Giovanni Montini has documented that he has no relevant financial relationships to disclose or conflict of interest to resolve.
Imaging in Pediatric UTI

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IMAGING AFTER A FIRST FEBRILE UTI

- Ultrasonography
- Voiding cystourethrography with a radiopaque, radioactive, or echocontrast medium
- Renal scintigraphy with DMSA

Acute Late
Current primary care management of children aged 1–36 months with urinary tract infections in Europe: large scale survey of paediatric practice

Adamos Hadjipanayis, Zachi Grossman, Stefano del Torso, Diego van Esso, Hans Juergen Dornbusch, Artur Mazur, Anna Drabik, Giovanni Montini

Design Web-based large scale survey evaluating knowledge of, attitudes towards and the methods for diagnosing, treating and managing urinary tract infections in children.

Setting Primary and secondary care practices in Europe.

Sample 1129 paediatricians.
Cystography is recommended for the following age group of children with confirmed diagnosis of UTI

1129 paediatricians

Elizabeth

Elizabeth is a 30 months old girl, whose family and past medical history is uneventful. Normal prenatal US, good general health, good statural and ponderal growth. She comes to the clinic because of fever (38.7°C). She is in good general conditions, normal physical examination.

Urine dipstick and subsequent culture (E. coli) confirmed a febrile UTI

• Would you recommend an acute DMSA?
• Would you recommend US?
• US shows normal kidneys and urinary tract

• Would you proceed to cystography?
• Grade II reflux

• Would you recommend late DMSA scan?
• Normal kidneys
Philip

Philip is an 8 months old uncircumcised boy, whose prenatal US demonstrated mild dilatation of both renal pelves. Otherwise he is in good general health, satisfactory growth percentiles. He comes to the clinic because of fever (38.7°C). He appears otherwise well, with normal physical examination.

Urine dipstick and subsequent culture (Pseudomonas) confirmed a febrile UTI

- Would you recommend an acute DMSA?
- Would you recommend US?
- US shows hyperechogenic kidneys, with the right kidney at the 10\textsuperscript{th} %ile

- Would you proceed to cystography?
- Right grade IV reflux; left grade II

- Would you recommend late DMSA scan?
- Mild hypodysplastic kidneys
### Demographic and clinical characteristics of 502 children with febrile UTI

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of children</td>
<td>502</td>
</tr>
<tr>
<td>Median age in months (range)</td>
<td>8 (1-99)</td>
</tr>
<tr>
<td>No girls (%)</td>
<td>322/502 (64%)</td>
</tr>
<tr>
<td>Confirmed AP (%)</td>
<td>278/438 (63.4%)</td>
</tr>
<tr>
<td>With VUR (%)</td>
<td>102/473 (21.5%)</td>
</tr>
<tr>
<td>VUR grade</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>24</td>
</tr>
<tr>
<td>II</td>
<td>37</td>
</tr>
<tr>
<td>III</td>
<td>34</td>
</tr>
<tr>
<td>IV</td>
<td>6</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
</tr>
<tr>
<td>Scar at late DMSA</td>
<td>15%</td>
</tr>
</tbody>
</table>

G. Montini et al. BMJ 2007
Febrile Urinary Tract Infections
Vesico-ureteric reflux
Renal hypo-dysplasia
Post infectious scarring
The reason for imaging is to detect:
• obstructive malformations,
• vesicoureteral reflux,
• and kidney damage.

yet consensus on the malformations, grade of reflux, and degree of damage that are important to detect is lacking
### Imaging Recommendation After a First fUTI According to Guidelines

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Ultrasound</th>
<th>VCUg</th>
<th>DMSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICE (2007)</td>
<td>YES Atypical UTI; &lt; 6 months</td>
<td>NO unless &gt; 6 months of age with positive US or atypical UTI</td>
<td>YES &gt; 6/12 m from UTI</td>
</tr>
<tr>
<td>AAP (2011)</td>
<td>YES</td>
<td>NO Unless abnormal US</td>
<td>NO</td>
</tr>
<tr>
<td>Italian (2012)</td>
<td>YES</td>
<td>NO Unless abnormal US</td>
<td>YES &gt;6/12 m from UTI if abnormal US or VUR</td>
</tr>
<tr>
<td>Australian (2014)</td>
<td>YES if no 2° or 3° trimester US ; &lt; 3 months; Atypical UTI</td>
<td>NO Unless abnormal US</td>
<td>NO</td>
</tr>
<tr>
<td>Canadian (2014)</td>
<td>YES</td>
<td>NO Unless abnormal US</td>
<td>NO</td>
</tr>
</tbody>
</table>
Febrile urinary tract infections in young children: recommendations for the diagnosis, treatment and follow-up

Anita Ammenti¹, Luigi Cataldi², Roberto Chimenz³, Vassilios Fanos⁴, Angela La Manna⁵, Giuseppina Marra⁶, Marco Materassi⁷, Paolo Pecile⁸, Marco Pennesi⁹, Lorena Pisanello¹⁰, Felice Sica¹¹, Antonella Toffolo¹², Giovanni Montini (giovanni.montini@aosp.bo.it) (Coordinator)¹³ on behalf of the Italian Society of Pediatric Nephrology
First febrile UTI

US

- Abnormal
- Abnormal prenatal US
- Chronic kidney disease
- Abnormal bladder emptying
- Bacteria other than E.coli

Risk factors including:

- Abnormal prenatal US
- Chronic kidney disease
- Abnormal bladder emptying
- Bacteria other than E.coli

Further imaging (cystography, renal radionuclide scan)

2nd febrile UTI

- Normal
- No risk factors

No necessary further imaging
UTI Imaging

Action Statement 6

Action Statement 6a
VCUG should not be performed routinely after the first febrile UTI; VCUG is indicated if RBUS reveals hydronephrosis, scarring, or other findings that would suggest either high-grade VUR or obstructive uropathy, as well as in other atypical or complex clinical circumstances (evidence quality: B; recommendation).

Action Statement 6b
Further evaluation should be conducted if there is a recurrence of febrile UTI (evidence quality: X; recommendation).

Action Statement 5
Febrile infants with UTIs should undergo renal and bladder ultrasonography (RBUS) (evidence quality: C; recommendation).
IMAGING AFTER A FIRST FEBRILE UTI

OUTCOME?

- Detection of reflux
- Detection of scarring
Demographic and clinical characteristics of the 304 children evaluated

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (range), mo</td>
<td>7.7 (2-36)</td>
</tr>
<tr>
<td>Females (%)</td>
<td>193/304 (64)</td>
</tr>
<tr>
<td>Positive US (%)</td>
<td>42/304 (14)</td>
</tr>
<tr>
<td>VUR III-V (%)</td>
<td>26/304 (8.5)</td>
</tr>
<tr>
<td>VUR I-V (%)</td>
<td>66/304 (22)</td>
</tr>
<tr>
<td>Pyelonephritis* (%)</td>
<td>160/304 (53)</td>
</tr>
<tr>
<td>Scars** (%)</td>
<td>45/304 (15)</td>
</tr>
</tbody>
</table>

*at acute DMSA; **at late DMSA scan.

AIM: to evaluate current diagnostic algorithms for their diagnostic accuracy in detecting VUR and permanent scarring, and to determine the economic and radiation costs incurred by the different protocols
Rate of missed reflux and scars of the 6 imaging recommendations evaluated

<table>
<thead>
<tr>
<th></th>
<th>Cincinnati</th>
<th>RCH</th>
<th>NICE</th>
<th>TDA</th>
<th>AAP</th>
<th>ISPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>N° VURs I-V missed (%)</td>
<td>0/66 (0)</td>
<td>40/66 (61)</td>
<td>47/66 (71)</td>
<td>16/66 (24)</td>
<td>48/66 (73)</td>
<td>34/66 (51)</td>
</tr>
<tr>
<td>N° VURs I-II missed (%)</td>
<td>0/40 (0)</td>
<td>28/40 (70)</td>
<td>34/40 (85)</td>
<td>12/40 (30)</td>
<td>32/40 (80)</td>
<td>27/40 (68)</td>
</tr>
<tr>
<td>N° VURs III-V missed (%)</td>
<td>0/26 (0)</td>
<td>12/26 (46)</td>
<td>13/26 (50)</td>
<td>4/26 (15)</td>
<td>16/26 (61)</td>
<td>7/26 (27)</td>
</tr>
<tr>
<td>N° of scars missed (%)</td>
<td>0/45 (0)</td>
<td>45/45 (100)</td>
<td>28/45 (62)</td>
<td>0/45 (0)</td>
<td>45/45 (100)</td>
<td>25/45 (53)</td>
</tr>
</tbody>
</table>

C La Scola et al. *Pediatrics* 2013
Economic and radiation costs of the 6 imaging recommendations evaluated

<table>
<thead>
<tr>
<th></th>
<th>Cincinnati</th>
<th>RCH</th>
<th>NICE</th>
<th>TDA</th>
<th>AAP</th>
<th>ISPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>total costs (€)</td>
<td>75,696</td>
<td>32,743</td>
<td>26,838</td>
<td>52,268</td>
<td>28,457</td>
<td>44,139</td>
</tr>
<tr>
<td>cost/patient (€)</td>
<td>249</td>
<td>108</td>
<td>88</td>
<td>172</td>
<td>94</td>
<td>145</td>
</tr>
<tr>
<td>total radiations (mSv)</td>
<td>608</td>
<td>92</td>
<td>156</td>
<td>624</td>
<td>42</td>
<td>228</td>
</tr>
<tr>
<td>radiation/patient (mSv)</td>
<td>2</td>
<td>0.3</td>
<td>0.5</td>
<td>2.05</td>
<td>0.14</td>
<td>0.75</td>
</tr>
</tbody>
</table>

C La Scola et al. *Pediatrics* 2013
Lack of unified agreement exists regarding the optimal diagnostic protocol at the time of an uncomplicated first febrile UTI, and it remains open to discussion the benefit of identifying minor abnormalities.

There is no ideal diagnostic protocol following a first febrile urinary tract infection. An aggressive protocol has a high sensitivity for detecting VUR and scarring but carries high financial and radiation costs with questionable benefit.
IMAGING AFTER A FIRST FEBRILE UTI

OUTCOME?

- Detection of reflux
- Detection of scarring
OBJECTIVES To identify independent prognostic factors for the development of renal scarring and to combine these factors in prediction models that could be useful in clinical practice.
Table 5. Risk for Renal Scarring by Model 1 Score

<table>
<thead>
<tr>
<th>Score</th>
<th>No. of Patients</th>
<th>Patients With Scarring, No. (%)</th>
<th>Patients With VUR Grade IV or V, No./Total No. (%)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>390</td>
<td>24 (6.2)</td>
<td>5/384 (1.3)</td>
<td>Very low</td>
</tr>
<tr>
<td>1</td>
<td>435</td>
<td>62 (14.3)</td>
<td>9/423 (2.1)</td>
<td>Intermediate</td>
</tr>
<tr>
<td>≥2</td>
<td>228</td>
<td>70 (30.7)</td>
<td>30/228 (13.2)</td>
<td>High</td>
</tr>
<tr>
<td>Total</td>
<td>1053*</td>
<td>156 (14.8)</td>
<td>44/1035 (4.3)</td>
<td>Baseline</td>
</tr>
</tbody>
</table>

CONCLUSIONS AND RELEVANCE  Children and adolescents with an abnormal renal ultrasonographic finding or with a combination of high fever (≥39°C) and an etiologic organism other than *E. coli* are at high risk for the development of renal scarring.
IMAGING AFTER A FIRST FEBRILE UTI

OUTCOME?

• Detection of reflux

• Detection of scarring

• Prevention of renal scarring and future complications
**Objective:** to determine whether routine imaging (US and MCUG), of children with their first UTI significantly reduced renal scarring or recurrent UTI.

**Methods:** Children 2–10 years (n = 172), with confirmed UTI, were allocated to routine (US and MCUG) or selected imaging (US and MCUG for recurrent UTI or persistent problems).

**Results:** No difference in the proportion of children with recurrent UTI or in the rate of renal scarring between the two groups after 2 years of follow-up.

Elizabeth & Philip

• An healthy infant (Elizabeth) with an uncomplicated first febrile UTI is not in need of aggressive investigation and management.

• An apparently healthy infant (Philip) with an abnormal US and atypical UTI warrants investigation
First febrile UTI

- Abnormal US

- Risk factors including:
  - Abnormal prenatal US
  - Chronic kidney disease
  - Abnormal bladder emptying
  - Bacteria other than E.coli

Further imaging (cystography, renal radionuclide scan)

2nd febrile UTI

- Normal US
- No risk factors

No necessary further imaging

ISPN Consensus
Imaging in Pediatric UTI

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