

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Montini G, Tullus K, Hewitt I. Febrile urinary tract infections in children. <i>N Engl J Med.</i> 2011;365(3):239-250.	Review/Other-Dx	N/A	Review febrile UTI in children.	No results stated in abstract.	4
2. Roberts KB. Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. <i>Pediatrics.</i> 2011;128(3):595-610.	Review/Other-Dx	N/A	To revise the American Academy of Pediatrics practice parameter regarding the diagnosis and management of initial UTIs in febrile infants and young children.	Diagnosis is made on the basis of the presence of both pyuria and at least 50,000 colonies per mL of a single uropathogenic organism in an appropriately collected specimen of urine. After 7 to 14 days of antimicrobial treatment, close clinical follow-up monitoring should be maintained to permit prompt diagnosis and treatment of recurrent infections. US of the kidneys and bladder should be performed to detect anatomic abnormalities. Data from the most recent 6 studies do not support the use of antimicrobial prophylaxis to prevent febrile recurrent UTI in infants without VUR or with grade I to IV VUR. Therefore, a VCUG is not recommended routinely after the first UTI; VCUG is indicated if renal and bladder US reveals hydronephrosis, scarring, or other findings that would suggest either high-grade VUR or obstructive uropathy and in other atypical or complex clinical circumstances. VCUG should also be performed if there is a recurrence of a febrile UTI. The recommendations in this guideline do not indicate an exclusive course of treatment or serve as a standard of care; variations may be appropriate. Recommendations about antimicrobial prophylaxis and implications for performance of VCUG are based on currently available evidence. As with all American Academy of Pediatrics clinical guidelines, the recommendations will be reviewed routinely and incorporate new evidence, such as data from the Randomized Intervention for Children With Vesicoureteral Reflux (RIVUR) study.	4

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3. Koyle MA, Elder JS, Skoog SJ, et al. Febrile urinary tract infection, vesicoureteral reflux, and renal scarring: current controversies in approach to evaluation. <i>Pediatr Surg Int.</i> 2011;27(4):337-346.	Review/Other-Dx	N/A	A review on the ideal approach to the radiological evaluation of children with UTI.	No results stated.	4
4. Lim R. Vesicoureteral reflux and urinary tract infection: evolving practices and current controversies in pediatric imaging. <i>AJR Am J Roentgenol.</i> 2009;192(5):1197-1208.	Review/Other-Dx	N/A	Review recent evolution and controversies in the management of UTI and VUR.	Multi-technique imaging of UTI and VUR is complex and controversial. Evolution in practice patterns is motivated by the desire to rationally minimize unnecessary interventions and radiation exposure. Ongoing evidence-based research is needed to further improve practice guidelines.	4
5. Merguerian PA, Sverrisson EF, Herz DB, McQuiston LT. Urinary tract infections in children: recommendations for antibiotic prophylaxis and evaluation. An evidence-based approach. <i>Curr Urol Rep.</i> 2010;11(2):98-108.	Review/Other-Dx	N/A	Review imaging protocols and use of antibiotic prophylaxis in children with UTI.	Risk of developing long-term complications after a UTI is extremely low, and evidence suggests selective imaging to a select group of children at risk. Finding those at risk for long-term complications is yet to be determined.	4
6. Williams GJ, Hodson EH, Isaacs D, Craig JC. Diagnosis and management of urinary tract infection in children. <i>J Paediatr Child Health.</i> 2012;48(4):296-301.	Review/Other-Dx	N/A	To review and summarize recent primary studies, systematic reviews and guidelines on the diagnosis and management of UTI in children.	No results stated.	4
7. Ismaili K, Wissing KM, Lolin K, et al. Characteristics of first urinary tract infection with fever in children: a prospective clinical and imaging study. <i>Pediatr Infect Dis J.</i> 2011;30(5):371-374.	Observational-Dx	209 children	To provide the clinical characteristics, uropathogen frequencies, and antimicrobial resistance rates of first UTI diagnosed in febrile Belgian children. The ability of noninvasive US to detect renal abnormalities and VUR in these patients was also assessed.	Among these children, 63% were females and 37% were males, and 75% of them had their first UTI before the age of 2 years. The most common causative agent was <i>Escherichia coli</i> (91% of cases) with high rate resistance to ampicillin (58%) and trimethoprim/sulfamethoxazole (38%). Of these children, 25% had evidence of VUR (15 boys and 38 girls). VUR was of low grade in 85% of cases. The overall performance of renal US as a diagnostic test to detect significant uropathies excluding low-grade VUR was excellent; the sensitivity attained 97% and the specificity 94%. Girls represent 63% of cases with first UTI. For 91% of UTIs, <i>Escherichia coli</i> is held responsible with a high rate of resistance to ampicillin and trimethoprim/sulfamethoxazole. US is an excellent screening tool that allows avoidance of unjustified VCUG studies.	3

\* See Last Page for Key

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8. Keren R, Carpenter MA, Hoberman A, et al. Rationale and design issues of the Randomized Intervention for Children With Vesicoureteral Reflux (RIVUR) study. <i>Pediatrics</i> . 2008;122 Suppl 5:S240-250.	Review/Other-Dx	600 children aged 2 to 72 months will be recruited	To determine if antimicrobial prophylaxis with trimethoprim/sulfamethoxazole prevents recurrent UTI and renal scarring in children who are found to have VUR after a first or second UTI in an ongoing RIVUR study.	The primary outcome is recurrence of UTI. Secondary outcomes include time to recurrent UTI, renal scarring (assessed by DMSA scan), treatment failure, renal function, resource utilization, and development of antimicrobial resistance in stool flora. The RIVUR study will provide useful information to clinicians about the risks and benefits of prophylactic antibiotics for children who are diagnosed with VUR after a first or second UTI. The data and specimens collected over the course of the study will allow researchers to better understand the pathophysiology of recurrent UTI and its sequelae.	4
9. Montini G, Rigon L, Zucchetta P, et al. Prophylaxis after first febrile urinary tract infection in children? A multicenter, randomized, controlled, noninferiority trial. <i>Pediatrics</i> . 2008;122(5):1064-1071.	Experimental-Tx	338 children aged 2 months to <7 years	Multicenter, open-label, randomized controlled multicenter trial to determine whether no prophylaxis is similar to antimicrobial prophylaxis for 12 months in reducing the recurrence of febrile UTI in children after a first febrile UTI.	Intention-to-treat analysis showed no significant differences in the primary outcome between no prophylaxis and prophylaxis: 12 (9.45%) of 127 vs 15 (7.11%) of 211. In the subgroup of children with reflux, the recurrence of febrile UTI was 9 (19.6%) of 46 on no prophylaxis and 10 (12.1%) of 82 on prophylaxis. No significant difference was found in the secondary outcome: 2 (1.9%) of 108 on no prophylaxis vs 2 (1.1%) of 187 on prophylaxis. Bivariate analysis and Cox proportional hazard model showed that grade III reflux was a risk factor for recurrent febrile UTIs. Whereas increasing age was protective, use of no prophylaxis was not a risk factor. For children with or without primary nonsevere reflux, prophylaxis does not reduce the rate of recurrent febrile UTIs after the first episode.	1

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10. Pennesi M, Travan L, Peratoner L, et al. Is antibiotic prophylaxis in children with vesicoureteral reflux effective in preventing pyelonephritis and renal scars? A randomized, controlled trial. <i>Pediatrics</i> . 2008;121(6):e1489-1494.	Experimental-Tx	100 patients	Multicenter, open-label, randomized, controlled trial to assess the effectiveness of antibiotic prophylaxis in preventing recurrence of pyelonephritis and avoiding new scars in a sample of children who were younger than 30 months and VUR.	The baseline characteristics in the 2 study groups were similar. There were no differences in the risk for having at least 1 pyelonephritis episode between the intervention and control groups. At the end of follow-up, the presence of renal scars was the same in children with and without antibiotic prophylaxis. Continuous antibiotic prophylaxis was ineffective in reducing the rate of pyelonephritis recurrence and the incidence of renal damage in children who were younger than 30 months and had VUR grades II through IV.	1
11. Hodson EM, Wheeler DM, Vimalchandra D, Smith GH, Craig JC. Interventions for primary vesicoureteric reflux. <i>Cochrane Database Syst Rev</i> . 2007(3):CD001532.	Review/Other-Dx	11 studies 1,148 children	Meta-analysis was performed to evaluate the benefits and harms of different treatment options for primary VUR.	Risk of UTI by 2, 5 and 10 years was not significantly different between surgical and medical groups (2 years RR 1.07, 95% CI, 0.32 to 2.09; 5 years RR 0.99, 95% CI, 0.79 to 1.26; 10 years RR 1.06, 95% CI, 0.78 to 1.44). Combined treatment resulted in a 50% reduction in febrile UTI by 10 years (RR 0.54, 95% CI, 0.55 to 0.92) but no concomitant reduction in risk of new or progressive renal damage by 10 years (RR 1.03, 95% CI, 0.53 to 2.00). In 2 small studies no significant differences in risk for UTI (RR 0.75, 95% CI, 0.15 to 3.84) or renal damage (RR 1.70, 95% CI, 0.36 to 8.07) were found between antibiotic prophylaxis and no treatment. It is uncertain whether the treatment of children with VUR confers clinically important benefit. The additional benefit of surgery over antibiotics alone is small at best. Assuming a UTI rate of 20% for children with VUR on antibiotics for 5 years, 9 reimplantations would be required to prevent 1 febrile UTI, with no reduction in the number of children developing any UTI or renal damage.	4

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12. Shaikh N, Ewing AL, Bhatnagar S, Hoberman A. Risk of renal scarring in children with a first urinary tract infection: a systematic review. <i>Pediatrics</i> . 2010;126(6):1084-1091.	Meta-analysis	33 studies	To review the prevalence of acute and chronic renal imaging abnormalities in children after an initial UTI.	Among children with an initial episode of UTI, 57% (95% CI: 50–64) had changes consistent with acute pyelonephritis on the acute-phase DMSA renal scan and 15% (95% CI: 11–18) had evidence of renal scarring on the follow-up DMSA scan. Children with VUR were significantly more likely to develop pyelonephritis (RR: 1.5 [95% CI: 1.1–1.9]) and renal scarring (RR: 2.6 [95% CI: 1.7–3.9]) compared with children with no VUR. Children with VUR grades III or higher were more likely to develop scarring than children with lower grades of VUR (RR: 2.1 [95% CI: 1.4–3.2]). The pooled prevalence values provided from this study provide a basis for an evidence-based approach to the management of children with this frequently occurring condition.	M
13. Ditchfield MR, De Campo JF, Cook DJ, et al. Vesicoureteral reflux: an accurate predictor of acute pyelonephritis in childhood urinary tract infection? <i>Radiology</i> . 1994;190(2):413-415.	Observational-Dx	150 consecutive patients; 300 kidneys	Prospective study to determine the association between VUR and the presence of acute pyelonephritis in children with UTI. All patients had renal cortical scintigraphy (with Tc-99m DMSA or Tc-99m gluconate) and VCUG to identify the presence of cortical defects and VUR, respectively.	Of 300 kidneys, 88 (29.3%) had a cortical defect at scintigraphy. 54/88 patients (61%) did not have VUR demonstrated at VCUG. Conversely, 72/300 kidneys (24%) had VUR; of these, 38 (53%) had no cortical defect. Sensitivity of VCUG in helping predict a defect was 38.6%, and the specificity was 82.1%. VUR (as shown by VCUG) and renal cortical scintigraphic defects frequently occur independently of each other. Renal cortical scintigraphy may be a more accurate predictor of patients at risk for scarring.	3
14. Goldman M, Bistrizter T, Horne T, Zoareft I, Aladjem M. The etiology of renal scars in infants with pyelonephritis and vesicoureteral reflux. <i>Pediatr Nephrol</i> . 2000;14(5):385-388.	Observational-Dx	74 patients	To determine by means of follow-up DMSA, the relationship between VUR and its degree, pyelonephritis during infancy, and renal parenchymal findings in infants with first UTI.	14/74 (19%) had abnormal DMSA scan. Grade of VUR positively correlated with abnormal DMSA scan ( $P<0.001$ ). No abnormal DMSA in renal units with VUR grade 0-2 (0/114). 12/32 (37.5%) renal units grade 3-4 VUR had abnormal DMSA. 2/2 (100%) renal units grade 5 VUR had abnormal DMSA. Follow-up DMSA scanning for scarring should not be performed routinely in every infant with UTI. It should be reserved for children with VUR grade 3 and above.	2

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15. Gordon I, Barkovics M, Pindoria S, Cole TJ, Woolf AS. Primary vesicoureteric reflux as a predictor of renal damage in children hospitalized with urinary tract infection: a systematic review and meta-analysis. <i>J Am Soc Nephrol.</i> 2003;14(3):739-744.	Review/Other-Dx	12 studies; 7 with data for 537 children and 7 with data for 1,062 kidneys	To determine how effectively the finding of VUR on VCUG in children hospitalized with UTI predicted renal parenchymal disease on DMSA scan. Observational studies were reviewed.	Positive VCUG increases the risk of renal damage in hospitalized UTI patients by 20%. Negative VCUG increases the chance of no renal involvement by 8%. Primary VUR detected by cystography is a weak predictor of renal isotopic defects and absence of demonstrable VUR does not rule out such renal defects.	4
16. Lee JH, Son CH, Lee MS, Park YS. Vesicoureteral reflux increases the risk of renal scars: a study of unilateral reflux. <i>Pediatr Nephrol.</i> 2006;21(9):1281-1284.	Observational-Dx	48 patients	To assess the impact of VUR after the first pyelonephritis on renal scar following acute pyelonephritis by comparing refluxing renal units with nonrefluxing renal units in children under age 5 with unilateral primary VUR.	34/48 (70.8%) refluxing units had positive DMSA on initial scan – dropped to 23/48 (47.9%) at 6 month follow-up DMSA. 13/48 (27.1%) of nonrefluxing units had a positive DMSA on initial scan – dropped to 7/48 (14.6%) at 6 month follow-up DMSA. No significant variance in scarring with VUR grade. VUR increases risk of post-pyelonephritic renal scars in children under age 5.	3
17. Orellana P, Baquedano P, Rangarajan V, et al. Relationship between acute pyelonephritis, renal scarring, and vesicoureteral reflux. Results of a coordinated research project. <i>Pediatr Nephrol.</i> 2004;19(10):1122-1126.	Review/Other-Dx	269 patients	Prospective study to determine the incidence of permanent renal damage in children after pyelonephritis and its relationship to VUR and demographic and clinical data.	150/269 children with UTI had VUR. 170/269 children with UTI had permanent renal damage. Of children with VUR, 72% had permanent renal damage compared with 52% of children without VUR. DMSA should be performed if it will change patient management, particularly in those patients with recurrent UTI, VUR, and older age.	4
18. Polito C, Rambaldi PF, Signoriello G, Mansi L, La Manna A. Permanent renal parenchymal defects after febrile UTI are closely associated with vesicoureteric reflux. <i>Pediatr Nephrol.</i> 2006;21(4):521-526.	Observational-Dx	206 patients with primary VUR and 77 without VUR	Prospective study to analyze the occurrence of DMSA detected renal scarring in children with febrile UTI in patients with and without VUR as detected by direct radionuclide cystography.	In patients with VUR, 40% had renal defects on DMSA, compared to 6% of patients without VUR. Most permanent renal defects in children with UTI are associated with VUR. Direct radionuclide cystography should be the first-line investigation in children with febrile UTI.	2

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19. Sastre JB, Aparicio AR, Cotallo GD, Colomer BF, Hernandez MC. Urinary tract infection in the newborn: clinical and radio imaging studies. <i>Pediatr Nephrol.</i> 2007;22(10):1735-1741.	Observational-Dx	301 neonates in 28 neonatal units community-acquired UTI, n=250; nosocomial UTI, n=51	Multicenter study to assess clinical characteristics and results of radio imaging studies and compare community-acquired UTI with nosocomial UTI in neonates with UTI consecutively admitted to neonatal units in Spain over 3 years.	Abnormal renal US was present in 37.1% of cases (34% in community-acquired UTI and 54.5% in nosocomial UTI, $P<0.01$ ). VCUG showed VUR in 27% of cases (23.8% in community-acquired UTI and 48.6% in nosocomial UTI, $P<0.01$ ). In patients with abnormal renal US and VUR, renal scan with DMSA performed early after UTI revealed cortical defects in 69.5% of cases. However, in patients with abnormal renal US and normal VCUG, DMSA also revealed cortical defects in 39% of cases. Absence of VUR in neonates with UTI and abnormal renal US does not exclude the presence of cortical defects suggestive of pyelonephritis.	3
20. Wennerstrom M, Hansson S, Jodal U, Stokland E. Primary and acquired renal scarring in boys and girls with urinary tract infection. <i>J Pediatr.</i> 2000;136(1):30-34.	Observational-Dx	1,221 patients (989 girls and 232 boys); 753 evaluated by urography	Population-based cohort. Prospective study to determine when pyelonephritic renal scarring was detected in children with UTI by urography and characterize those with primary and acquired scarring.	74 children had renal scarring (40 had acquired scarring). Primary scarring found in 18/21 (86%) of the boys and 16/53 (30%) of the girls. Majority of boys had VUR (67%) compared to 23% for girls. Most boys had primary, probably congenital, reflux-associated renal damage, whereas most girls had acquired scarring related to recurrences of febrile UTI.	3
21. Papadopoulou F, Efremidis SC, Oiconomou A, et al. Cyclic voiding cystourethrography: is vesicoureteral reflux missed with standard voiding cystourethrography? <i>Eur Radiol.</i> 2002;12(3):666-670.	Observational-Dx	275 patients had 2 cycles	Prospective study to determine how often VUR is intermittent in children under age 2 and to determine the reliability of VCUG.	50/257 patients had VUR only detected on second fill. 13/18 children with reflux on first fill had discordant finding on second fill. Cyclic VCUG enhances the ability of the method to detect and grade reflux.	3
22. Polito C, Moggio G, La Manna A, Cioce F, Cappabianca S, Di Toro R. Cyclic voiding cystourethrography in the diagnosis of occult vesicoureteric reflux. <i>Pediatr Nephrol.</i> 2000;14(1):39-41.	Review/Other-Dx	370 patients	To determine if higher grade VUR can be missed on a single-cycle VCUG and whether older children can benefit from a 2-cycle VCUG. Patients consecutively had 2 cycles of filling and voiding cyclic VCUG.	104/378 patients who underwent cyclic VCUG were over age 3. 61 refluxing ureters from 45 patients detected only on second fill. 4 with grade 4 and 3 with grade 5; VUR missed on first fill. 10/22 patients over age 3 had their reflux diagnosed only on second fill. Even high-grade VUR can be missed on a single fill VCUG. Cyclic VCUG is useful in children over age 3, in addition to younger children.	4

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23. Rosenberg AR, Rossleigh MA, Brydon MP, Bass SJ, Leighton DM, Farnsworth RH. Evaluation of acute urinary tract infection in children by dimercaptosuccinic acid scintigraphy: a prospective study. <i>J Urol.</i> 1992;148(5 Pt 2):1746-1749.	Review/Other-Dx	65 children evaluated; 34 had abnormal DMSA scans	A prospective study examining the incidence of DMSA abnormalities in children at the time of acute UTI, the progression of these abnormalities following treatment and their correlation with the presence of VUR is reported.	DMSA scans performed within 72 hours of presentation in 65 previously healthy children with acute UTI were abnormal in 34 (52%). The scan appearances of 30/36 (83%) initially abnormal kidneys improved or became normal on the repeat DMSA study performed at 3 to 6 months after the acute UTI. A cystogram demonstrated significant VUR in 11/45 cases (24%). Of these 11 cases 10 had abnormal DMSA studies and 1 had dilated upper tracts on US. The incidence of DMSA abnormalities at the time of acute UTI is high but these abnormalities tend to resolve with time. An abnormal DMSA study at the time of UTI identifies most children with significant VUR, and in the series a combination of US and DMSA identified all cases. This study may have major implications for the clinical investigation of children with UTI.	4
24. Ataei N, Madani A, Habibi R, Khorasani M. Evaluation of acute pyelonephritis with DMSA scans in children presenting after the age of 5 years. <i>Pediatr Nephrol.</i> 2005;20(10):1439-1444.	Observational-Dx	52 patients	Prospective study to assess the occurrence of renal parenchymal lesions using DMSA in children over 5 years admitted with a first-time symptomatic UTI.	41/52 (79%) had renal lesion demonstrated via DMSA in acute phase of illness. 16/41 (39%) with positive DMSA also had abnormal US. 9/32 (28%) who underwent repeat DMSA had persistent lesions. 23/32 (72%) who underwent repeat DMSA showed partial regression of the lesions. Older children are not less susceptible to renal parenchymal scarring than younger children. Findings suggest in children over 5 years DMSA may be more appropriate than VCUG.	2
25. Chesney RW, Carpenter MA, Moxey-Mims M, et al. Randomized Intervention for Children With Vesicoureteral Reflux (RIVUR): background commentary of RIVUR investigators. <i>Pediatrics.</i> 2008;122 Suppl 5:S233-239.	Review/Other-Dx	N/A	A background commentary of RIVUR investigators. A definitive study is needed to determine the value of antimicrobial prophylaxis with regards to the recurrence of UTI and the incidence of renal scarring.	No results stated.	4



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26. Lahdes-Vasama T, Niskanen K, Ronnholm K. Outcome of kidneys in patients treated for vesicoureteral reflux (VUR) during childhood. <i>Nephrol Dial Transplant.</i> 2006;21(9):2491-2497.	Observational-Dx	127 patients	Retrospective study to determine outcome of renal function and blood pressure at early middle age in patients treated for VUR during childhood.	US detected no scarring in 53/127 (42%). Unilateral scarring seen in 44/127 (35%) and bilateral scarring in 30/127 (24%). GFR showed moderate to severe renal insufficiency in 4/127 (3%) all with bilateral scarring. Abnormal GFR in 83% with bilateral scarring and 62% of remaining participants. Hypertension previously diagnosed in 14/127 (11%), 8 of which had bilateral scarring. Renal function was slightly lowered in more than half of participants. Unilateral scarring patients were similar to unscarred patients except for tendency for hypertension in scarred. 83% of patients with bilateral scarring had lowered renal function—half had hypertension. Long term follow-up of patients with VUR is emphasized.	3

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27. Williams G, Craig JC. Long-term antibiotics for preventing recurrent urinary tract infection in children. <i>Cochrane Database Syst Rev.</i> 2011(3):CD001534.	Meta-analysis	12 studies 1,557 children	To determine the efficacy and harms of long-term antibiotics to prevent recurrent UTI in children.	6 (5 analyzed, 1,069 children) of 12 studies compared antibiotics with placebo/no treatment. Compared to placebo/no treatment, when all studies were included, antibiotics did not appear to reduce the risk of symptomatic UTI (RR 0.75, 95% CI, 0.36 to 1.53) however, when authors evaluated the effects of antibiotics in studies with low risk of bias, there was a statistically significant reduction (RR 0.68, 95% CI, 0.48 to 0.95). The effect was similar in children with VUR (RR 0.65, 95% CI, 0.39 to 1.07) compared to those without VUR (RR 0.56, 95% CI, 0.15 to 2.12). There was no consistency in occurrence of adverse events. 3 studies reported antibiotic resistance, showing a nonsignificant increased risk for resistance to the antibiotic in the active treatment groups (RR 2.4, 95% CI, 0.62 to 9.26). 5 studies (4 analyzed, 367 children) compared 1 antibiotic with another but all compared different combinations or different outcomes and studies were not pooled. 2 studies reported microbial resistance, nitrofurantoin having a significantly lower risk of resistance than cotrimoxazole (RR 0.54, 95% CI, 0.31 to 0.92). 1 study compared alternate with every day cefadroxil treatment. Long-term antibiotics appear to reduce the risk of repeat symptomatic UTI in susceptible children but the benefit is small and must be considered together with the increased risk of microbial resistance.	M

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28. Craig JC, Simpson JM, Williams GJ, et al. Antibiotic prophylaxis and recurrent urinary tract infection in children. <i>N Engl J Med.</i> 2009;361(18):1748-1759.	Review/Other-Dx	11 trials 2,046 children	Systematic review was performed to determine whether long-term antibiotics prevent UTI in children with and without VUR.	Recurrent single symptomatic UTI was not reduced by prophylaxis (RR 0.83, 95% CI, 0.66 to 1.05). Prophylactic efficacy was not affected by a priori subgroup analysis considering children with or without VUR, site of UTI or duration of treatment. It was, however, affected when trials were divided by study quality: in trials with adequate allocation concealment, recurrent UTI was reduced by prophylaxis (RR 0.68, 95% CI, 0.48 to 0.95). Antibiotic prophylaxis reduced the risk of a repeat positive urine culture. There was no significant difference in the rate of new or deteriorated renal scars. The most common adverse events were vomiting or gastrointestinal intolerance (7.3% reported in 1 study). In children with or without VUR, antibiotic prophylaxis may not prevent recurrent symptomatic UTI.	4
29. Hoberman A, Greenfield SP, Mattoo TK, et al. Antimicrobial prophylaxis for children with vesicoureteral reflux. <i>N Engl J Med.</i> 2014;370(25):2367-2376.	Experimental-Tx	607 children	To determine whether long-term antimicrobial prophylaxis is effective in preventing febrile or symptomatic recurrences and reducing the likelihood of renal scarring, and the extent to which it contributes to bacterial resistance.	Recurrent UTI developed in 39/302 children who received prophylaxis as compared with 72/305 children who received placebo (RR, 0.55; 95% CI, 0.38 to 0.78). Prophylaxis reduced the risk of recurrences by 50% (hazard ratio, 0.50; 95% CI, 0.34 to 0.74) and was particularly effective in children whose index infection was febrile (hazard ratio, 0.41; 95% CI, 0.26 to 0.64) and in those with baseline bladder and bowel dysfunction (hazard ratio, 0.21; 95% CI, 0.08 to 0.58). The occurrence of renal scarring did not differ significantly between the prophylaxis and placebo groups (11.9% and 10.2%, respectively). Among 87 children with a first recurrence caused by <i>Escherichia coli</i> , the proportion of isolates that were resistant to trimethoprim-sulfamethoxazole was 63% in the prophylaxis group and 19% in the placebo group.	1

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30. Shaikh N, Hoberman A, Rockette HE, Kurs-Lasky M. Identifying children with vesicoureteral reflux: a comparison of 2 approaches. <i>J Urol.</i> 2012;188(5):1895-1899.	Observational-Dx	309 children 1 to 24 months old	To compare the sensitivities of the top-down Tc-99m-DMSA renal scan to screen) and biomarker based (CRP level at presentation) approaches in identifying children with VUR.	The top-down and CRP based approaches missed 33% and 29% of cases of high grade VUR, respectively.	3
31. Downs SM. Technical report: urinary tract infections in febrile infants and young children. The Urinary Tract Subcommittee of the American Academy of Pediatrics Committee on Quality Improvement. <i>Pediatrics.</i> 1999;103(4):e54.	Review/Other-Dx	432 articles	Comprehensive review and analysis of literature for diagnosis and management of febrile UTI in children under 2 years of age. Recommendations for the management of UTI are presented.	Gold standard definition of a UTI is growth on a culture of a urine specimen obtained from a tap. PPV of a positive culture from a bagged urine specimen is 15%. Sensitivity and specificity of positive catheterization urine culture is 95% and 99% respectively. Prevalence of VUR drops from ~0.5 to ~0.3 from age 0 to ~2, plateaus at ~0.3 from age ~2 to ~7, and then drops precipitously at age ~7 (based on meta-analysis of 54 studies of VUR in children with UTI). Higher grade of VUR correlates with higher risk of renal scarring (based on meta-analysis of 48 studies). Renal US has low sensitivity for low-grade VUR, but relatively higher sensitivity for high-grade VUR. Renal US alone is an inadequate imaging evaluation for children under age 2 with a febrile UTI. VCUG must also be performed.	4
32. Urinary tract infection in children: diagnosis, treatment and long-term management. National Institute for Health and Clinical Excellence. August 2007. 2007; <a href="http://www.nice.org.uk/nicemedia/pdf/CG54NICEguideline.pdf">http://www.nice.org.uk/nicemedia/pdf/CG54NICEguideline.pdf</a> .	Review/Other-Dx	N/A	Guideline on the diagnosis, treatment and long-term management of UTI in children. The aim of the guideline is to achieve more consistent clinical practice, based on accurate diagnosis and effective management.	N/A	4
33. Marks SD, Gordon I, Tullus K. Imaging in childhood urinary tract infections: time to reduce investigations. <i>Pediatr Nephrol.</i> 2008;23(1):9-17.	Review/Other-Dx	N/A	Review literature on investigations of childhood UTI and propose a protocol for carrying out selected investigations in high-risk children.	Authors recommend that targeting investigations to specific children (as opposed to protocol-based investigations of all children with UTI), will be clinically safe and effective and will avoid the unnecessary distress and cost of invasive investigations.	4

Urinary Tract Infection-Child  
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
34. Brandstrom P, Neveus T, Sixt R, Stokland E, Jodal U, Hansson S. The Swedish reflux trial in children: IV. Renal damage. <i>J Urol.</i> 2010;184(1):292-297.	Experimental-Tx	203 total patients; 128 girls and 75 boys younger than 2 years with grade III-IV reflux	Multicenter randomized trial to compare the development of new renal damage in small children with dilating VUR randomly allocated to antibiotic prophylaxis, endoscopic treatment or surveillance as the control group.	New renal damage in a previously unscarred area was seen in 13 girls and 2 boys. 8/13 girls were on surveillance, 5 received endoscopic therapy and none were on prophylaxis ( $P=0.0155$ ). New damage was more common in children with than without febrile recurrence (11/49 or 22% vs 4/152 or 3%, $P<0.0001$ ). In boys the rate of new renal damage was low. It was significantly higher in girls and most common in the control surveillance group. There was also a strong association between recurrent febrile UTI and new renal damage in girls.	1
35. Peters CA, Skoog SJ, Arant BS, Jr., et al. Summary of the AUA Guideline on Management of Primary Vesicoureteral Reflux in Children. <i>J Urol.</i> 2010;184(3):1134-1144.	Review/Other-Dx	131 articles 17,972 patients	To summarize the existing evidence pertaining to children with diagnosed reflux including those young or older than 1 year without evidence of bladder and bowel dysfunction and those older than 1 year with evidence of bladder and bowel dysfunction.	Meta-analysis identified increasing frequency of UTI, increasing grade of VUR and presence of bladder and bowel dysfunction as unique risk factors for renal cortical scarring. The efficacy of continuous antibiotic prophylaxis could not be established with current data. However, its purported lack of efficacy, as reported in selected prospective clinical trials, also is unproven owing to significant limitations in these studies. Reflux resolution and endoscopic surgical success rates are dependent upon bladder and bowel dysfunction. The lack of robust prospective randomized controlled trials limits the strength of these guidelines but they can serve to provide a framework for practice and set boundaries for safe and effective practice. As new data emerge, these guidelines will necessarily evolve.	4

**Urinary Tract Infection-Child  
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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Yang SS, Chiang IN, Lin CD, Chang SJ. Advances in non-surgical treatments for urinary tract infections in children. <i>World J Urol.</i> 2012;30(1):69-75.	Review/Other-Dx	N/A	To review nonsurgical management of UTI in children.	The proposed nonsurgical management of pediatric UTI included behavioral modification (timed voiding and adequate fluids intake), topical steroid for phimosis, nutrient supplements (breast milk, cranberry, probiotics, and vitamin A), biofeedback training for dysfunctional voiding, anticholinergics for reducing intravesical pressure, alpha-blockers in dysfunctional voiding and neurogenic bladder, and intermittent catheterization for children with large postvoid residual urine volume. The published reports usually included small number of patients and were lacking of randomization and controlled group. Further well-designed studies are warranted to support the concepts of nonoperative management for pediatric UTI.	4
37. Baracco R, Mattoo TK. Diagnosis and management of urinary tract infection and vesicoureteral reflux in the neonate. <i>Clin Perinatol.</i> 2014;41(3):633-642.	Review/Other-Dx	N/A	To diagnose and manage UTI and VUR in the neonate.	No results stated in abstract.	4
38. Goldman M, Lahat E, Strauss S, et al. Imaging after urinary tract infection in male neonates. <i>Pediatrics.</i> 2000;105(6):1232-1235.	Review/Other-Dx	45 male neonates <8 weeks old	To assess the frequency of urinary tract anomalies in male neonates <8 weeks old who presented with UTI, and to evaluate a suitable imaging approach after the initial infection.	Urinary tract abnormalities were observed in 22/45 male neonates. 19 had VUR, 1 had VUR and a double collecting system, 1 had VUR and a posterior urethral valve, and 1 had an ureteropelvic junction stricture. Renal atrophy or scars, as demonstrated by DMSA scan, were detected almost exclusively in neonates with VUR grade 3 and above. Only 1 neonate with VUR grade 1 had a pathologic DMSA, and the US of this male also demonstrated renal atrophy. <i>Escherichia coli</i> was the pathogen in 62% (28/45), and 9 boys had bacteremia. Authors suggest that US and VCUG should be performed routinely after the initial UTI in male neonates. Renal scan should be reserved for those cases in which the US suggests renal parenchymal damage or when VCUG detects VUR grade 3 and above.	4

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
39. Milas V, Puseljic S, Stimac M, Dobric H, Lukic G. Urinary tract infection (UTI) in newborns: risk factors, identification and prevention of consequences. <i>Coll Antropol.</i> 2013;37(3):871-876.	Review/Other-Dx	1200 newborns	To study the identification of UTIs and urinary tract anomalies already in the perinatal period.	The frequency of a UTI in the perinatal period amounted to 4.5%. A urinary tract anomaly was found in 29.6% of the examinees. The infection was more likely to appear among newborns with a urinary tract anomalies in their families, a UTI, pre-eclampsia and a febrile infection in mother, intrauterine growth retardation, premature rupture of membranes, umbilical cord strangulation, jaundice, cyanosis, breathing difficulties, seizures and asphyxia.	4
40. Santoro JD, Carroll VG, Steele RW. Diagnosis and management of urinary tract infections in neonates and young infants. <i>Clin Pediatr (Phila).</i> 2013;52(2):111-114.	Review/Other-Dx	N/A	To review the diagnosis and management of urinary tract infections in neonates and young infants.	No abstract available.	4
41. Sillen U, Brandstrom P, Jodal U, et al. The Swedish reflux trial in children: v. Bladder dysfunction. <i>J Urol.</i> 2010;184(1):298-304.	Review/Other-Dx	203 children	Randomized controlled multicenter study to examine the prevalence and types of lower urinary tract dysfunction in children with VUR grades III and IV, and related improved dilating reflux, renal damage and recurrent UTI to dysfunction.	At study entry 20% of patients had lower urinary tract dysfunction, characterized by high bladder capacity and increased post-void residual urine. At 2 years there was dysfunction in 34% of patients. Subdivision into groups characteristic of children after toilet training revealed that 9% had isolated overactive bladder and 24% had voiding phase dysfunction. There was a negative correlation between dysfunction at 2 years and improved dilating reflux ( $P=0.002$ ). Renal damage at study entry and follow-up was associated with lower urinary tract dysfunction at 2 years ( $P=0.001$ ). Recurrent UTI were seen in 33% of children with and in 20% without dysfunction ( $P=0.084$ ). After toilet training a third of these children with dilating reflux had lower urinary tract dysfunction, mainly voiding phase problems. Dysfunction was associated with persistent reflux and renal damage while dysfunction at study entry did not predict the 2-year outcome.	4

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Foresman WH, Hulbert WC, Jr., Rabinowitz R. Does urinary tract ultrasonography at hospitalization for acute pyelonephritis predict vesicoureteral reflux? <i>J Urol.</i> 2001;165(6 Pt 2):2232-2234.	Observational-Dx	184 patients	Retrospective study to determine if US findings during acute pyelonephritis episode in children predict presence or grade of VUR at follow-up VCUG.	77/184 (42%) US exams during clinical acute pyelonephritis episode were abnormal. 139/184 (76%) patients underwent follow-up VCUG 39 days later. 35% of normal US patients demonstrated reflux, and 36% of abnormal US patients demonstrated reflux. No correlation between US findings during acute pyelonephritis episode and presence or absence of reflux on follow-up VCUG.	3
43. Kenney IJ, Negus AS, Miller FN. Is sonographically demonstrated mild distal ureteric dilatation predictive of vesicoureteric reflux as seen on micturating cystourethrography? <i>Pediatr Radiol.</i> 2002;32(3):175-178.	Observational-Dx	285 renal units in 144 patients	To evaluate whether the diameter of the distal ureter on US is predictive of the presence of VUR on VCUG in children.	Distal ureter diameter of >3.5 mm on US has a sensitivity of 0.63 and specificity of 0.78 for presence of VUR, and 0.78 and 0.77 respectively for grade 3 or higher VUR. In this study, with a prevalence of VUR of 0.19, this yields a PPV of 0.41 and NPV of 0.90. The NPV of a distal ureter diameter of <3.5 mm in excluding dilating reflux was 0.96. Absence of distal ureteral dilation on US cannot reliably exclude VUR.	3
44. Mahant S, Friedman J, MacArthur C. Renal ultrasound findings and vesicoureteral reflux in children hospitalised with urinary tract infection. <i>Arch Dis Child.</i> 2002;86(6):419-420.	Observational-Dx	162 patients 6 reviewers	Retrospective study to determine the sensitivity, specificity, and predictive values of US for VUR in children under 5 admitted for first febrile UTI.	Prevalence of VUR was 22%. Sensitivity, specificity, PPV and NPV for renal US suggesting VUR was 40%, 76%, 32%, and 82% respectively. Renal US is neither sensitive nor specific for VUR in children with a first UTI.	3
45. Moorthy I, Wheat D, Gordon I. Ultrasonography in the evaluation of renal scarring using DMSA scan as the gold standard. <i>Pediatr Nephrol.</i> 2004;19(2):153-156.	Observational-Dx	930 kidneys	To determine how US performs in comparison to DMSA scan (gold standard) in detection of post-infectious renal scarring in children.	Sensitivity, specificity, PPV and NPV for US detection of focal renal scarring was 5.2%, 98.3%, 50%, and 75.8%, respectively. Sensitivity, specificity, PPV and NPV for US detection of diffuse renal scarring was 47.2%, 91.8%, 60.8%, and 86.6%, respectively. US cannot be substituted for DMSA in the evaluation of renal scarring.	3



**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Muensterer OJ. Comprehensive ultrasound versus voiding cysturethrography in the diagnosis of vesicoureteral reflux. <i>Eur J Pediatr.</i> 2002;161(8):435-437.	Observational-Dx	205 patients 407 renal units reviewed	Retrospective study to assess the accuracy of comprehensive renal US in detecting dilating VUR (grade 3 or higher) when abnormal age-adjusted renal length was taken into consideration along with pelvic dilatation and cortical thinning, compared to VCUG.	When taking abnormal kidney length into account, as well as traditional markers such as pelvic dilatation and cortical thinning, dilative VUR (grade 3 or higher) was detected with sensitivity and specificity of 91% and 67% respectively with US. 99% NPV. Much poorer results when not considering abnormal renal length. US cannot accurately diagnose VUR by morphological changes alone. When taking abnormal renal length into consideration, in addition to traditional morphologic changes, a normal US exam makes the presence of dilative VUR highly unlikely.	3
47. Nelson CP, Johnson EK, Logvinenko T, Chow JS. Ultrasound as a screening test for genitourinary anomalies in children with UTI. <i>Pediatrics.</i> 2014;133(3):e394-403.	Observational-Dx	3,995 clinical encounters	To determine test characteristics and predictive values of renal and bladder US for VCUG findings in this setting.	We identified 2259 patients age <60 months who had UTI as the indication for imaging. Renal and bladder US was reported as “normal” in 75%. On VCUG, any VUR was identified in 41.7%, VUR grade >II in 20.9%, and VUR grade >III in 2.8%. Sensitivity of renal and bladder US for any abnormal findings on VCUG ranged from 5% (specificity: 97%) to 28% (specificity: 77%). Sensitivity for VUR grade >III ranged from 18% (specificity: 97%) to 55% (specificity: 77%). Among the 1203 children aged 2 to 24 months imaged after a first febrile UTI, PPV of renal and bladder US was 37% to 47% for VUR grade >II (13% to 24% for VUR grade >III); NPV was 72% to 74% for VUR grade >II (95% to 96% for VUR grade >III).	3
48. Majd M, Nussbaum Blask AR, Markle BM, et al. Acute pyelonephritis: comparison of diagnosis with 99mTc-DMSA, SPECT, spiral CT, MR imaging, and power Doppler US in an experimental pig model. <i>Radiology.</i> 2001;218(1):101-108.	Observational-Dx	35 piglets (70 kidneys)	To compare Tc-99m DMSA SPECT, spiral CT, MRI, and power Doppler US for the detection and localization of acute pyelonephritis in piglets using histology as the standard of reference.	38/70 kidneys had pyelonephritis by histology. Sensitivity and specificity: 92% and 94% for SPECT DMSA. Sensitivity and specificity: 90% and 88% for MRI. Sensitivity and specificity: 87% and 88% for CT. Sensitivity and specificity: 74% and 57% for Doppler US. SPECT DMSA, MRI, and CT are equally sensitive and reliable for the detection of acute pyelonephritis. Doppler US is significantly less accurate.	2

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
49. Piepsz A, Blafox MD, Gordon I, et al. Consensus on renal cortical scintigraphy in children with urinary tract infection. Scientific Committee of Radionuclides in Nephrourology. <i>Semin Nucl Med.</i> 1999;29(2):160-174.	Review/Other-Dx	30 experts	30 experts provided guidance by questionnaire on renal cortical scintigraphy in children with UTI.	Consensus reached whenever 75% or more of the experts agreed on a given matter. Consensus reached by 89% that DMSA was the most appropriate tracer for renal cortical imaging. DMSA most appropriate radiotracer for renal cortical imaging in children with UTI.	4
50. Craig JC, Wheeler DM, Irwig L, Howman-Giles RB. How accurate is dimercaptosuccinic acid scintigraphy for the diagnosis of acute pyelonephritis? A meta-analysis of experimental studies. <i>J Nucl Med.</i> 2000;41(6):986-993.	Review/Other-Dx	7 studies; 242 animals	Meta-analysis of experimental studies to evaluate the performance of DMSA in the diagnosis of acute pyelonephritis and to compare planar DMSA with SPECT DMSA.	Most studies of planar DMSA clustered in a range of sensitivity values around 80% and specificity around 95%. SPECT DMSA studies demonstrate both higher true-positive and false-positive rates than planar DMSA. Planar DMSA performs well for diagnosis of acute pyelonephritis. SPECT DMSA results in a larger number of false-positives.	4
51. Zhang X, Xu H, Zhou L, et al. Accuracy of early DMSA scan for VUR in young children with febrile UTI. <i>Pediatrics.</i> 2014;133(1):e30-38.	Observational-Dx	523 children	To evaluate the accuracy of an acute Tc-99m-DMSA scan in predicting dilating VUR among young children with a febrile UTI.	A total of 523 children were included in this study, of whom 397 children (75.9%) had abnormal DMSA results and 178 children (34.0%) were identified as VUR on micturating cystourethrography. Among all the patients, the number of children with dilating VUR was 151 (28.9%). The rate of abnormal results on DMSA for the dilating VUR group was significantly higher than the rates for the non-VUR and low-grade VUR groups ( $P<.01$ ). In the <6 months age group and $\geq 6$ months age group, the sensitivities of DMSA in predicting dilating VUR were 96.15% and 100.0%, respectively, the NPVs were 97.26% and 100.0%, respectively, and the negative likelihood ratios were 0.0911 and 0.0000, respectively.	3

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
52. Berrocal T, Gaya F, Arjonilla A, Loneragan GJ. Vesicoureteral reflux: diagnosis and grading with echo-enhanced cystosonography versus voiding cystourethrography. <i>Radiology</i> . 2001;221(2):359-365.	Observational-Dx	216 patients 440 kidney units	To evaluate the usefulness of echo-enhanced cystosonography compared with VCUG for detecting and grading VUR.	VUR was detected in 123 kidney units at cystosonography and in 104 at VCUG. In 401 kidney units, there was concordance between results at cystosonography and at VCUG regarding the presence or absence of VUR. 94 kidney units showed VUR with both methods. 77/94 refluxing units were depicted with the same grade of VUR with both modalities, and in 17 the VUR grade was greater at cystosonography than at VCUG. 29/94 units showed VUR at only cystosonography, and 10 units at only VCUG. The McNemar test showed that cystosonography depicted a significantly ( $P=.003$ ) higher number of units with VUR. By patient, VUR was depicted with both studies in 67 and with only 1 study in 25. VUR was seen at only cystosonography in 16 patients and at only VCUG in 9. The McNemar test for patients showed no significant difference between the 2 tests in detection of VUR. Cystosonography with SH U 508A appears comparable to VCUG in the depiction of VUR.	2
53. Darge K, Troeger J, Duetting T, et al. Reflux in young patients: comparison of voiding US of the bladder and retrovesical space with echo enhancement versus voiding cystourethrography for diagnosis. <i>Radiology</i> . 1999;210(1):201-207.	Observational-Dx	188 patients	To compare the usefulness of voiding US of the bladder and retrovesical space with echo enhancement with that of VCUG for diagnosis of VUR and to assess patient tolerance of the echo-enhancing agent.	VUR was detected in 80 of the units with 1 ( $n = 18$ ) or both ( $n = 62$ ) methods. All grades of reflux were identified. In 15 units, reflux diagnosed at voiding US was not observed at VCUG; the reverse was true in 3 units. In 208 (92%) of the 226 kidney-ureter units, there was concordance between the 2 methods regarding the diagnosis or exclusion of VUR. The echo-enhancing agent was well tolerated. SH U 508 A enhanced voiding US is as good as VCUG in the detection or exclusion of VUR and thus will make it possible to reduce the number of children having to be exposed to ionizing radiation.	2
54. McCarville MB. Contrast-enhanced sonography in pediatrics. <i>Pediatr Radiol</i> . 2011;41 Suppl 1:S238-242.	Review/Other-Dx	N/A	To discuss several proven and potential pediatric applications of contrast-enhanced sonography.	No result stated in abstract.	4

Urinary Tract Infection-Child  
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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55. Kljucvsek D, Battelino N, Tomazic M, Kersnik Levart T. A comparison of echo-enhanced voiding urosonography with X-ray voiding cystourethrography in the first year of life. <i>Acta Paediatr.</i> 2012;101(5):e235-239.	Experimental-Dx	66 children	To compare voiding urosonography with X-ray VCUG and to evaluate the predictive value of pelvicalyceal dilatation for detecting VUR in the first year of life.	According to VCUG, VUR was present in 16/132 (12%) renal units. Voiding urosonography confirmed all these and additionally revealed VUR in 26 renal units (all together 42/132 (32%) renal units with VUR). It should be noted that all VUR detected only with voiding urosonography and missed by VCUG were of grades II and III. In 27/92 (29%) US normal and in 15/40 (37%) renal units with pelvicalyceal dilatation, VUR was detected by voiding urosonography.	2
56. Duran C, del Riego J, Riera L, Martin C, Serrano C, Palana P. Voiding urosonography including urethrosonography: high-quality examinations with an optimised procedure using a second-generation US contrast agent. <i>Pediatr Radiol.</i> 2012;42(6):660-667.	Observational-Dx	307 voiding urosonography examination in 295 children	To evaluate the quality of images of the entire urinary tract when using a second-generation US contrast agent and a modified voiding urosonography technique.	3 criteria were used for quality assessment of the bladder image: (1) progressive incorporation of contrast material in the bladder, (2) homogeneous bladder-filling to maximum capacity, and (3) visualization of the posterior bladder wall. Criterion 1 was fulfilled in 305 (99.3%), criterion 2 in 304 (99%) and criterion 3 in 304 (99%) studies. In children who underwent voiding urosonography with both contrast agents, the concordance between the 2 techniques was moderate for findings in the bladder (Cohen K = 0.487; $P < .0001$ ) and perfect for findings in the male urethra.	4
57. Papadopoulou F, Ntoulia A, Siomou E, Darge K. Contrast-enhanced voiding urosonography with intravesical administration of a second-generation ultrasound contrast agent for diagnosis of vesicoureteral reflux: prospective evaluation of contrast safety in 1,010 children. <i>Pediatr Radiol.</i> 2014;44(6):719-728.	Observational-Tx	1010 children	To evaluate the safety of intravesical administration of a second-generation US contrast agent for the diagnosis of VUR in children.	No case of serious adverse event was recorded. Minor events were reported in 37 children (3.66% of the study population). These included dysuria (n = 26, 2.57%), urinary retention (n = 2, 0.2%), abdominal pain (n = 2, 0.2%), anxiety (n = 1, 0.1%) and crying (n = 1, 0.1%) during micturition, blood and mucous discharge (n = 1, 0.1%), increased frequency of micturition (n = 1, 0.1%), vomiting (n = 1, 0.1%), perineal irritation (n = 1, 0.1%), and an episode of UTI 10 days after contrast-enhanced voiding urosonography (n = 1, 0.1%). Of these adverse events, 91.9% were subacute in onset and 8.1% were delayed. All events were self-limited and none required hospitalization.	2

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58. Cheng CH, Tsai MH, Su LH, et al. Renal abscess in children: a 10-year clinical and radiologic experience in a tertiary medical center. <i>Pediatr Infect Dis J.</i> 2008;27(11):1025-1027.	Observational-Dx order	45 children	To compare the demographic data and clinical results of patients with different US admission indications for subsequent CT confirmation at 2 different regimes (1997–2003 and 2004–2006).	CT image analysis revealed that 43 patients presented radiologic features of acute lobar nephronia in addition to renal abscesses in the affected kidneys. Statistical analysis revealed no significant differences in the gender distribution, age, VUR, clinical symptoms, WBC count, serum CRP, E. coli percentage in urine culture, and the preadmission fever duration between the first (18 patients) and second (27 patients) study periods. However, longer fever continuation after antibiotic treatment was noted in the first study period (14.1–7.1 vs 7.8–6.1 day; $P=0.01$ ). In addition, for patients in the first study period, it took longer to have the final CT confirmation after the onset of the symptoms and signs (11.9–4.2 vs 7.8–4.0 days; $P=0.01$ ). Experiences gained from this 10-year study on patients with CT-proved diagnosis include the varied clinical presentations and use of sonographic marked nephromegaly and focal mass as indications for further CT diagnosis.	3
59. Chan YL, Chan KW, Yeung CK, et al. Potential utility of MRI in the evaluation of children at risk of renal scarring. <i>Pediatr Radiol.</i> 1999;29(11):856-862.	Observational-Dx	24 patients; UTI present in 10 (42%) children; 14 (58%) children had a history of asymptomatic bacteriuria; 2 blinded readers	To evaluate potential utility of fat-saturated T1-weighted and post-gadolinium, short-tau inversion-recovery sequences in detecting renal scarring in children with increased susceptibility to UTI, but without history of acute pyelonephritis, using DMSA as gold standard.	Of the kidneys studied, 33% (n=16) had evidence of a renal parenchymal defect suggestive of scarring on Tc-99m DMSA. Using Tc-99m DMSA as the gold standard, MRI had a sensitivity of 100% and a specificity of 78% in the diagnosis of a scarred kidney. MRI had a sensitivity of 84% and a specificity of 86% in the diagnosis of a scarred zone, using Tc-99m DMSA as the gold standard. MRI is of potential utility in the evaluation of children at risk of renal scarring. Both MR sequences are needed.	2

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
60. Kavanagh EC, Ryan S, Awan A, McCoubrey S, O'Connor R, Donoghue V. Can MRI replace DMSA in the detection of renal parenchymal defects in children with urinary tract infections? <i>Pediatr Radiol.</i> 2005;35(3):275-281.	Observational-Dx	37 patients; 3 reviewers	To compare DMSA with MRI for the detection of renal parenchymal defects in children 1-9 months after a first UTI.	Using DMSA as gold standard, MRI sensitivity, specificity, PPV and NPV for detection of scarring was 77%, 87%, 77%, and 87% respectively. T1 fat saturated coronal sequence subjectively determined to be optimal sequence for detection of parenchymal scarring. MRI diagnosed pyelonephritis in 2 children that had been interpreted as scar by DMSA. The investigation of renal scarring can be replaced using a single, coronal, fat-saturated T1 weighted MR sequence.	3
61. Faletti R, Cassinis MC, Fonio P, et al. Diffusion-weighted imaging and apparent diffusion coefficient values versus contrast-enhanced MR imaging in the identification and characterisation of acute pyelonephritis. <i>Eur Radiol.</i> 2013;23(12):3501-3508.	Observational-Dx	88 patients	To compare contrast-enhanced and DWI MRI in diagnosing acute pyelonephritis and to assess ADC measurement reliability in differentiating among normal renal parenchyma, acute pyelonephritis and abscesses.	Agreement between contrast-enhanced MRI and DWI was 94.3% (83/88 patients; $P<0.05$ ). In the acute pyelonephritis group, DWI was awarded the highest visibility score compared to contrast-enhanced MRI ( $P<0.05$ ), while in the abscess group contrast-enhanced MRI had the highest score ( $P<0.04$ ). The difference between ADC values of the acute pyelonephritis-healthy parenchyma and abscess-acute pyelonephritis groups was significant ( $P<0.05$ ). The area under the receiver operating characteristic curve of ADC values of the acute pyelonephritis-healthy and abscess-acute pyelonephritis groups were found to be 0.94 (95% CI; cutoff value = 2) and 0.78 (95% CI; cutoff value = 1.2) respectively.	3
62. Vivier PH, Sallem A, Beurdeley M, et al. MRI and suspected acute pyelonephritis in children: comparison of diffusion-weighted imaging with gadolinium-enhanced T1-weighted imaging. <i>Eur Radiol.</i> 2014;24(1):19-25.	Observational-Dx	39 patients	To evaluate the performance of DWI against the reference standard of gadolinium-enhanced T1-weighted imaging in children.	32 kidneys (41%) had hypo-enhancing areas on gadolinium-enhanced T1-weighted images. The sensitivity and specificity of DWI were 100% (32/32) and 93.5% (43/46). DWI demonstrated excellent agreement (kappa = 0.92,) with gadolinium-enhanced T1-weighted, with no significant difference ( $P<0.25$ ) in detection of abnormal lesions. Interobserver reproducibility was excellent with DWI (kappa = 0.79).	2

Urinary Tract Infection-Child  
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
63. Kocyigit A, Bayram R, Yuksel S, Yilmaz I, Karabulut N. Diffusion weighted magnetic resonance imaging of kidneys in children with vesicoureteral reflux. <i>Eur J Radiol.</i> 2014;83(1):e56-60.	Observational-Dx	46 patients	To investigate whether renal tissue alterations associated with VUR can be displayed by DWI and to assess how ADC values change with age in kidneys with and without VUR.	The mean ADC values were (1.93 +/- 0.36)x10(-3)mm(2)/s, (1.97 +/- 0.24)x 10(-3)mm(2)/s, (1.83 +/- 0.37)x 10(-3)mm(2)/s, (1.98 +/- 0.20)x10(-3)mm(2)/s and (2.08 +/- 0.42)x 10(-3)mm(2)/s in normal kidneys, and in those with grade 1, grade 2, grade 3 and grade 4 VUR, respectively. There was no significant difference in ADC values between kidneys with and without VUR. There was a significant positive correlation between the age and ADC values both in kidneys with and without VUR (r=0.79, P<0.001 and r=0.82; P<0.001, respectively).	2
64. Bonadio W, Maida G. Urinary tract infection in outpatient febrile infants younger than 30 days of age: a 10-year evaluation. <i>Pediatr Infect Dis J.</i> 2014;33(4):342-344.	Review/Other-Dx	670 febrile neonates	To determine the prevalence of outpatient-diagnosed UTI in consecutive febrile neonates ≤30 days of age and correlate demographic, laboratory and radiographic imaging results with infectious etiology.	Of 670 febrile neonates ≤30 days of age evaluated for sepsis, urine culture was obtained in 651 cases (97%). Of 100 patients with UTI (15.4%), 73% were male; the most common uropathogens were Escherichia coli (71%), Enterococcus (10%) and Klebsiella sp. (10%). In all, 39% had a maximum documented fever ≥102 degrees F, and 40% had CBC total WBCs count ≥15,000/mm(3). Urine dipstick test was positive for leukocyte esterase or nitrite in 79%. Renal US performed in 95 patients (95%) showed anatomic abnormalities in 47%; 5/26 (24%) with hydronephrosis had VUR on voiding cystourethrogram. 4 patients had urosepsis; none had bacterial meningitis and no patients died.	4
65. Bisset GS, 3rd, Strife JL, Dunbar JS. Urography and voiding cystourethrography: findings in girls with urinary tract infection. <i>AJR Am J Roentgenol.</i> 1987;148(3):479-482.	Review/Other-Dx	523 examinations 2 independent readers	Retrospective study to evaluate the usefulness of VCUG and excretory urogram in girls with UTI.	Higher grades of VUR had higher rates of parenchymal scarring: 3/37 (8%) grade 1, 13/114 (11%) grade 2, 12/32 (37%) grade 3, 5/5 (100%) grade 4. 0 of 523 females had urethral anomalies. VUR grade associated with renal scarring. VCUG has significantly higher ovarian radiation dose than radionuclide. Single spot film of urethra is sufficient.	4

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
66. Lee HY, Soh BH, Hong CH, Kim MJ, Han SW. The efficacy of ultrasound and dimercaptosuccinic acid scan in predicting vesicoureteral reflux in children below the age of 2 years with their first febrile urinary tract infection. <i>Pediatr Nephrol.</i> 2009;24(10):2009-2013.	Observational-Dx	220 children with first febrile UTI	Retrospective study to evaluate the efficacy of DMSA scan and US in comparison with VCUG in predicting VUR in children below the age of 2 years.	Among 220 children with their first febrile UTI, VUR was detected in 67 (30.4%). The detection rate of VUR by US was 41.7% and 86% in the low (I, II) and high grade (III~IV) groups, respectively. Detection rate of VUR by DMSA scan was 37.5% and 88.4% in the low and high grade groups, respectively. Combining US and DMSA scan, authors found that the detection rate of high grade VUR was 95.3% and that of low grade was 62.5%. During follow up, most of the low grade VURs with normal DMSA and US scans resolved or were downgraded. Most high grade VURs could be detected by US and DMSA scan, but the prediction rate was not as high in low grade VURs.	3
67. Quirino IG, Silva JM, Diniz JS, et al. Combined use of late phase dimercaptosuccinic acid renal scintigraphy and ultrasound as first line screening after urinary tract infection in children. <i>J Urol.</i> 2011;185(1):258-263.	Observational-Dx	553 children	To evaluate the diagnostic accuracy of DMSA renal scintigraphy and renal US in identifying high grade VUR in children after a first episode of UTI.	246 patients had reflux, of whom 144 (27%) had high grade (III to V) disease. Sensitivity, NPV and diagnostic OR of US for high grade reflux were 83.3%, 90.8% and 7.9, respectively. DMSA scan had the same sensitivity as US but a higher NPV (91.7%) and diagnostic OR (10.9). If both tests were analyzed in parallel by using the OR rule, ie, a negative diagnosis was established only when both test results were normal, sensitivity increased to 97%, NPV to 97% and diagnostic OR to 25.3. Only 9 children (6.3%) with dilating reflux had an absence of alterations in both tests. Findings support the idea that US and DMSA scan used in combination are reliable predictors of dilating VUR.	2



**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
68. Biggi A, Dardanelli L, Pomero G, et al. Acute renal cortical scintigraphy in children with a first urinary tract infection. <i>Pediatr Nephrol.</i> 2001;16(9):733-738	Observational-Dx	101 patients	Prospective study to evaluate the diagnostic value of clinical, biological, and US parameters in detecting children with acute renal infection documented by DMSA scintigraphy.	CRP is significantly higher in patients with severe kidney involvement than those with mild/moderate 151 vs 92 ( $P<0.015$ ). WBC is significantly higher in patients with severe kidney involvement than those with mild/moderate 15k vs 20k ( $P<0.013$ ). Sensitivity and specificity of CRP was 85% and 20%. Sensitivity and specificity of WBC was 77% and 18%. US detected abnormal cortical echogenicity in 2/70 (3%) of kidneys with abnormal DMSA scan. US detected collecting system dilatation in 17/70 (24%) of kidney with abnormal DMSA scan. Clinical, biological, and US parameters do not accurately distinguish cystitis from pyelonephritis in children with UTI and do not identify children with severe renal damage. DMSA should be added to initial workup of children with UTI.	2
69. Christian MT, McColl JH, MacKenzie JR, Beattie TJ. Risk assessment of renal cortical scarring with urinary tract infection by clinical features and ultrasonography. <i>Arch Dis Child.</i> 2000;82(5):376-380.	Observational-Dx	990 patients 404 children had upper tract UTI and 586 lower tract UTI	To determine if renal cortical scarring in children with history of UTI would be missed if US were used in lieu of DMSA scan.	127/204 (62%) abnormal kidneys by DMSA had a normal US. 22% sensitivity for US detection of renal scarring. Risk of missing DMSA scarring by US between 0.4% and 11.1% depending on age of child and lower vs upper tract infection. US should not replace DMSA for detection of post-UTI scarring in children.	3
70. Giorgi LJ, Jr., Bratslavsky G, Kogan BA. Febrile urinary tract infections in infants: renal ultrasound remains necessary. <i>J Urol.</i> 2005;173(2):568-570.	Observational-Dx	282 consecutive patients	Retrospective review to determine whether US has a role in the diagnosis and treatment of infants (<6 months old) with febrile UTI.	32/203 (16%) infants with normal VCUG had an abnormal US. 9 out of these 32 cases resulted in change in management/parental counseling. Renal/bladder US is recommended in the evaluation of febrile UTI in infants younger than 6 months.	3
71. Jahnukainen T, Honkinen O, Ruuskanen O, Mertsola J. Ultrasonography after the first febrile urinary tract infection in children. <i>Eur J Pediatr.</i> 2006;165(8):556-559.	Observational-Dx	155 patients 2 reviewers	Retrospective study to determine whether US detects significant non-VUR upper tract abnormalities in hospitalized children with first febrile UTI and whether these findings alter management.	23/155 (14.8%) patients had an abnormal US during acute first febrile UTI. 81% of these patients were under age 2. 9/23 (39%) with abnormal US had a normal VCUG, 4 of whom underwent surgery. 9/23 (39%) patients with abnormal US had management changed. US performed after first febrile UTI can play a major role as a primary imaging tool and can affect management.	3

Urinary Tract Infection-Child  
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
72. Temiz Y, Tarcan T, Onol FF, Alpay H, Simsek F. The efficacy of Tc99m dimercaptosuccinic acid (Tc-DMSA) scintigraphy and ultrasonography in detecting renal scars in children with primary vesicoureteral reflux (VUR). <i>Int Urol Nephrol</i> . 2006;38(1):149-152.	Observational-Dx	62 patients	To compare the efficacy of DMSA and US in detecting renal scars in children with primary VUR.	DMSA detected renal scars in 57% of reflexive units while US detected only 34%. All scars identified by US were also identified by DMSA. 21/51 (40%) of cases where DMSA demonstrates renal scarring were missed by US. DMSA detected scars in 35% of kidneys reported normal on US. US is an inappropriate study in the detection of renal parenchymal scars regardless of reflux grade.	3
73. Zamir G, Sakran W, Horowitz Y, Koren A, Miron D. Urinary tract infection: is there a need for routine renal ultrasonography? <i>Arch Dis Child</i> . 2004;89(5):466-468.	Observational-Dx	255 patients	Prospective study to assess the yield of renal US in the management of children under 5 hospitalized with first uncomplicated febrile UTI.	Sensitivity, specificity, PPV, and NPV of abnormal renal US for detecting VUR were 17.7%, 87.6%, 23.5%, and 83.2% respectively. Renal US did not cause a change in the management of any children during and following the admission.	3
74. Hoberman A, Charron M, Hickey RW, Baskin M, Kearney DH, Wald ER. Imaging studies after a first febrile urinary tract infection in young children. <i>N Engl J Med</i> . 2003;348(3):195-202.	Experimental-Dx	309 patients 2 independent reviewers	Prospective study to assess the value of routine imaging studies after the diagnosis of first febrile UTI in children less than 2 years of age. US and an initial renal scan were obtained within 72 hours after diagnosis, contrast VCUG was performed 1 month later, and renal scanning was repeated 6 months later. Study was part of a multicenter, randomized clinical trial.	272/309 (88%) of patients had normal US during acute episode. The identified US abnormalities did not alter management. Renal US at the time of the acute illness is of limited value because it does not modify management. Routine performance of renal US after the diagnosis of first febrile UTI is not recommended in children who have undergone prenatal US after 30-32 weeks gestation.	2
75. Halevy R, Smolkin V, Bykov S, Chervinsky L, Sakran W, Koren A. Power Doppler ultrasonography in the diagnosis of acute childhood pyelonephritis. <i>Pediatr Nephrol</i> . 2004;19(9):987-991.	Observational-Dx	62 patients aged 2 weeks to 5 years; 2 blinded reviewers	To evaluate the ability of power Doppler US to detect acute pyelonephritis in infants and young children in comparison with DMSA scintigraphy as a reference standard.	27/31 (87%) patients with DMSA abnormality demonstrated a matching perfusion defect on Doppler US. 24/26 (92%) of patients with normal DMSA scan had normal Doppler US. Sensitivity, specificity, PPV and NPV of Doppler US in detection of affected kidneys was 87%, 92%, 93%, and 86% respectively. Power Doppler US has a high sensitivity and specificity for differentiating acute pyelonephritis from lower UTI.	2
76. Stogianni A, Nikolopoulos P, Oikonomou I, et al. Childhood acute pyelonephritis: comparison of power Doppler sonography and Tc-DMSA scintigraphy. <i>Pediatr Radiol</i> . 2007;37(7):685-690.	Observational-Dx	74 patients 147 kidneys	To compare the predictive value of power Doppler US with DMSA in the diagnosis of pyelonephritis in possible UTI within the first 48 hours after symptom onset.	Pyelonephritis was diagnosed by power Doppler US in 46 kidneys. Using DMSA as the gold standard, sensitivity and specificity for power Doppler were 74% and 86% respectively. Power Doppler US has acceptable specificity and sensitivity if performed within the first 48 hours.	2

Urinary Tract Infection-Child  
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
77. Basiratnia M, Noohi AH, Lotfi M, Alavi MS. Power Doppler sonographic evaluation of acute childhood pyelonephritis. <i>Pediatr Nephrol.</i> 2006;21(12):1854-1857.	Observational-Dx	34 children with mean age of 2.8 +/- 2.7 years	Prospective study to assess the role of power Doppler US for diagnosis of acute pyelonephritis compared with Tc-99m DMSA scan.	According to the patient's number, sensitivity, specificity, PPV and NPV, and accuracy of power Doppler US were 89%, 53%, 70%, 80%, and 74%, respectively, but based on the renal units, changed to 66%, 81%, 46%, 91%, and 79%, respectively. Although power Doppler US has the potential for identifying acute pyelonephritis in children, it is still soon to replace DMSA scan.	2
78. Bykov S, Chervinsky L, Smolkin V, Halevi R, Garty I. Power Doppler sonography versus Tc-99m DMSA scintigraphy for diagnosing acute pyelonephritis in children: are these two methods comparable? <i>Clin Nucl Med.</i> 2003;28(3):198-203.	Observational-Dx	40 patients (78 kidneys)	Prospective study to assess the role of renal power Doppler US to detect acute pyelonephritis in hospitalized children under aged 6 with first time febrile UTI and clinically suspected pyelonephritis, and to determine if power Doppler US can replace Tc-99m DMSA in children.	27/78 (35%) kidneys appeared abnormal on DMSA. In 7/27 (26%) of these kidneys, power Doppler was normal. 51/78 (65%) kidneys appeared normal on DMSA. In 3/51 (6%) of these kidneys, power Doppler demonstrated apparent disease. Sensitivity, specificity, PPV and NPV for power Doppler US was 87%, 74%, 87% and 87% respectively. When considering lesions, power Doppler missed 16 lesions in 27 kidneys detected by DMSA (26% false negative rate; sensitivity 58%). A positive power Doppler renal US should obviate the use of DMSA in children with clinically suspected pyelonephritis. However, it cannot replace DMSA in the diagnosis of acute pyelonephritis in children.	1
79. Hitzel A, Liard A, Vera P, Manrique A, Menard JF, Dacher JN. Color and power Doppler sonography versus DMSA scintigraphy in acute pyelonephritis and in prediction of renal scarring. <i>J Nucl Med.</i> 2002;43(1):27-32.	Observational-Dx	57 patients (mean age, 5 +/- 3 years) US – 1 blinded reviewer DMSA – 2 blinded reviewers	Prospective study to assess the value of color and power Doppler US for diagnosing pyelonephritis and for predicting the development of renal scars in comparison with DMSA (gold standard).	Using DMSA as the gold standard, color/power Doppler US had a sensitivity and specificity of 80% and 81% respectively for diagnosis of pyelonephritis. US had PPV and NPV of 57% and 75% respectively for predicting scarring after infection, compared to 62% and 100% for DMSA. No scars developed in children with a normal acute phase DMSA. Doppler/power US is relatively reliable in the acute phase for detection of acute pyelonephritis, but it cannot predict scarring well.	2

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
80. Lin KY, Chiu NT, Chen MJ, et al. Acute pyelonephritis and sequelae of renal scar in pediatric first febrile urinary tract infection. <i>Pediatr Nephrol.</i> 2003;18(4):362-365.	Review/Other-Dx	216 patients	To investigate the incidence of acute pyelonephritis and renal scarring in children with febrile UTI. 19/216 (88%) children with their first episode of UTI received Tc-99m DMSA renal SPECT.	≤1 year old (149 in group) – 82/131 (63%) had acute pyelonephritis on DMSA and 16/72 (22%) had VUR on VCUG. 1-5 years (33 in group) – 25/29 (86%) had acute pyelonephritis on DMSA and 11/16 (69%) had VUR on VCUG. 5-17 years (34 in group) – 26/34 (84%) had acute pyelonephritis on DMSA and 8/18 (44%) had VUR on VCUG. Totals (216 total patients) – 133/191 (70%) had acute pyelonephritis on DMSA and 35/106 (33%) had VUR on VCUG. 61 patients had follow up DMSA scan >6 months with 35 (57%) demonstrating renal scarring. 70% incidence of acute pyelonephritis in children with first febrile UTI and over half develop renal scar.	4
81. Preda I, Jodal U, Sixt R, Stokland E, Hansson S. Normal dimercaptosuccinic acid scintigraphy makes voiding cystourethrography unnecessary after urinary tract infection. <i>J Pediatr.</i> 2007;151(6):581-584, 584 e581.	Observational-Dx	290 consecutive children	Prospective study to determine the frequency at which dilating VUR occurs when acute DMSA is normal in infants with first UTI.	27/290 children had dilating VUR. DMSA abnormal in 26/ 27 of these patients. VCUG does not need to be performed routinely in infants with UTI and a normal acute DMSA scan.	2
82. Tseng MH, Lin WJ, Lo WT, Wang SR, Chu ML, Wang CC. Does a normal DMSA obviate the performance of voiding cystourethrography in evaluation of young children after their first urinary tract infection? <i>J Pediatr.</i> 2007;150(1):96-99.	Observational-Dx	142 patients	10-year retrospective review to determine if a normal DMSA scan during an acute first UTI can obviate the need for VUR evaluation with VCUG.	70% of patients had evidence of pyelonephritis on DMSA scan. 30% of children with first UTI had VUR. 67% of children with pyelonephritis did not have VUR. No child with a normal DMSA had high-grade VUR, only 5 had low-grade VUR. Children with a negative DMSA during their first UTI rarely have VUR, and may never have high-grade VUR.	3

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
83. Mantadakis E, Vouloumanou EK, Georgantzi GG, Tsalkidis A, Chatzimichael A, Falagas ME. Acute Tc-99m DMSA scan for identifying dilating vesicoureteral reflux in children: a meta-analysis. <i>Pediatrics</i> . 2011;128(1):e169-179.	Review/Other-Dx	13 cohort studies	Meta-analysis was performed to evaluate the accuracy of acute-phase DMSA scanning in identifying dilating (grades III through V) VUR documented by VCUG in children with a first febrile UTI.	Pooled (95% CI) sensitivity and specificity rates of DMSA scanning were 79% and 53%, respectively, for the patient-based analysis (8 studies) and 60% and 65% for the renal unit-based analysis (5 studies). The respective areas under the hierarchical summary receiver operating curves were 0.71 and 0.67. Marked statistical heterogeneity was observed in both analyses, as indicated by I(2) test values of 91% and 87%, respectively. Acute-phase DMSA renal scanning cannot be recommended as replacement for VCUG in the evaluation of young children with a first febrile UTI.	4
84. Flynn JT. Don't stop performing voiding cystourethrography in young children after the initial febrile urinary tract infection--at least not yet. <i>J Pediatr</i> . 2009;155(5):761.	Review/Other-Dx	699 children (aged 2 months to 2 years)	Commentary on a retrospective case series by Lee et al that determines the accuracy of renal US scanning and DMSA scintigraphy in diagnosing high-grade VUR.	The author points out the limitations of the study by Lee et al.	4
85. Ward VL, Strauss KJ, Barnewolt CE, et al. Pediatric radiation exposure and effective dose reduction during voiding cystourethrography. <i>Radiology</i> . 2008;249(3):1002-1009.	Observational-Dx	145 children	Retrospective study to compare radiation exposure and effective dose in children who underwent VCUG performed with grid-controlled variable-rate pulsed fluoroscopy with radiation exposure and effective dose in children who underwent VCUG performed with continuous fluoroscopy and to compare these effective doses with those estimated with radionuclide cystography.	Grid-controlled variable-rate pulsed fluoroscopy resulted in a significant reduction in total radiation exposure, which was at least 8 times lower than that with continuous fluoroscopy in all 3 groups ( $P < .001$ for all). There was no significant difference in fluoroscopy time ( $P > .50$ ). Effective radiation doses from grid-controlled variable-rate pulsed fluoroscopy were approximately 1 order of magnitude lower than those from continuous fluoroscopy but 1 order of magnitude higher than those from radionuclide cystography. In children, VCUG can be performed with a grid-controlled variable-rate pulsed fluoroscopy unit that delivers radiation exposures that are at least 8 times lower than those delivered by a conventional continuous fluoroscopy unit.	3

Urinary Tract Infection-Child  
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
86. Polito C, Rambaldi PF, La Manna A, Mansi L, Di Toro R. Enhanced detection of vesicoureteric reflux with isotopic cystography. <i>Pediatr Nephrol.</i> 2000;14(8-9):827-830.	Observational-Dx	124 patients	To compare isotope cystography with cyclic fluoroscopic cystourethrography in children with suspected VUR.	84% concordance between 2 methods in detection of VUR. 93% concordance between 2 methods for detection or exclusion of severe VUR. Fluoroscopic VCUG missed 23/51 (45%) VUR cases including 12 with severe VUR. Isotope cystography missed 3 cases of VUR. Isotope cystography is more accurate than VCUG in diagnosis of VUR, even severe grade.	3
87. Unver T, Alpaya H, Biyikli NK, Ones T. Comparison of direct radionuclide cystography and voiding cystourethrography in detecting vesicoureteral reflux. <i>Pediatr Int.</i> 2006;48(3):287-291.	Observational-Dx	41 patients (82 kidney ureter units)	Direct radionuclide cystography compared to fluoroscopic VCUG for detection of VUR in children with UTI or antenatal hydronephrosis.	18 refluxing ureters detected by radionuclide cystography, 22 by VCUG, and 14 by both methods. The 2 methods were concordant in 85% of kidney ureter units. VUR missed by VCUG in 4 units and by radionuclide cystography in 8 units. Good correlation between radionuclide cystography and VCUG in evaluation of VUR.	3
88. Mazzola BL, von Vigier RO, Marchand S, Tonz M, Bianchetti MG. Behavioral and functional abnormalities linked with recurrent urinary tract infections in girls. <i>J Nephrol.</i> 2003;16(1):133-138.	Review/Other-Dx	141 girls	To determine if predisposing behavioral and functional abnormalities: infrequent voiding, inadequate fluid intake, stool retention, poor genital hygiene and voiding dysfunction are associated with recurrent UTIs.	A total of 141 girls aged 3.9 to 18 years were evaluated between 1996 and 1999; 212 abnormalities were noted in 120 patients: infrequent voiding (isolated, 16; combined with other abnormalities, 47), poor fluid intake (isolated, 10; combined, 50), functional stool retention (isolated, 5; combined, 25), inadequate hygiene or toilet habits (isolated, 3; combined, 24), dysfunctional voiding (isolated, 15; combined, 10), bladder overactivity (isolated, 5; combined, 2).	4
89. Compoj E, Cassar W, Farina A, et al. Conservative management of paediatric renal abscess. <i>J Pediatr Urol.</i> 2013;9(6 Pt B):1214-1217.	Review/Other-Dx	6 children	To describe the conservative management of renal abscesses without percutaneous drainage in 6 children.	In all patients, the abscesses were solitary, unilateral and located in the right kidney. The median abscess diameter was 38 mm. The diagnosis was made by US. All 6 children were treated conservatively with a urinary catheter or suprapubic catheter and broad-spectrum antibiotics. None of the renal abscesses were surgically or percutaneously drained.	4
90. De Palma D, Manzoni G. Different imaging strategies in febrile urinary tract infection in childhood. What, when, why? <i>Pediatr Radiol.</i> 2013;43(4):436-443.	Review/Other-Dx	N/A	To critically analyze and give to the reader a complete, up-to-date and flexible overview recommendations of published guidelines and strengths and weaknesses of the available biochemical and imaging tools	No results stated in abstract.	4

**Urinary Tract Infection-Child  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
91. Mingin GC, Nguyen HT, Baskin LS, Harlan S. Abnormal dimercapto-succinic acid scans predict an increased risk of breakthrough infection in children with vesicoureteral reflux. <i>J Urol.</i> 2004;172(3):1075-1077; discussion 1077.	Review/Other-Dx	120 consecutive patients	Retrospective review to determine if a delayed DMSA scan in patients with a febrile UTI can help predict which children are at risk for breakthrough UTI.	57/120 abnormal DMSA scans. 88% of these had grade 3-5 VUR, of which 60% had a breakthrough UTI. 63/120 had a normal DMSA scan. 61% of these had grade 3-5 VUR, of which only 5 children had a breakthrough infection. Children with grade 3-5 VUR and an abnormal DMSA scan are at increased risk of breakthrough UTI. DMSA is a useful study for prognostic purposes.	4
92. Cheng CH, Tsau YK, Lin TY. Is acute lobar nephronia the midpoint in the spectrum of upper urinary tract infections between acute pyelonephritis and renal abscess? <i>J Pediatr.</i> 2010;156(1):82-86.	Review/Other-Dx	115 patients	To examine acute lobar nephronia in the spectrum of upper UTIs between acute pyelonephritis and renal abscess.	The study included 21 patients with acute pyelonephritis, 85 with acute lobar nephronia (63 simple acute lobar nephronia, 22 complicated acute lobar nephronia), and 9 with renal abscesses. The volume fraction of CT lesions correlated well with duration of fever before and after treatment in patients with acute pyelonephritis or simple acute lobar nephronia, and only the correlation between fever duration after treatment and CT lesions was significant in patients with complicated acute lobar nephronia or renal abscess.	4

## Evidence Table Key

### Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  - c) the study is an expert opinion or consensus document.
- M = Meta-analysis

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Dx = Diagnostic

Tx = Treatment

## Abbreviations Key

ADC = Apparent diffusion coefficient

CI = Confidence interval

CRP = C-reactive protein

CT = Computed tomography

DMSA = Dimercaptosuccinic acid

DWI = Diffusion-weighted imaging

GFR = Glomerular filtration rate

MRI = Magnetic resonance imaging

NPV = Negative predictive value

OR = Odds ratio

PPV = Positive predictive value

RR = Relative risk

SPECT = Single-photon emission tomography

US = Ultrasound

UTI = Urinary tract infection

VCUG = Voiding cystourethrography

VUR = Vesicoureteral reflux

WBC = White blood cell