Urinary Tract Infection
What’s New

AFTAB S. CHISHTI, MD., FAAP., CCST
Department of Pediatrics
Division of Pediatric Nephrology,
Hypertension & Renal Transplantation
University of Kentucky,
KY Children’s Hospital
Lexington, KY

Urinary Tract Infection

• No Financial conflict of interests to Declare

Scope, Aims & Objectives

• Diagnosis of urinary tract infections (UTI)
• Risk Factors for UTI
• Management of UTI
• Post UTI Evaluation
• Imaging strategies
• Antibiotic Prophylaxis
Urinary Tract Infection

- **Classification:**
  - Anatomic
    - Pyelonephritis
    - Cystitis
    - Urethritis
  - Severity
    - Complicated Vs Uncomplicated
  - First Vs Recurrent UTI
    - Recurrent UTI
      - Unresolved Bacteriuria
      - Bacterial Persistence
      - Reinfection
    - Asymptomatic Bacteriuria

Risk Factors for UTI

- Neonate/Infant
- Gender
- Foreskin
- Fecal & Perianal Colonization
- Urinary Tract anomalies
- Functional abnormalities
  - Dysfunctional Elimination Syndrome
- Immunocompromised states

Probability of UTI in Febrile Infants

<table>
<thead>
<tr>
<th>Individual Risk Factors: Girls</th>
<th>Probability of UTI</th>
<th>No. of Factors Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>White race</td>
<td>≤1%</td>
<td>No more than 1</td>
</tr>
<tr>
<td>Age 0-12 mos</td>
<td>≥ 9°C</td>
<td></td>
</tr>
<tr>
<td>Fever ≥ 3 d</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Absence of another source of infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Risk Factors: Boys</td>
<td>Probability of UTI</td>
<td>No. of Factors Present</td>
</tr>
<tr>
<td>Uncircumcised</td>
<td>≤1%</td>
<td>No more than 1</td>
</tr>
<tr>
<td>Circumcised</td>
<td>≤2%</td>
<td>No more than 2</td>
</tr>
<tr>
<td>Black race</td>
<td>None</td>
<td>No more than 3</td>
</tr>
<tr>
<td>Temperature ≥ 39°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever ≥ 24 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of another source of infection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UTI-CPG by AAP Pediatrics 2011; 128:595-610
Common Urinary Pathogen

- Gm Negative Rods
  - E coli
  - Pseudomonas
  - Klebsiella spp
  - Citrobacter
  - Enterobacter cloacae
  - Morganella morganii
  - Proteus Mirabilis
- Gm Negative Cocci
  - Neisseria gonorrhoea
- Gm Positive Cocci
  - Enterococcus spp
  - Streptococcus Group B/Group D/faecalis
  - Staphylococcus aureus/epidermidis/aerolyticus
- Candida sp.
- Adenovirus

Clinical Presentation

- Based on Age
  - Birth - 90 days of age
  - 3 months – 2 years of age
  - 2 – 5 years of age
  - More than 5 years of age
- Pertinent Physical findings
  - Anthropometric measures
  - Blood Pressure
  - Genitourinary exam

UTI-Symptoms

- Upper Tract
  - Fever
  - Lethargy
  - Vomiting
  - Malaise
  - Loin Pain

- Lower Tract
  - Frequency
  - Urgency
  - Wetting
  - Gross Hematuria
  - Non Specific Abd. Pain

Nonspecific Symptoms more likely in children < 2 years
Diagnosis

- Urinalysis
  - Dipstick
  - Microscopic Analysis
  - Enhanced Urinalysis

- Urine Culture
  - Catheterized
  - Supra-pubic Aspiration
Urine Culture

<table>
<thead>
<tr>
<th>Collection Technique</th>
<th>CFU/ml (growing colony)</th>
<th>Probability of Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suprapubic aspiration</td>
<td>10^4</td>
<td>99%</td>
</tr>
<tr>
<td>Catheterization</td>
<td>10^5</td>
<td>99%</td>
</tr>
<tr>
<td>Clean catch, void urine</td>
<td>10^5</td>
<td>99%</td>
</tr>
<tr>
<td>Clean catch, indwelling urine</td>
<td>10^5</td>
<td>99%</td>
</tr>
</tbody>
</table>

 UTI CPG by AAP Action Statement # 3

- To Establish the diagnosis of UTI clinician should require both
  - UA suggestive of infection
    - Pyuria &/or Bacteruria
  - Urine Culture with > 50000 colony forming units per ml of uropathogen cultured from a urine specimen obtained through Catheterization or Suprapubic aspiration

  (Evidence Quality: C, Recommendation)

Management of UTI

- Avoid Constipation
- Scheduled Voiding
- Antibiotics
  - Simple
  - Broad Spectrum
  - Step down after sensitivities are available
  - Oral Vs Intravenous
  - Avoid Nephrotoxic antibiotics
  - Duration
  - Prophylaxis
UTI CPG by AAP Action Statement # 4

• 4B
  – The Clinician should choose 7-14 days as duration of antimicrobial therapy
    (Evidence Quality: B; Recommendation)

Empiric Oral Antibiotics

<table>
<thead>
<tr>
<th>Antimicrobial Agent</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin trihydrate</td>
<td>20-40 mg/kg per d in 3 doses</td>
</tr>
<tr>
<td>Sulfinamide</td>
<td></td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>6-12 mg/kg trimethoprim and 20-60 mg/kg sulfamethoxazole per d in 2 doses</td>
</tr>
<tr>
<td>Sulfasazole</td>
<td>120-150 mg/kg per d in 4 doses</td>
</tr>
<tr>
<td>Cephalosporin</td>
<td></td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>10 mg/kg per d in 2 doses</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td></td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>30 mg/kg per d in 3 doses</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>20-30 mg/kg per d in 2 doses</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>50-100 mg/kg per d in 4 doses</td>
</tr>
</tbody>
</table>

Empiric Parenteral Antibiotics

<table>
<thead>
<tr>
<th>Antimicrobial Agent</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceftriaxone</td>
<td>75 mg/kg, every 24 h</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>150 mg/kg per d, divided every 6-8 h</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>100-150 mg/kg per d, divided every 8 h</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>7.5 mg/kg per d, divided every 8 h</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>5 mg/kg per d, divided every 8 h</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>300 mg/kg per d, divided every 6-8 h</td>
</tr>
</tbody>
</table>
Post UTI Imaging

- Renal and Bladder Ultrasound – RBUS
- Voiding Cystouretherogram – VCUG
  - Conventional VS Radionuclide
- Dimercaptosuccinic Acid Scan – DMSA Scan

UTI CPG by AAP

Action Statement # 5 & 6

- Febrile Infants with UTIs should undergo Renal & Bladder Ultrasonography (RBUS)
  [Evidence Quality: C; Recommendation]
- 6A
  - VCUG should not be performed after first Febrile UTI; its indicated if RBUS reveals Hydrenephrosis, scarring, or other finding either suggestive of high grade reflux or obstructive uropathy, as well as in other atypical or complex clinical circumstances.
  [Evidence Quality: B; Recommendation]

- 6B
  - Further Evaluation should be conducted if there is recurrence of febrile UTIs
  [Evidence Quality: X; Recommendation]

United Kingdom’s NICE Guidelines

- All children with atypical UTI need Renal Sonogram in acute stage
- Infant younger than 6 months with first UTI – do sonogram within 6 weeks of infection
- Children younger than 3 with atypical or recurrent UTI do DMSA scan 4-6 months after the acute infection to detect scarring
- No routine imaging to detect VUR
European Guidelines

- European Association of Urology / European Society of Pediatric Urology
  - RBUS
  - VCUG
    - Initial Febrile or Recurrent UTI in girls
    - Initial UTI in Boys
  - DMSA
    - Initial Febrile UTI
- European Society of Pediatric Research
  - RBUS & DMSA
  - VCUG only if DMSA positive

Prophylax or NOT to Prophylax

Effect of Prophylaxis on the recurrence of symptomatic UTI

Prophylaxis or NO Prophylaxis

Effect of Antibiotic Prophylaxis on repeat positive Cultures
Prophylaxis or NO to Prophylaxis

The Effect of Antibiotic Prophylaxis on the rate of renal scars


Relationship between Renal Scarring and repeated bouts of Pyelonephritis

Craig JC et al. NEJM 361:18, 1748-59

Antibiotic Prophylaxis & Rec. UTI

Time to Symptomatic UTI

Time to Febrile UTI

Craig JC et al. NEJM 361:18, 1748-59
Antibiotic Prophylaxis in preventing APN or Scar

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Prophylaxis</th>
<th>No Prophylaxis</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Pyelonephritis Recurrence During the First 2 Years of Follow-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with at least 1 pyelonephritis recrurrence in the first 2 years of follow-up</td>
<td>30 (76)</td>
<td>29 (74)</td>
<td>.50</td>
</tr>
<tr>
<td>First year after enrollment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of episodes, mean (SD)</td>
<td>1 episode</td>
<td>2 episodes</td>
<td>3 episodes</td>
</tr>
<tr>
<td>Patients with recurrence, n (%)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>2 episodes</td>
<td>10 (25)</td>
<td>7 (18)</td>
<td>.50</td>
</tr>
<tr>
<td>3 episodes</td>
<td>4 (5)</td>
<td>3 (7)</td>
<td>.50</td>
</tr>
<tr>
<td>Patients without recurrence, n (%)</td>
<td>16 (40)</td>
<td>13 (34)</td>
<td>.20</td>
</tr>
<tr>
<td>Ureteral reflux, n (%)</td>
<td>0.2 (86)</td>
<td>0.3 (93)</td>
<td>.71</td>
</tr>
<tr>
<td>Patients with recurrence, n (%)</td>
<td>1 episode</td>
<td>2 episodes</td>
<td>3 episodes</td>
</tr>
<tr>
<td>1 episode</td>
<td>1 (4)</td>
<td>1 (6)</td>
<td>.50</td>
</tr>
<tr>
<td>2 episodes</td>
<td>1 (4)</td>
<td>1 (6)</td>
<td>.50</td>
</tr>
<tr>
<td>3 episodes</td>
<td>1 (4)</td>
<td>1 (6)</td>
<td>.50</td>
</tr>
<tr>
<td>Patients without recurrence, n (%)</td>
<td>41 (87)</td>
<td>42 (84)</td>
<td>.40</td>
</tr>
</tbody>
</table>

Marco Pennesi et al. Pediatrics Vol 121, # 6, June 08

Antibiotic Prophylaxis in preventing APN or Scar

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Prophylaxis</th>
<th>No Prophylaxis</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMSA Uptake and Rate of Renal Scars at the End of the First 2 Years of Follow-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMSA, mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uptake right kidney</td>
<td>51.5 (14.3)</td>
<td>50.3 (16.7)</td>
<td>.6</td>
</tr>
<tr>
<td>Uptake left kidney</td>
<td>48.7 (14.3)</td>
<td>49.6 (16.7)</td>
<td>.7</td>
</tr>
<tr>
<td>Renal scar presence, n (%)</td>
<td>22 (40)</td>
<td>18 (36)</td>
<td>.4</td>
</tr>
</tbody>
</table>

Marco Pennesi et al. Pediatrics Vol 121, # 6, June 08

Take Home Message

• High Index of suspicion
• Prompt treatment of UTI/Pyelonephritis
  — Oral Antibiotics are as good as Intravenous
  — Rx for 7-10 days
• Individualize work up post UTI
  — RUS in almost all with Febrile UTI
  — VCUG should still be considered
    • After second febrile UTI
    • Atypical UTI
  — DMSA still may be helpful but should be done by specialist
• Consider Dysfunctional Elimination
• Antibiotic Prophylaxis in high grade reflux patients