UTI imaging algorithms revisited in the light of modern approaches - when to image, whom, how?

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ESUR pediatric work group
Introduction

• UTI common in children
  – overall prevalence 2-8%

• Risk of recurrent UTI = 12- 30%
  – in first year after initial UTI
  – particularly in first years of life
Introduction

• UTI common in children
• Risk of recurrent UTI = 12-30%

• Complications & risks of upper UTI
  - acute complications = abscess ...
  - develop renal scars
    ▪ particularly in infancy

• Complications from renal scarring
  - hypertension
  - proteinuria
  - pregnancy-related complications
  - end-stage renal failure
Introduction: UTI - diagnosis

- UTI common in children, risk of recurrent UTI
- Complications & risks of upper UTI, renal scarring
- Symptoms in infancy often unspecific
  ⇄ proper urine sample essential
  - proper technique (sampling, culture, ...)
  - reliable results? additional laboratory data?
Introduction: UTI - diagnosis

- UTI common in children, risk of recurrent UTI
- Complications & risks of upper UTI, renal scarring
- Symptoms in infancy often unspecific
  ➡ proper urine sample essential
  ➡ classification
    - febrile = upper UTI / aPN
    - lower UTI / cystitis & urethritis
    - difference: renal involvement
      NOTE: only renal involvement causes scaring
Imaging in UTI

Aim of imaging in UTI

• to (early) identify risk factors & abnormalities that can be modified
• to decrease likelihood of recurrent (upper) UTI
• to reduce risk of renal scarring

How to image: Top-down and/or Down-Up?

Previously

- **US**
- **IVU + DMSA**
  - diagnose & localize UTI
- **VCUG in all patients**
  - for detection of VUR
  + follow-up

**BUT:** Today's knowledge based on this approach
  - though invasive and rigorous, still was helpful
Congenital VUR often vanishes spontaneously
  - or at least diminishes
  - even higher grades
  - without sequalea

Low grade VUR (I / II°) in itself without risk
  - not for UTI recurrence
  - not for renal damage
Today’s new knowledge on VUR

- Congenital VUR often vanishes spontaneously
- Low grade VUR (I / II°) in itself without risk
- High grade VUR has varying & unpredictable impact
  - even in patients with UTI
  - often already fetal dysplasia (cRNP) - cannot be influenced
- Renal scarring
  - can occur after UTI even without detectable VUR

**BUT: limited VUR detection by VCUG**

- VUR in children with UTI without VUR on VCUG?
- in many: VUR on ce-VUS or endoscopic techniques (PIC)
Today’s new knowledge on VUR

• Congenital VUR often vanishes spontaneously
• Low grade VUR (I / II°) in itself without risk
• High grade VUR has varying & unpredictable impact
• Renal scarring, UTI cause & course
  – many factors may impact UTI frequency & renal scarring
    ▪ behavior / fashion / social aspects …
    ▪ epidemiologic, kind & behavior of micro-organism
    ▪ treatment onset, kind, response …
    ▪ genetic preposition?
    ▪ bladder function disturbance
Today’s new knowledge on VUR

- Congenital VUR often vanishes spontaneously
- Low grade VUR (I / II°) in itself without risk
- High grade VUR has varying & unpredictable impact
- Renal scarring, UTI reasons multi-factorial
- Treatment also changed
  - less aggressive surgically, new endoscopic treatment options ...
  - even AB-prophylaxis under discussion

lots of controversy, ongoing debate

Objective

• To discuss role of imaging in UTI
  – reflecting new therapy concepts
  – based on new knowledge & insights into pathophysiology
  – address “bottom-up” versus “top-down” approach

• To describe relevant imaging techniques

• To give typical examples

• To propose imaging algorithm for diagnostic imaging

• To address how to deal with complications
Objective of imaging today

- Find underlying conditions that make patient more susceptible for renal damage
- Monitor kidneys to assess (risk of) renal damage
- growth impairment
Imaging methods

• US

• VCUG / RNC, ce-VUS

• DMSA

• IVU

• MRI

• CT
Imaging methods

- **US** = accepted initial & universal imaging tool
  - HN, UTI, screening ...

- **Requisites:**
  - proper transducers
  - good hydration
  - full bladder
  - knowledge & experience
  - clinical data
  - post-void assessment
  - need sufficient time
Imaging methods - US

- **US signs for VUR**
  - gaping ostium (diagnostic)
  - VUR visualization by CDS (diagnostic)
  - ureteral / pelvic / caliceal dilatation
  - changing upper dilatation? (indirect signs)
Imaging methods - US

- **US signs for VUR**
  - gaping ostium, VUR visualisation, dilatation
  - bladder wall thickening, trabeculation (unspecific)
  - lateralized or duplex ostium (indirect sign)
  - “urothelial sign” (indirect sign)
Imaging methods - US

- **US signs for VUR**
  - gaping ostium, VUR visualisation, dilatation
  - wall thickening, lateralized/duplex ostium
  - other (indirect) hints & signs (unspecific)
    - residual volume
    - renal scar, size difference, dysplasia
Imaging methods - US

• US signs for VUR
  – gaping ostium, VUR visualisation, dilatation
  – wall thickening, lateralized/duplex ostium
  – other (indirect) hints & signs (unspecific)
    ▪ residual volume, renal scar, dysplasia
    ▪ urethral & pelvic floor pathology
Imaging methods - US

• US signs for (upper) UTI
  – altered parenchymal echogenicity
  – increased size, spherically swollen
  – wall thickening - secondary?
  – peripyleonal echogenicity
  – other (indirect) hints & signs
    ▪ laxity & dilatation with echoes in urine
    ▪ perirenal alteration
Imaging methods - US

- US in complications of UTI
  - pyohydronephrosis
  - necrosis / abscess
  - xanthogranulomatous pyelonephritis
    - stone formation, fungus ball
    - tuberculosis ....
Imaging methods - US

• US in complications of UTI
  - pyohydronephrosis
  - necrosis / abscess
  - xanthogranulomatous pyelonephritis
  - pseudotumnor / lobar nephroma
Imaging methods - US

- **US in UTI - role of aCDS**
  - segmental perfusion defects
  - necrosis / abscess
  - role of ce-US?
Imaging methods - US

- US in UTI - role of aCDS
  - segmental perfusion defects necrosis/abscess, ce-US?
  - incidental alternate findings
    - infarction, retro-aortal left renal vein
    - tumor, stones ...


Restrictions of basic US

- no panoramic display
- poor for definite VUR diagnosis
- high observer variability
- restrictions for
  - anatomy of urethra
  - ureteral anatomy
  - diverticula
  - (small) scars
  - bladder function assessment

⇒ additional imaging tools essential
Imaging methods

- **VCUG** = "gold standard"
  - excellent panoramic display
  - proper technique essential
    - pulsed fluoroscopy
    - last image hold
    - short screening time
    - reduce shots
  - modified protocol
    - allows function assessment
  - cyclic filling helpful / recommended
    - better yield ...
Imaging methods - VCUG

- How does it work?
  - catheterism
    - trans-urethral? supra-pubic?
    - check urine, empty bladder
    - sedation? fasted child?
  - fill bladder with radiopaque CM
    - observe intermittently fluoroscopically
    - drip infusion (physiologic pressure) till urge
    - some advocate pressure infusion to speed up
      - unable to obtain functional information
      - may influence findings (bladder volume, VUR incidence & degree ...)
Imaging methods - VCUG

- How does it work?
  - catheterism, fill bladder with CM
  - document findings
    - before/during/after voiding
    - use last image hold & spot films
    - bladder capacity? bladder neck?
    - observe residual urine
      - drainage of refluxed CM ...
  - describe & grade VUR
Imaging methods - VCUG

- **VCUG benefits**
  - standardized grading
  - less investigator dependent
  - excellent anatomy
    - ureter, diverticula, urethra
  - reproducible ...
Imaging methods - VCUG

• VCUG restrictions
  – catheter = invasive
  – radiation burden
    ▪ particularly in girls
  – short, particularly if only 1 cycle ...
    ▪ for radiation protection
      = incomplete / wrong result
  – non-physiologic approach
    ▪ artificial function disturbance
VUR imaging - alternate methods

Alternate VUR detection techniques

1) ce-VUS
   - bladder filling with NaCL + US-CM
   - observe before, during after ...
Alternate VUR detection techniques

1) ce-VUS
   - bladder filling with NaCL + US-CM, observe & scan ...
   - excellent VUR detection & grading
   - urethral assessment possible, but more difficult
Alternate VUR detection techniques

1) ce-VUS

2) radionuclide cystography (RNC)
   - bladder filling with tracer = direct RNC
     - catheter needed, as in VCUG
   - observe with gamma camera
     - before, (during?), after voiding
     - longer observation period
     - less radiation burden ...
   - any activity in ureter & kidney area = VUR

grading established, standardised - see European Society for Nuclear Medicine
Alternate VUR detection techniques

1) ce-VUS

2) radionuclide cystography (RNC)
   - direct RNC
   - indirect RNC: no catheterism, must be toilet trained
     - late phase of dynamic Tc\(^{99m}\) MAG3 renography
       = bladder filled physiologically, no catheter needed
     - observe for activity increase in kidney area with gamma camera
       o after clearance of activity from kidney = late phase
       o before, (during?), after voiding
VUR imaging - alternate methods

Alternate VUR detection techniques

1) ce-VUS

2) radionuclide cystography (RNC)
   - direct & indirect RNC
   - setbacks of RNC
     - poor anatomical resolution (urethra, kidney ...)
     - restricted grading
       - less comparability with VCUG ...
     - no bladder function assessment
     - some radiation, catheterism (direct RNC)
     - only after 4-5 y of age (cooperative patient)
VUR imaging - alternate methods

Alternate VUR detection techniques

- ce-VUS, RNC
- MRI (MR-VCUG)
  - several papers report feasibility
    - promising technique, reasonable results
  - method
    - catheterism & Gd (0.005 mmol) filling of bladder
    - rapid switching T1-GRE or T1-TRUFI covering entire urinary tract
    - CM reflux to upper tract detectable, urethra assessable
  - present restrictions
    - restricted resolution? availability? functional assessment?
    - presently "work in progress"

e.g., Arthurs OJ, Eur Radiol 2011
Imaging methods

- **IVU**
  - declining importance in children
  - NO importance in VUR / RNP / UTI setting any longer
  - however, has been major imaging tool
    - initially only comprehensive assessment of upper UT
    - could evaluate anatomy + function
    - detection of scaring (Smellie)
    - easy accessible, standardized, reliable
  - replaced by US, (DMSA) scintigraphy, MRI
    - less / no radiation, no / less / other contrast needs ...
    - improved diagnostic capabilities ...
Imaging methods - IVU

• If you do it, do it properly
  – reduce number of films
  – no zonograms
  – adapted CM & radiation dose, hydration ...
    ▪ age adapted, adequate filters
      ◦ also DR needs to adapted to pediatric needs
    ▪ initial US to properly plan investigation
    ▪ individually choose image timing
**Imaging methods - IVU**

**ESPR procedural recommendation**

**Preparation**: NPO, hydration, creatinine, venous line ...
- age: minimum 4-6 weeks infants: before next meal

**Procedure**
- adapt exposure & contrast agent
- proper use of filters, grid, shutters
  - renal area, or KUB (include symphisis)
- initial KUB only if indispensable (e.g., urolithiasis)
- reduced number exposures:
  - one early renal view at 5 min
  - single late KUB at 15-20 min
  - additional focused images, if needed for treatment

**diuretic IVU**: Furosemide iv. 1 mg/kg BW (max. 20 mg) 20 min before view
- inject 5 min before, with, or 5-10 min after CM application

**Goal**: answer specific query with minimal radiation (ALARA)
- avoid multiple, unnecessary or particularly tomographic views

**Indications**
- restricted access to MRU/CT
- pre- or/and post-operative
- urolithiasis, (trauma)
- caliceal diverticula
- ureteral & subtle caliceal pathology

**NOTE:**
- previous dedicated US mandatory

**IV contrast dose**

<table>
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<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt;4</td>
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</table>
Imaging methods

- **Renal scintigraphy** = gold standard for assessment of:
  - renal involvement in UTI (?)
  - scarring
  - (split) renal function
  - usually Tc$^{99m}$ DMSA as tracer
    - better than MAG3 for VUR- / UTI-associated queries
Imaging methods - renal scintigraphy

- **Gold standard**

- **BUT:**
  - sufficient renal function mandatory
  + anatomic information needed
    - initial US? MRI?
    - examiner variability
    - (sedation?) ...

- Split function: \( R 40\%: L 60\% \)
  - "RUP 16\%, RLP 24\%"?
  - \( \Rightarrow \) RUP >5\%, RLP 35-40\%

Courtesy U. Willi
Imaging methods

- **Renal MRI & MRU** = future gold standard for assessment of
  - scars, upper UTI, dysplasia, upper UT involvement ...
  - complications, DDx
  - UT-malformations
  - (split) function & drainage
  - GFR? VUR? ...
  - constantly new techniques being introduced
    - enhanced functional imaging
    - DWI, perfusion, BOLD ... - rTx with VUR & sars?
Imaging methods - renal MRU

- Method
  - scars - T2* & IR sequences
  - upper UTI: + Gd-enhanced T1
    - T1 fs, GRE, VIBE, + Perfusion, DWI …
  - malformations: T2-MRU
    - 3d sequences after Frusemide
**Imaging methods - renal MRU**

- **Method**
  - scars - T2* & IR sequences, upper UTI: + Gd-enhanced T1
  - malformations: T2-MRU
  - function & drainage
    - T1 & BOLD & DWI
    - function assessment possible
    - split renal function & GFR calculated
    - ce-MRI essential for complications
Imaging methods - renal MRU

- Method
  - scars - T2* & IR sequences upper UTI: + Gd-enhanced T1
  - malformations: T2-MRU, function & drainage

BUT: partially still "work in progress"
  - restricted availability, costs, expertise, sedation needs ...

= future one stop imaging after initial US?...
Dilemma in imaging of UTI (& VUR)

Whom?

When?

How?

Whom?
New guidelines

• National Institute For Clinical Excellence (NICE), UK, 2007

• American Urological Association (AUA), 2010

• ESPR/ESUR workgroup-session, 2007

• Numerous national guidelines

• Various guidelines by (sub)specialties
How to image?

- **US**
- **VCUG / RNC, ce-VUS**
- **DMSA**

*has been addressed & discussed!*
How to image?

- **US**
- **VCUG / RNC, ce-VUS**
- **DMSA**
- **IVU - no role in UTI**
- **MRI - no defined place in routine imaging of UTI**
  - mostly for complications or associated malformation ...
- **CT - only in complications, if no MRI available**
  - **DDx, underlying/secondary stones ...**
When to image?
When to image?

Major questions

- early US effective for outcome?
  - first day? first days?
    - feasible & realistic
    - sufficient quality granted?
    - can US answer relevant questions?
  - in all? in whom?
    - only with unclear upper UTI?
    - with no earlier (fetal, neonatal ...) UT screening?
    - only in complicated UTI?
When to image?

Major questions

• early US?

• early DMSA?
  – differentiation upper versus lower UTI?
  – diagnostic or prognostic, treatment relevant impact?
  – consider restrictions
    ▪ needs anatomic imaging for correct reading = needs US
    ▪ involvement ≠ scar – but only scaring relevant …
  – assessment of scaring
    ▪ ONLY reliable 4 - 6 months after UTI
When to image?

Major questions

• early US? early DMSA?

• early VCUG? other VUR assessment test?
  – urine should be clear, UTI treated
  – what for & in whom?
    ▪ impact on acute treatment? long term relevance?
    ▪ in all infants with UTI, what about older children?
  – only with upper or complicated UTI / scaring?
  – benefit of early VUR assessment
    ▪ only compliance may be an argument
When to image?

Major questions

• early US? early DMSA?
• early VCUG? other VUR assessment test?
• MRI needed
  – evident in complication or underlying condition

≡

must be timed individually
When to image?

Major questions
- i.e., depends on query & suspicion & compliance & clinic
  - e.g., in / after upper UTI, with scars, dysplasia ...
    - earliest option for VCUG: as soon as urine is sterile
    - best at 4-6 weeks after UTI, no emergency ... - don't rush
    - prompt US & CT/MRI in complications, severe course ...
    - DMSA for scarring after 4-6 mo
When to image?

Major questions

• early US? early DMSA? early VCUG? MRI?
• i.e., depends on query & suspicion & compliance & clinic
  – e.g., in / after upper UTI, with scars, dysplasia ...
  – PUV, neonatal renal failure ...
    = early imaging (US + VCUG) = first 24 hours
  – suspicion of high grade VUR / complex malformation
    = neonatal assessment
    ▪ less urgent, parental compliance? US day 5-7 …, VCUG at all?
    ▪ don’t rush
    ▪ DMSA after 3-6 mo
Whom to image?
Whom to image?

When to investigate entire UT (early?)

- at least in (complicated) febrile UTI
  - clinically unclear, risk factors ...
    - history of family condition
    - not responding to treatment, urosepsis ...
    - infants, unknown urinary tract anatomy
  - known relevant UT malformation
  - signs for sever disease, not responding ...
Whom to image?

When to look for entire UT

• at least in (complicated) febrile UTI
  – clinically unclear, risk factors …
  – known relevant UT malformation …

• always performed by comprehensive US as first step
  – other / further imaging planned according to results
Whom to image?

When to look for VUR

• (recurrent) febrile (complicated) UTI
  – pathology on DMSA / US
    ▪ renal involvement / damage
    ▪ dilatation or bladder pathology
    ▪ <5 years, therapy implication
  – relevant UT malformation (DDx)
    ▪ infravesical obstruction (boys)
    ▪ megaureter, UPJO …
    ▪ duplex kidney …
Whom to image?

When to look for VUR

- (recurrent) febrile (complicated) UTI
  - pathology on DMSA / US
  - relevant UT malformation (DDx)
  - lower UT dysfunction
  - family screening?
  - neonatal HN?
    - grade? only boys? when?
    - therapy implications? …

= in selected patients (groups)
Whom to image?

How to look for VUR

- VCUG
  - boys / neonates
  - pre-operatively, complex malformation
- ce-VUS (& RNC)
  - girls, follow-up, family screening? bed side
  - exception: indirect RNC for all older patients?
    - supplemented by VCUG, when positive & surgery planned?
    - therapy implications? ...
How to image: When to use what?

European consensus recommendations for VUR

• **VCUG**
  - infant boys, preoperative
  - complex malformation
  - query “urethra” or “diverticula”

• **ce-VUG & RNC**
  - girls
  - follow-up
  - family screening
    - if RNC ⇒ + comprehensive US
How to image: When to use what for VUR?

VUR?

(infant) boys, PUV, malformation -> VCUG

- stop

+ US follow-up + DMSA (fMRI?)

ce-VUS, RNC, (VCUG*)

girls, all others -> - stop

* VCUG in suspected infra-vesical obstruction, para-ostial diverticula, pre-operatively, no ce-VUS / RNC available
Task of (pediatric) radiology

- Know potential diseases & conditions & DDx
  - pathogenesis, origin, history

- Know suitable imaging techniques
  - potential, risks, & limitation, economical aspects

- Know implications of imaging results
  - on patient management & prognosis

- Suggest imaging algorithm
  - adapt individually, follow established guidelines
Discussion

Role of imaging for VUR in combination with UTI

- Remains controversial
  - depends on therapy consequences
  - growing knowledge, new concepts ...
    - like a pendulum

- Try to reduce overuse of imaging
  - invasive (catheter)
  - radiation (VCUG, RNC)
    - BUT: lack of approved US-CM (ce-VUS)
  - without missing important conditions
Role of imaging for VUR in combination with UTI

• Remains controversial

• Try to reduce overuse of imaging

• Avoid missing important conditions
  – with long term sequelae
  – goal: prevent harm to the kidney
    = if you do invasive imaging
      do it right, don’t miss important aspects
Discussion

Role of imaging for VUR in combination with UTI

• controversial, reduce overuse, avoid missing conditions

⇒ extensive use of comprehensive US
  – high quality, extended criteria
  – post-void check
  – apply modern methods ...
Conclusion

• Imaging in UTI remains controversial
  – still: an important condition, deserves dedicated imaging
    ▪ though less generous indications than earlier

  But: imaging must address all essential aspects

• Properly select patients
  – based on history
  – and on initial detailed US findings
    ▪ with respect to therapeutic consequences
    ▪ and possible long term sequelae
Conclusion

- Imaging in UTI remains important
- Properly select patients
- Select appropriate method
  - US, VCUG, ce-VUS, RNC, DMSA, MRU ...
  - based on availability & query / history, when in course
    - gender, treatment plan, available expertise ...
    - include assessment of intra-renal VUR, dysfunction
    - high quality must be granted
  - avoid too frequent follow-up
    - proper timing, correct technique
    - consequence?
„Take away“

• Established “gold standards” exist
  – not to be dropped light mindedly
    ▪ individualized imaging approach?

• New imaging concepts
  – at present complimentary, introduce only when proven
    = evaluation of new modalities & algorithms essential
    ▪ potential, impact on management & outcome
    ▪ strong research efforts necessary

• If benefit proven, make it available to all
  = introduce altered imaging protocols at high quality
US

- Most important diagnostic tool
- Always first modality
  - sometimes only investigation in UTI
- Acute phase + follow-up

**US**

- Most important diagnostic tool
- *Always first modality, acute phase + follow-up*
- To be performed by pediatratically experienced investigator
- Include (a)CDS, careful assessment
  - well hydrated child
  - pre- + post-void imaging
  - use aCDS = reduces need for DMSA

US

• Most important diagnostic tool, always first modality
• Acute + follow-up, experienced investigator, (a)CDS …
• Allows
  – grading of UTI
  – detection of obstruction & malformation
  – assessment of complications & stones & …
  – evaluation of (evidence of) VUR
### NICE Guideline

<table>
<thead>
<tr>
<th>Age</th>
<th>responds well to treatment in 48 h</th>
<th>atypical UTI 1</th>
<th>recurrent UTI 2</th>
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<tr>
<td>Age &lt;6months</td>
<td>US 3</td>
<td>US, DMSA, VCUG</td>
<td>US, DMSA, VCUG</td>
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<td>Age 6 months - 3 years</td>
<td>None</td>
<td>US + DMSA 4</td>
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<tr>
<td>Age &gt; 3 years</td>
<td>None</td>
<td>US</td>
<td>US + DMSA 4</td>
</tr>
</tbody>
</table>

= routine use of imaging for localization of UTI not recommended

**But:** in young children clinical & laboratory diagnosis can be difficult

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1. Atypical UTI: Non-Escherechia coli UTI: seriously ill, poor urine flow, abdominal or bladder mass, raised creatinine, septicemia, failure to respond to treatment with suitable antibiotics within 48 h
2. Two or more episodes of UTI with acute pyelonephritis/upper urinary tract infection or one episode of UTI with acute pyelonephritis/upper urinary tract infection plus one or more episode of UTI with cystitis/lower urinary tract infection or three or more episodes of UTI with cystitis/lower urinary tract infection
3. If ultrasound is abnormal, consider a VCUG
4. Consider VCUG if dilatation on ultrasound, poor urine flow, non-E. coli infection, family history of VUR
**ESPR imaging algorithm - UTI**

if clinically clear + known normal urinary tract anatomy
- if respond well to treatment, 
  - only delayed imaging for scaring in upper UTI?

**UTI**

- recommended within first days, particularly in severe symptoms and in infants / neonates

**US + power Doppler**

- normal US
- clinically cystitis

- stop

- follow-up US?

- normal

**normal US**

- no power Doppler or Doppler equivocal
- But: clinically upper UTI

**Pyo(hydro)nephrosis => PCN**

- if no response to AB-treatment

**Pyelonephritis / Nephritis**

- aPN/scar/upper UTI

**follow-up US**

- VUR-evaluation
  - always in infants
  - mostly in < 5 years
  - recurrent UTI in > 5 ys
  - VCUG in boys
  - ce-VUS in girls (if available)
  - for VUR follow-up
  - ce-VUS or RNC (if available)

**late DMSA**

- after 6 - 12 months
- or (functional) renal MRI

**bladder function studies**

- > 4 years, urodynamics

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**UTI criteria**: urine sample and blood count

- Leucocyturia, positive nitrite
- positive culture (10^4 = catheter sample, 10^6 normal voiding), Leucocytosis, elevated CRP
- reliable clinical diagnosis essential = most important entry criteria for imaging!!

**for DD => MRI/CT; Indications**:

- complicated stone disease (CT, un-enhanced scan)
- complicated UTI (XPN, Tb, abscess ...)
- DD tumour, complicated / infected cyst

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**The NICE Guideline**
Controversies

• Do we pick up those at risk of recurrence
• Do we pick up those at risk of renal scarring?
• Evaluation of guidelines & recommendations?
• Evidence vs economy vs eminence?
• Invasiveness justified? ...
• Long term impact?


Tse NK et al. (2009) Imaging studies for first urinary tract infection in infants less than 6 months old: can they be more selective? Pediatr Nephrol 24:1699-1703
Controversies

- Pick up those at risk of recurrence & renal scarring?
- Evidence versus economy versus eminence? Invasive?
- Proper evaluation of guidelines & recommendations?
- “...The best approach for imaging studies in children with UTI is debatable - because of doubtful evidence & concerns over actual value of these studies in altering management & final outcome.”
- “... In view of all these studies and recommendations, VUR (& UTI) management is a subject of constant debate. The need for higher-quality evidence to guide management is increasing.”
Conclusion

• Imaging in UTI remains important, but controversial
  – to detect underlying pathology in selected patients
  – to monitor kidneys in order to prevent renal scarring

• Focus moved - from «down-up» to «top-down» approach
  – with focus on kidney
  – preferably using non-invasive, non-radiating imaging

• Patients must be carefully selected
  – for more invasive investigations, particularly older children
  – (bladder) function will become even more important

• Proper validation of new guidelines needed
Questions?
- welcome!
Imaging methods - urosonography

**ESPR procedural recommendation**

well hydrated patient, full bladder, adequate equipment/transducer/training ... 

**Urinary bladder:** size (capacity), shape, ostium, wall, bladder neck  
include distal ureter & retrovesical space/inner genitalia, urachus? ...  
optional: CDS for urine inflow, perineal US, scrotal US ... 

**Kidneys:** lateral and/or dorsal, longitudinal & axial sections  
parenchyma? pelvo-caliceal system?  
standardised measurements in 3 dimensions & volume calculation  
if dilated: max. axial pelvis & calix, narrowest parenchymal width, + UPJ  
optional: (a)CDS & duplex-Doppler ... 

**Post void evaluation**  
**Bladder:** residual volume, bladder neck, shape & configuration  
**Kidneys:** dilatation of pelvo-caliceal system / ureter changed?  
optional: contrast-enhanced urosonography, 3DUS ... 

*additional abdominal US survey recommended*
Imaging methods - VCUG

**ESPR procedural recommendation**

No diet restriction or enema, urine analysis, potentially antibiotics ...

**catheterism:** feeding tube, 4-8 french or suprapubic puncture
latex precaution: neuro tube defect, bladder extrophy ...

**fluoroscopic view** of renal fossae & bladder, initial + early filling
Bladder filling with radiopaque contrast
gravity drip = bottle 30-40 cm above table, watch dripping, AB?

**fluoroscopy:** if signs of increased bladder pressure, imminent voiding, urge ...
   bilateral oblique views of distal ureters, include catheter
document VUR, include kidney (spot film, intra-renal reflux)

**when voiding:** remove catheter, unless cyclic VCUG = 3 fillings, 1st y(s)
   female: 2 spots of distended urethra (slightly oblique)
   male: 2-3 spots during voiding (ap & high oblique / lateral)
 ⇒ include renal fossae during voiding, if VUR => spot film

**after voiding:** ap view of bladder & renal fossae
   assess contrast drainage form kidney if refluxed

**Note:** VUR staging, AB-prophylaxis? ...
**Imaging methods - ce-VUS**

**ESPR procedural recommendation**

No diet restriction or enema, urine analysis; AB as in VCUG ...

**Catheterism:** feeding tube, 4-8 french, or suprapubic puncture

anaesthetic lubricant or coated plaste

**Standard US of bladder & kidneys** (supine, ± prone)

Bladder filling with NaCl (only from plastic containers)

**Install US contrast medium,** e.g., SonoVue®, 0.5-1.0% of bladder volume

slow, US monitoring, potentially fractional administration

**Peri-/ post-contrast US of bladder + kidneys:** continuous, alternating

US modalities: fundamental, HI, CDS, contrast specific methods

alternate scans of right & left side during & after filling

**During/after voiding:** US of bladder & kidneys & urethra

supine ± prone, laying or sitting or standing

VUR diagnosis: echogenic micro-bubbles in ureters or renal pelves
UTI

US + αCDS especially if severe or in infant

- normal+clinically cystitis
- normal+clinically upper UTI
- pyelitis/nephritis
- pyo/hydro-nephrosis

DMSA in acute phase

Normal

consider repeat US

Follow-up US

VUR-evaluation
- always in infants
- usually if <4 years
- usually if recurrent UTI

DMSA in 4-6 months (or fMRU)

Bladder function studies (Urodynamics if over 6 years)

STOP

If normal

If normal US

DMSA

- The main role of DMSA is to detect renal scarring 4-6 months post UTI

- Large renal scars can also be seen on US, but US is not as sensitive for renal scarring as DMSA