Current Trends in Pediatric GU Imaging
European Perspective

Pierre-Hugues Vivier, MD, PhD

CHU C. Nicolle, Rouen, France
Générale de Santé, Hôpital Privé de l’Estuaire, Le Havre, France
Urinary tract infection

- 1.6% of boys / 7.8% of girls

- 10-40% of children: permanent renal scarring
  - Benador D. Lancet 97.
  - Hewitt IK. Pediatrics 08.

- May lead to:
  - Recurrent pyelonephritis
  - Poor renal growth, impaired GFR
  - Early hypertension, preeclampsia
  - End-stage renal disease
Urinary tract infection

- Imaging: tailor the management of patients

American Academy of Pediatrics
2011
CLINICAL PRACTICE GUIDELINE

European Association of Urology
2015
Guidelines
Urinary Tract Infections in Children
Urinary tract infection

Ultrasound: YES

American Academy of Pediatrics
Clinical Practice Guideline 2011

European Association of Urology
Urinary Tract Infections in Children 2015
• 394 children 2-24 months, prenatal US: normal
• First UTI
• Abnormal US: 22% (dilatation = 13%)

US : systematic after the first UTI even if normal prenatal US
Urinary tract infection

Ultrasound: When?

- Not during the acute phase: can be misleading
- During the 48h of treatment if:
  - Clinical illness unusually severe
  - No clinical improvement
- Early US in case of febrile UTI or urosepsis
- Can be delayed in those with a previous normal US
Urinary tract infection

Ultrasound: Bladder and bowel dysfunction (BBD)

- Not mentioned

- Look at:
  - Rectal diameter
  - Post-void residual (PVR)
Urinary tract infection

Ultrasound: Bladder and bowel dysfunction (BBD)

Constipation must be considered if:
Pelvic US shows filling of the rectum > 30 mm

Supported by:
Berger MY. J Pediatr, 12.
Joensson IM. J Urol, 08.
Klijn AJ. J Urol, 04.
Singh SJ. J Pediatr Surg, 05.

Not confirmed by:
Mason MD. J Ped Urol 15.
Urinary tract infection

Abnormal if:
4-6 years: > 30 mL
7-9 years > 22 mL
10-12 years > 19 mL

If: Pre-void vesical volume > 50 mL

Urinary tract infection

VCUG

• Not after the first UTI

• Performed if:
  • Hydronephrosis
  • Scarring
  • Findings suggestive of high-grade VUR or obstructive uropathy
  • Atypical or complex clinical circumstances
  • Recurrence of febrile UTI

• Recommended after the first UTI (≠ AAP) in:
  • Infants (<12 months)
  • Girls
  • Boys if recurrence
Urinary tract infection

- Meta-analysis
- 1091 children: 2–24 months

**TABLE 4** Recurrences of Febrile UTI/Pyelonephritis in Infants 2 to 24 Months of Age With and Without Antimicrobial Prophylaxis, According to Grade of VUR

<table>
<thead>
<tr>
<th>Reflux Grade</th>
<th>No. of Recurrences</th>
<th>Total N</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>11 6%</td>
<td>163</td>
<td>.15</td>
</tr>
<tr>
<td>I</td>
<td>2 6%</td>
<td>35</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>10 8%</td>
<td>124</td>
<td>.95</td>
</tr>
<tr>
<td>III</td>
<td>40 28%</td>
<td>145</td>
<td>.29</td>
</tr>
<tr>
<td>IV</td>
<td>21 43%</td>
<td>49</td>
<td>.14</td>
</tr>
</tbody>
</table>
Urinary tract infection

- Meta-analysis
- 1091 children: 2–24 months

**TABLE 4** Recurrences of Febrile UTI/Pyelonephritis in Infants 2 to 24 Months of Age With and Without Antimicrobial Prophylaxis, According to Grade of VUR

<table>
<thead>
<tr>
<th>Reflux Grade</th>
<th>No. of Recurrences</th>
<th>Total N</th>
<th>Prophylaxis</th>
<th>No. of Recurrences</th>
<th>Total N</th>
<th>No Prophylaxis</th>
<th>No Prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11 6%</td>
<td>163</td>
</tr>
<tr>
<td>I</td>
<td>7</td>
<td>210</td>
<td>3%</td>
<td></td>
<td></td>
<td>2 6%</td>
<td>35</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>37</td>
<td>5%</td>
<td></td>
<td></td>
<td>2 6%</td>
<td>35</td>
</tr>
<tr>
<td>III</td>
<td>11</td>
<td>133</td>
<td>8%</td>
<td></td>
<td></td>
<td>10 8%</td>
<td>124</td>
</tr>
<tr>
<td>IV</td>
<td>31</td>
<td>140</td>
<td>22%</td>
<td></td>
<td></td>
<td>40 28%</td>
<td>145</td>
</tr>
<tr>
<td>V</td>
<td>16</td>
<td>55</td>
<td>29%</td>
<td></td>
<td></td>
<td>21 43%</td>
<td>49</td>
</tr>
</tbody>
</table>

\[P \text{ (Prophylaxis)} = .15 \]

\[P \text{ (No Prophylaxis)} = 1.00 \]
Urinary tract infection

- $^{99m}$Tc-DMSA renal scintigraphy:
- Not recommended
- 1 mSv
Based on 2 prospective studies

- **Swedish Reflux trial.** J Pediatr Urol, 2011. (n=203)
- **RIVUR Study.** NEJM, 2014. (n=607)

- 203 children, (12-24 months old) with VUR grade III or IV and IV
- Follow-up of 2 years

**Antibiotic prophylaxis:**

*In girls:* 19% of recurrent febrile UTI vs 57% on surveillance. \((p=0.0002)\)

*In boys:* recurrence low. No difference.

- 203 children, (12-24 months old) with VUR grade III or IV and IV
- Follow-up of 2 years

**Figure 1.** Febrile UTI recurrence rate by gender and treatment group.

**Figure 2.** New renal damage in children with dilating VUR by allocated treatment. (Modified from Brandstrom et al. The Swedish Reflux Trial in Children: IV. Renal Damage. J. Urol. 2010; 184:292–7. Reprinted by permission.)

**Antibiotic prophylaxis:** Significant reduction of renal scars in comparison with surveillance and endoscopic treatment.
Urinary tract infection

RIVUR Study. NEJM, 2014.
- 607 children, (2 months-6 years) with VUR grade I to IV
- Antimicrobial prophylaxis vs placebo
- Follow-up of 2 years

Antibiotic prophylaxis:
- 50% decrease of recurrent febrile UTI
  - ↓ 80% in case of BBD
  - ↓ 60% in case of febrile index UTI
- No effect on renal scarring
Urinary tract infection


- 986 children, (2 months-6 years) with VUR low grade (I-II) and high grade (III-IV)
- Antimicrobial prophylaxis vs no prophylaxis

Supports antibiotic prophylaxis in all children with VUR regardless of reflux grade

- Number needed to treat (NNT): low grade = 15.36 / high grade = 12.15
Urinary tract infection

Prophylaxis necessary in case of VUR

VUR screening necessary

**Bottom-up approach**

VCUG $0.1-0.55\text{ mSv}$

DMSA scintigraphy

**Top-down approach**

DMSA scintigraphy $1\text{ mSv}$

VCUG
Urinary tract infection

- $^{99m}$Tc-DMSA renal scintigraphy:
  - *Reference method for acute pyelonephritis*
    - Rarely performed in practice
    - 1 mSv
    - Long (>3h after DMSA injection)
    - Expensive

- *Reference method for renal scarring*
MRI: DWI
DWI
### Agreement (concordance)

<table>
<thead>
<tr>
<th></th>
<th>Per kidney (n=78)</th>
<th>Per zone (n=234)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2-W</td>
<td>κ =0.69 p = 0.0010</td>
<td>κ =0.63 p &lt; 0.0001</td>
</tr>
<tr>
<td>DWI</td>
<td>κ =0.92 p = 0.2500</td>
<td>κ =0.92 p = 0.2266</td>
</tr>
</tbody>
</table>

**Agreement defined as** *(Majd M. Radiology, 2001)*

- **excellent,** κ > 0.75
- **good,** κ = 0.40 – 0.75
- **poor,** κ < 0.40.

*Vivier PH. Eur Radiol, 2014.*
DWI

- Comparable results to Gd-T1-W imaging.
- Excellent interobserver reproducibility.
- Not suited in children < 6 months

Diffusion tensor imaging

**DWI**
Respiratory triggering
7 min ± 2.4 (SD)

**DTI**
Free breathing
4.3 min
Renal scars
With contrast

- *Cerwinka WH. J Pediatr Urol, 14. (n=25)*
  - MRU: Sens = 100% and a Spe = 100%

« MRU is superior to DMSA scan in the identification of renal parenchyma defects. »

Without contrast

- *Kavanagh EC. Pediatr Radiol, 05. (n=37)*
  - MRU: Sens = 77% and a Spe = 87%
  - “The true sensitivity and specificity of MRI for the detection of renal defects would in fact be higher if a true gold standard were available”.

- *Koçyiğit A. Pediatr Nephrol, 14. (n=49)*
  - MRU: Sensitivity = 80% and specificity = 82.6%
MRI

- **MRI: DTI + T2-W (± T1-Gd)**
  - *Comprehensive examination within 15 minutes*
  - **DTI: hyperintense areas**
    - Comparable results to Gd-T1-W imaging with excellent interobserver reproducibility
  - **T2-W: morphology**
    - Abscess, renal scarring, CM differentiation, dilatation

- **Advantages:**
  - **No need for IV access:** more acceptable to both children and their parents
  - **No contrast injection:** no NSF issue
  - **No radiation exposure:** unlike $^{99m}$Tc-DMSA scintigraphy (1 mSv)
  - **No respiratory triggering:** unlike DWI
Conclusion

- US: first-line imaging

- Benefit of prophylaxis in VUR
  - Need to prove VUR even in case of normal US?

- Promising role of MRI