE Trace or greater</th>
<th>(+) (-) Nitrite</th>
<th>(+) gram stain</th>
<th>(+) (-) WBC &gt; or = 5 per HPF</th>
<th>WBC &gt; or = 10 per HPF</th>
<th>&gt; 1 bacteria per HPF</th>
<th>(+) (-) LR Point estimate (95% CI)</th>
<th>(-) (-) LR GRADE</th>
<th>(-) (-) Post-test probability (low prevalence estimate of 5%)</th>
<th>(-) (-) Post-test probability (high prevalence estimate of 25%)</th>
<th>(+) (-) LR Point estimate (95% CI)</th>
<th>(+) (-) LR GRADE</th>
<th>(+) (-) Post-test probability (low prevalence estimate of 25%)</th>
<th>(+) (-) Post-test probability (high prevalence estimate of 25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Standard: Urine Culture</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>0.12 (0.09-0.18)</td>
<td>+4 High certainty</td>
<td>1 (0-1)</td>
<td>4 (3-6)</td>
<td>104.3 (74.3-146.3)</td>
<td>+4 High certainty</td>
<td>85 (80-89)</td>
<td>97 (96-98)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) LE Trace or greater</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>0.29 (0.18-0.46)</td>
<td>+2 Low certainty</td>
<td>2 (1-2)</td>
<td>9 (6-13)</td>
<td>13.9 (11.7-16.4)</td>
<td>+4 High certainty</td>
<td>42 (38-46)</td>
<td>82 (80-85)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) LE Trace or greater</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>WBC &gt; or = 10 per HPF</td>
<td>0.26 (0.07-1.02)</td>
<td>+1 Very low certainty</td>
<td>1 (0-5)</td>
<td>8 (2-25)</td>
<td>16.3 (10.4, 25.6)</td>
<td>+3 Moderate certainty</td>
<td>46 (35-57)</td>
<td>84 (78-90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) LE Trace or greater</td>
<td>0.13 (0.05-0.34)</td>
<td>+2 Low certainty</td>
<td>1 (0-2)</td>
<td>4 (2-10)</td>
<td>50 (39-62)</td>
<td>87 (80-91)</td>
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<td></td>
</tr>
<tr>
<td>WBC &gt; or = 5 per HPF and &gt; 1 bacteria per HPF in unspun sample (1 study, n = 388)</td>
<td>WBC &gt; or = 5 per HPF</td>
<td>WBC &gt; or = 5 per HPF</td>
<td>0.51 (0.36-0.72)</td>
<td>+3 Moderate certainty</td>
<td>3 (2-4)</td>
<td>15 (11-19)</td>
<td>22.1 (10.6, 45.9)</td>
<td>+3 Moderate certainty</td>
<td>54 (36-71)</td>
<td>88 (78-94)</td>
<td></td>
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</tr>
</tbody>
</table>

Recommended based on PPV > 50% threshold

- (-) LR Post-test probability (% low prevalence estimate of 5%)
- (+) LR Post-test probability (% high prevalence estimate of 25%)
- (-) LR Point estimate (95% CI)
- (+) LR Point estimate (95% CI)

(+) LE: Trace or greater

(-) LR: Point estimate (95% CI)

Grade: Very low, Low, Moderate, High certainty

Return to Diagnosis Page  |  Return to Part 1
Suprapubic Aspiration (SPA)
- SPA is an available option if there is difficulty obtaining a catheterized specimen
- Additionally, UAs may be falsely (+) in uncircumcised infant boys
- SPA may be offered to parents and performed in the following circumstances:
  - Uncircumcised infant boy with positive cath screening tests (urinalysis, microscopy)
  - Operationally difficult to obtain a catheterized specimen
- The following criteria must be met prior to performing SPA:
  - Provider with demonstrated competency available (consult Urology, Nephrology, or Neonatology for teaching or help performing SPA)
  - Ultrasound guidance available
  - With agreement of family after discussion of risks/benefits

UTI: Typical vs. Atypical Clinical Course
- Approximately 80-90% of first-time UTI is due to *E. coli*
- Patients on appropriate treatment typically improve clinically by 48 hours
- Atypical clinical course may have one or more of the following features:
  - Seriously ill
  - Poor urine flow (oliguria not due to dehydration)
  - Elevated creatinine
  - Failure to respond to treatment with suitable antibiotics within 48 hours
- In patients who have not improved by 48 hours or have an atypical clinical course, recommend renal bladder ultrasound (RBUS) during the acute infection to assess for abscess or other condition that may require acute surgical intervention
  - If RBUS negative and continued clinical concern for abscess, consider CT scan (the gold standard)
  - Consult Radiology as needed to discuss imaging options
- In the United Kingdom’s NICE UTI Guidelines, non-*E. coli* UTI and bacteremic UTI are considered “atypical UTI” because of concerns that there is a higher prevalence of urinary tract abnormalities in these patients, especially younger infants. The AAP’s UTI Guideline does not make this distinction.
Empiric Antibiotic Choice
- Overuse of broad spectrum antibiotics has led to emergence of resistant *E. coli* and other Gram-negatives
- ~80% of first-time UTIs are due to *E. coli*
- 3rd generation cephalosporins, such as oral cefixime, are NOT recommended as first-line empiric therapy
- Narrow spectrum (1st generation) cephalosporin, such as cephalexin, is recommended
  - Cephalosporins should not be used where enterococci are suspected, due to intrinsic resistance
  - If cephalexin allergy concern, see Beta-Lactam Antibiotic Allergy Reference
- Antibiotic therapy should always be targeted to the sensitivities of the organism when those sensitivities are known

Rationale for Cephalexin
- Cephalexin is highly concentrated in the urine (~100 fold)
- Cephalexin is approximately 10 times less expensive than 2nd and 3rd generation cephalosporins
- Most *E. coli* are susceptible to cephalexin (=cefaazolin) in the urine, even when susceptibility testing based on treatment for bloodstream infections report intermediate or resistant susceptibility
- Some children would be expected to respond to treatment with cephalexin even when their urinary isolate was reported intermediate or resistant to cefazolin
- Questions can be directed to the ID service if questions about antibiotic choice for resistant organisms

MIC Breakpoints for Cefazolin
- In January 2011, the Clinical and Laboratory Standards Institute (CLSI) published new minimum inhibitory concentration (MIC) breakpoints for cefazolin against Enterobacteriaceae
- These new breakpoints were largely based on data from bloodstream infections in adults
- Following adoption of this new standard in March 2011, Seattle Children's antibiograms gave the false impression that intrinsic resistance of *E. coli* to cefazolin was increasing
- Because of this, the Microbiology lab now includes a comment for *E. coli* isolates from the urine discussing this issue
Criteria for Urology Referral

- Children with recurrent febrile UTIs
- Abnormal imaging: anatomic abnormality detected on ultrasound or VCUG, including complex congenital urologic problems such as:
  - Renal parenchymal loss or kidney size discrepancies
  - Ureterocele
  - Bladder or cloacal extrophy
  - Any grade vesicoureteral reflux with febrile UTI
  - Posterior urethral valves
  - Other structural abnormalities of genitourinary development, such as persistent genitourinary sinus or cloacal abnormalities
- If uncertain if patient’s medical condition requires Urology management, please consult Urology to discuss further
- DMSA Scan is an imaging study used to assess renal scarring approximately 12 months post-UTI and if needed, should be ordered via consultation with Urology

Return to Outpatient Page   Return to Inpatient Page
Urinary Tract Dilation (UTD) Classification

- The UTD grading system classifies findings seen on renal bladder ultrasounds
- See [https://www.jpurol.com/article/S1477-5131(14)00310-6/fulltext](https://www.jpurol.com/article/S1477-5131(14)00310-6/fulltext), Figure 6
- Voiding cystourethrogram is needed for definitive evaluation and grading of vesicoureteral reflux (VUR)
Antibiotic Prophylaxis Prior to VCUG

- For patients with UTD P3 results or kidney size discrepancy on RBUS, clinicians should prescribe antibiotic prophylaxis for patients until VCUG is performed or Urology evaluation has occurred
- Patients < 2 months of age
  - Amoxicillin
- Patients 2 months to 18 years of age
  - Trimethoprim-sulfamethoxazole or
  - Nitrofurantoin

Voiding Cystourethrogram (VCUG)

- VCUG is the definitive test for vesicoureteral reflux (VUR)
- Although VCUG is felt to be the best imaging study for detection of VUR, it is no longer necessary for most patients (Guideline, AAP 2016)
  - Approximate prevalences of VUR among girls 0-18 years of age
    - Grade I: 7%
    - Grade II: 22%
    - Grade III: 6%
    - Grade IV: 1%
    - Grade V: < 1%
  - Antibiotic prophylaxis is not felt to be helpful for patients with no reflux or grade I-III reflux (AAP 2016, Chand 2003)
  - This suggests that over 30 VCUGs would need to be performed to find a patient with high grade (IV-V) reflux
- VCUG is not a good study for detection of acute pyelonephritis or to delineate renal parenchymal anatomy
- VCUG is an invasive test that involves fluoroscopy; children may need sedation to tolerate the procedure
Antibiotic Prophylaxis if Vesicoureteral Reflux (VUR) is Found

- Ongoing antibiotic prophylaxis IS NOT routinely recommended for patients with first-time febrile UTI or with low grade (I-III) VUR
- Multiple randomized trials examined the relationship between the effectiveness of antibiotic prophylaxis in different patient populations; this recommendation was reaffirmed by the 2014 RIVUR study (level of evidence: +4 high certainty)
- Children with high grade VUR should be referred to Urology

Summaries of Literature Evidence for VUR Antibiotic Prophylaxis

- A trial of 338 randomized children with first febrile UTI showed no benefit of prophylaxis (Montini et al. 2008)
- A trial of 100 randomized patients showed no benefit in children under 30 months of age with grade II-IV reflux (Pennesi et al. 2008)
- A study of 225 randomized patients 1 month to 3 years of age with grade I-III reflux show no benefit of prophylaxis (Roussey-Kesler et al. 2008)
- A retrospective review suggested that recurrent UTIs were associated with high grade (IV-V) reflux, Caucasian race, and 3-5 years of age and that antibiotic prophylaxis was associated with increasing resistance of organisms (Conway et al. 2007)
- A prospective randomized study of 218 children 3 months to 18 years of age suggests that grade I-III reflux does not increase the incidence of UTI / pyelonephritis and that antibiotic prophylaxis does not appear to prevent the recurrence of UTI nor the development of renal scarring (Garin et al. 2006)
- The RIVUR study was a randomized control study that assigned children 2 to 71 months of age with grade I-IV reflux to receive placebo vs. antibiotic prophylaxis
  - The study found fewer symptomatic recurrences in the placebo group (RR: 0.55; 95% CI: 0.38-0.78) but no significant difference in renal scarring at 2 years of follow-up
  - Antimicrobial resistance rates were higher in the prophylaxis group compared to placebo (63% vs. 19%) (Hoberman et al. 2014)
Approved by the UTI Pathway team for February 20, 2020, go-live

**CSW Urinary Tract Infection (UTI) Pathway Team:**

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Medicine, Owner</td>
<td>Pearl Chang, MD</td>
</tr>
<tr>
<td>Emergency Medicine, Owner</td>
<td>Ron Kaplan, MD</td>
</tr>
<tr>
<td>Urology, Stakeholder</td>
<td>Jennifer Ahn, MD, MS</td>
</tr>
<tr>
<td>Pharmacy, Stakeholder</td>
<td>Adam Brothers, PharmD</td>
</tr>
<tr>
<td>Emergency Medicine, Team Member</td>
<td>Sara Fenstermacher, MSN, RN, ACCNS-P</td>
</tr>
<tr>
<td>Medical Unit, Team Member</td>
<td>Ellie McMahon, MSN, RN, CPN</td>
</tr>
<tr>
<td>Radiology, Stakeholder</td>
<td>Elizabeth Tang, MD</td>
</tr>
</tbody>
</table>

**Clinical Effectiveness Team:**

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant</td>
<td>Lisa Abrams, MSN, RN, ARNP</td>
</tr>
<tr>
<td>Project Manager</td>
<td>Ivan Meyer, PMP</td>
</tr>
<tr>
<td>Data Analyst</td>
<td>Nathan Deam</td>
</tr>
<tr>
<td>Librarian</td>
<td>Peggy Cruse, MLIS</td>
</tr>
<tr>
<td>Program Coordinator</td>
<td>Kristyn Simmons</td>
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</table>

**Clinical Effectiveness Leadership:**

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<tr>
<th>Role</th>
<th>Name</th>
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<tbody>
<tr>
<td>Medical Director</td>
<td>Darren Migita, MD</td>
</tr>
<tr>
<td>Operations Director</td>
<td>Karen Rancich Demmert, BS, MA</td>
</tr>
</tbody>
</table>


**Please cite as:**
Evidence Ratings

This pathway was developed through local consensus based on published evidence and expert opinion as part of Clinical Standard Work at Seattle Children’s. Pathway teams include representatives from Medical, Subspecialty, and/or Surgical Services, Nursing, Pharmacy, Clinical Effectiveness, and other services as appropriate.

When possible, we used the GRADE method of rating evidence quality. Evidence is first assessed as to whether it is from randomized trial or cohort studies. The rating is then adjusted in the following manner (from: Guyatt G et al. J Clin Epidemiol. 2011;4:383-94, Hultcrantz M et al. J Clin Epidemiol. 2017;87:4-13.):

- Quality ratings are *downgraded* if studies:
  - Have serious limitations
  - Have inconsistent results
  - If evidence does not directly address clinical questions
  - If estimates are imprecise OR
  - If it is felt that there is substantial publication bias

- Quality ratings are *upgraded* if it is felt that:
  - The effect size is large
  - If studies are designed in a way that confounding would likely underreport the magnitude of the effect OR
  - If a dose-response gradient is evident

Certainty of Evidence:
- 🌟🌟🌟🌟 High: The authors have a lot of confidence that the true effect is similar to the estimated effect
- 🌟🌟🌟 Moderate: The authors believe that the true effect is probably close to the estimated effect
- 🌟🌟🌟 Low: The true effect might be markedly different from the estimated effect
- 🌟🌟 Very low: The true effect is probably markedly different from the estimated effect

Guideline: Recommendation is from a published guideline that used methodology deemed acceptable by the team

Expert Opinion: Based on available evidence that does not meet GRADE criteria (for example, case-control studies).
Summary of Version Changes

- **Version 1.0 (12/2011):** Go live.
- **Version 2.0 (12/3/2011):** Expanded recommendation for empiric outpatient antibiotics to include oral cephalexin or oral cefuroxime.
- **Version 2.3 (4/3/2013):** Removed race from the decision to treat parameter. Included information on timing of obtaining a VCU. Expanded discussion about cephalexin still being first-line treatment for *E. coli* in UTI.
- **Version 3.0 (6/3/2014):** Added additional content/information regarding the VCU and SFU grade with a link to the SFU grade training slide.
- **Version 4.1 (7/6/2015):** Updated bibliography formatting.
- **Version 5.0 (9/29/2015):** Updated inclusion/exclusion criteria to coincide with Nephrolithiasis pathway go live. Added to imaging page, specifically renal ultrasound to consider Nephrolithiasis pathway if stones are present.
- **Version 6.0 (1/20/2016):** Performed CSW value analysis, including review of positive blood culture recommendation.
- **Version 7.0 (2/26/2016):** Updated thresholds for positive urine cultures to better align with most recent AAP Guidelines.
- **Version 7.1 (11/22/2016):** Updated approval page to include Laboratory.
- **Version 8.0 (10/31/2018):** Updated UTI diagnosis criteria to include UA results and added UA’s false negative rate and LR from literature review.
- **Version 9.0 (4/4/2019):** Changed cephalexin approximate daily dosing to Q8H instead of QID. This change is supported by recognition of actual practice in antibiotic frequency ordering and evidence that reducing frequency of antibiotic dosing is effective per pharmacy consultation.
- **Version 10.0 (2/20/2020):** Periodic review go live. Overhauled entire document: modified inclusion criteria to include recurrent UTI; added CFU criteria to include possible UTI; and extensively revised the screening and management algorithms to align with 2011 and 2016 AAP Guideline and current literature, including age group classification, risk factors for screening, IV antibiotic duration in neonates, and when to obtain imaging.
- **Version 10.1 (4/14/2020):** Clarified admit criteria for infants.
Medical Disclaimer

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required.

The authors have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication.

However, in view of the possibility of human error or changes in medical sciences, neither the authors nor Seattle Children’s Healthcare System nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they are not responsible for any errors or omissions or for the results obtained from the use of such information.

Readers should confirm the information contained herein with other sources and are encouraged to consult with their health care provider before making any health care decision.
Literature Search Methods:
For this update, we revised the search strategies in line with current Library practices. Literature searches were conducted in July 2019. The search targeted synthesized literature on urinary tract infections from 2014 to current, and was executed in Ovid Medline, Embase, Cochrane Database of Systematic Review (CDSR), and Turning Research into Practice database (TRIP).

Screening and data extraction were completed using DistillerSR (Evidence Partners, Ottawa, Canada). Two reviewers independently screened abstracts and included guidelines and systematic reviews that addressed optimal diagnosis, treatment, and prognosis of patients who meet pathway inclusion/exclusion criteria. One reviewer screened full text and extracted data and a second reviewer quality checked the results. Differences were resolved by consensus.

Literature Search Results:
The search retrieved 935 records. No additional records were included from other sources. Once duplicates had been removed, we had a total of 746 records. We excluded 722 records based on titles and abstracts. We obtained the full text of the remaining 24 records and excluded 12; twelve articles were used for this review. The flow diagram summarizes the study selection process.

Identification
- Records identified through database searching (n=935)
- Additional records identified through other sources (n=0)

Screening
- Records after duplicates removed (n=746)

Eligibility
- Records screened (n=746)
- Records excluded (n=722)

- Records assessed for eligibility (n=24)
- Articles excluded (n=12)
  - Did not answer clinical question (n=4)
  - Did not meet quality threshold (n=6)
  - Review article of included study (n=2)

Included
- Studies included in pathway (n=12)

Flow diagram adapted from Moher D et al. BMJ 2009;339:bmj.b2535
Included Studies


Additional References for Urinalysis Post-Test Probability Tables


Additional References for VCUG and VUR


