

Acute Pyelonephritis
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. <i>Am J Med.</i> 2002; 113 Suppl 1A:5S-13S.	Review/Other-Dx	N/A	Review incidence, morbidity, and economic costs of UTI.	UTIs are considered the most common bacterial infection, but it is difficult to accurately assess the incidence of UTIs. Catheter-associated UTI is the most common nosocomial infection. The risk of UTI increases with increasing duration of catheterization. The estimated annual cost of community-acquired UTI is significant (approximately \$1.6 billion).	4
2. Craig WD, Wagner BJ, Travis MD. Pyelonephritis: radiologic-pathologic review. <i>Radiographics.</i> 2008;28(1):255-277; quiz 327-258.	Review/Other-Dx	N/A	Review imaging of pyelonephritis.	CT, when performed before, immediately after, and at delayed intervals from contrast material injection, is the preferred modality for evaluating acute bacterial pyelonephritis. CT is also preferred over conventional radiography and US for assessing emphysematous pyelonephritis.	4
3. Hoepelman AI, Meiland R, Geerlings SE. Pathogenesis and management of bacterial urinary tract infections in adult patients with diabetes mellitus. <i>Int J Antimicrob Agents.</i> 2003; 22 Suppl 2:35-43.	Review/Other-Dx	N/A	Review epidemiology, pathogenesis, clinical presentation and treatment of bacterial UTI in adult patients with diabetes mellitus.	No evidence is available on the optimal treatment of acute cystitis and pyelonephritis in patients with diabetes mellitus. Because of the frequent (asymptomatic) upper tract involvement and the possible serious complications, many experts recommend a 7-14-day oral antimicrobial regimen for bacterial cystitis in these patients, with an antimicrobial agent that achieves high levels both in the urine and in urinary tract tissues. Current data suggest that shorter regimens will lead to failure also in uncomplicated UTI in women. The recommended treatment of acute pyelonephritis does not differ from that in nondiabetic patients. Clinical trials specifically dealing with the treatment of UTIs in diabetic patients, comparing the optimal duration and choice of antimicrobial agent, are needed.	4

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4. June CH, Browning MD, Smith LP, et al. Ultrasonography and computed tomography in severe urinary tract infection. Arch Intern Med. 1985; 145(5):841-845.	Observational-Dx	35 patients	Prospective study to evaluate utility of CT and US in treatment of UTI.	Renal CT is a sensitive test for acute upper UTI. US detects focal bacterial nephritis and abscesses but is insensitive to uncomplicated upper UTI. Painless pyelonephritis may be more common in patients with diabetes mellitus.	2
5. Sfakianaki E, Sfakianakis GN, Georgiou M, Hsiao B. Renal scintigraphy in the acute care setting. Semin Nucl Med. 2013;43(2):114-128.	Review/Other-Dx	N/A	To highlight the possible applications of renal scintigraphy in the acute care setting, including colic, APN, urine leaks, and ARF.	No results stated in abstract.	4
6. Mitchell CH, Fishman EK, Johnson PT. Nuances of the unenhanced abdominal CT: careful inspection discloses critical findings. [Review]. Abdom Imaging. 40(7):2883-93, 2015 Oct.	Review/Other-Dx	N/A	To review unenhanced CT findings in the setting of pulmonary embolus, acute aortic syndromes, mesenteric and deep venous thrombosis, gastrointestinal hemorrhage, pancreatitis and its complications, as well as pyelonephritis.	No results stated in abstract.	4
7. Soulen MC, Fishman EK, Goldman SM, Gatewood OM. Bacterial renal infection: role of CT. Radiology. 1989; 171(3):703-707.	Observational-Dx	62 patients	Retrospective review of imaging studies of patients hospitalized for acute renal infections.	Abnormality more likely when fever >72 hours. CT better than US for diagnosis both abscess and pyelonephritis.	4
8. Stunell H, Buckley O, Feeney J, Geoghegan T, Browne RF, Torreggiani WC. Imaging of acute pyelonephritis in the adult. Eur Radiol. 2007; 17(7):1820-1828.	Review/Other-Dx	N/A	To review the role of CT and MRI techniques in the imaging of acute pyelonephritis and its complications.	Imaging may not only aid in making the diagnosis of acute pyelonephritis, but may help identify complications such as abscess formation.	4
9. Lee JH, Kim MK, Park SE. Is a routine voiding cystourethrogram necessary in children after the first febrile urinary tract infection? Acta Paediatr. 2012;101(3):e105-109.	Observational-Dx	618 children	To estimate the value of identifying vesicoureteral reflux (VUR) on a voiding cystourethrogram (VCUG) and the benefit of VUR management according to imaging strategies at the first febrile urinary tract infection (UTI).	Abnormal US or DMSA scans had a sensitivity of 100% and a negative predictive value (NPV) of 100% to detect high-grade reflux. In hydronephrotic kidneys, DMSA scanning had a sensitivity of 88.2% and a NPV of 97.1% to detect high-grade reflux.	2
10. Choi YD, Yang WJ, Do SH, Kim DS, Lee HY, Kim JH. Vesicoureteral reflux in adult women with uncomplicated acute pyelonephritis. Urology. 2005;66(1):55-58.	Review/Other-Dx	86 patients	To evaluate the significance of vesicoureteral reflux (VUR) in adult women with uncomplicated acute pyelonephritis.	There were only 2 (2.3%) cases of VUR among 86 patients with uncomplicated acute pyelonephritis. No VUR was found in group I, and grade II reflux was found in 2 patients of group II.	4

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11. Bova JG, Potter JL, Arealos E, Hopens T, Goldstein HM, Radwin HM. Renal and perirenal infection: the role of computerized tomography. <i>J Urol.</i> 1985; 133(3):375-378.	Review/Other-Dx	24 patients	Retrospective study to determine CT contribution to diagnosis of renal inflammatory disease.	CT differentiates those requiring surgery from those managed medically.	4
12. Dalla-Palma L, Pozzi-Mucelli F, Pozzi-Mucelli RS. Delayed CT findings in acute renal infection. <i>Clin Radiol.</i> 1995; 50(6):364-370.	Review/Other-Dx	12 patients	Report on delayed CT findings in acute renal infection.	Delayed CT appears to be useful because it improves diagnostic confidence and gives a more exact evaluation of the extent of infection.	4
13. Demertzis J, Menias CO. State of the art: imaging of renal infections. [Review] [7 refs]. <i>Emergency Radiology.</i> 14(1):13-22, 2007 Apr.	Review/Other-Dx	N/A	Review indications for imaging known or suspected upper UTI, and the relative benefits and limitations of the different imaging modalities for a given clinical presentation. Also review various types of renal infections with a pictorial review of their imaging appearances and differential diagnoses.	No results stated in abstract.	4
14. Kawashima A, Sandler CM, Ernst RD, Goldman SM, Raval B, Fishman EK. Renal inflammatory disease: the current role of CT. <i>Crit Rev Diagn Imaging.</i> 1997; 38(5):369-415.	Review/Other-Dx	N/A	Review of the value of CT in renal inflammatory disease.	No results stated in abstract.	4
15. Kawashima A, Sandler CM, Goldman SM. Imaging in acute renal infection. <i>BJU Int.</i> 2000; 86 Suppl 1:70-79.	Review/Other-Dx	N/A	To review value of the current role of and controversies in imaging the kidneys to evaluate patients with acute renal infection.	While renal imaging is not routinely indicated in cases of uncomplicated renal infection, CT is a readily available, highly sensitive modality for the diagnosis and management of patients with acute renal infection.	4
16. Kawashima A, Sandler CM, Goldman SM, Raval BK, Fishman EK. CT of renal inflammatory disease. <i>Radiographics.</i> 1997; 17(4):851-866; discussion 867-858.	Review/Other-Dx	N/A	Review of the value of CT in renal inflammatory disease.	Although not routinely indicated in uncomplicated renal infection, CT is of value in establishing the diagnosis in equivocal cases, in evaluating high-risk patients, and in determining the extent of disease.	4

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17. Wan YL, Lee TY, Bullard MJ, Tsai CC. Acute gas-producing bacterial renal infection: correlation between imaging findings and clinical outcome. <i>Radiology</i> . 1996; 198(2):433-438.	Observational-Dx	38 patients	Retrospective study to correlate imaging findings of types I and II emphysematous pyelonephritis with clinical course and prognosis.	Two types of emphysematous pyelonephritis were identified. Type I emphysematous pyelonephritis was characterized by parenchymal destruction with either absence of fluid collection or presence of streaky or mottled gas. Type II emphysematous pyelonephritis was characterized as either renal or perirenal fluid collections with bubbly or loculated gas or gas in the collecting system. The mortality rate for type I emphysematous pyelonephritis (69%) was higher than that for type II (18%). Type I emphysematous pyelonephritis tended to have a more fulminant course with a significantly shorter interval from clinical onset to death ($P < .001$). Two distinct types of emphysematous pyelonephritis can be seen radiologically, and the differentiation is important due to the prognostic difference.	3
18. Leyendecker JR, Gianini JW. Magnetic resonance urography. <i>Abdom Imaging</i> . 2009; 34(4):527-540.	Review/Other-Dx	N/A	To demonstrate the current potential of MRU to demonstrate a spectrum of urologic pathology involving the kidneys, ureters, and bladder while discussing the limitations and current status of this evolving technique.	No results stated in abstract.	4
19. Rathod SB, Kumbhar SS, Nanivadekar A, Aman K. Role of diffusion-weighted MRI in acute pyelonephritis: a prospective study. <i>Acta Radiol</i> . 56(2):244-9, 2015 Feb.	Observational-Dx	42 patients	To describe results of the first prospective study to evaluate accuracy of quantitative ADC values to differentiate nephritis from renal abscesses in patients with acute pyelonephritis using contrast-enhanced CT as the gold standard.	For the diagnosis of pyelonephritis, DW MRI had a higher sensitivity of 95.3% as compared to that of non-contrast CT (66.7%) and contrast-enhanced CT (88.1%). Areas of nephritis had significantly lower ADC values ($P < 0.001$) than the normal renal cortical parenchyma. Also, renal abscesses had significantly lower ADC values ($P < 0.001$) than areas of nephritis. However, CT is more useful for the diagnosis of renal calculi and emphysematous pyelonephritis.	3

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20. Taniguchi LS, Torres US, Souza SM, Torres LR, D'&Ippolito G. Are the unenhanced and excretory CT phases necessary for the evaluation of acute pyelonephritis?. <i>Acta Radiol.</i> 58(5):634-640, 2017 May.	Observational-Dx	100 patients	To establish the accuracy, reproducibility, and degree of confidence in CT diagnosis of acute pyelonephritis (APN) and urolithiasis using only images obtained during the nephrographic phase.	The accuracy of only nephrographic phase for diagnosis of APN and urolithiasis was in the range of 90.3-91.78% and 96.27-99.25%, respectively. There was no significant difference in comparison with the triphasic reading (z: -0.4 - 0.2; P = 0.34-0.83). The average degree of confidence for APN also showed no significant variation for both readers (P = 0.4 and 0.08). Almost perfect inter-observer agreements for the diagnosis of APN (k = 0.86, P < 0.001) and for urolithiasis (k = 0.84, P < 0.001) were observed when considering only the nephrographic phase.	2
21. Cerwinka WH, Kirsch AJ. Magnetic resonance urography in pediatric urology. <i>Curr Opin Urol.</i> 2010; 20(4):323-329.	Review/Other-Dx	N/A	To describe current techniques and applications of MRU and review recent advances.	MRU has the potential to revolutionize imaging of the urinary tract in children. It integrates exquisite anatomical information with a variety of functional data and avoids ionizing radiation. MRU is increasingly employed as a problem solver when conventional imaging studies remain inconclusive and its growing application will likely improve availability and cost in the future.	4
22. Cerwinka WH, Grattan-Smith JD, Jones RA, et al. Comparison of magnetic resonance urography to dimercaptosuccinic acid scan for the identification of renal parenchyma defects in children with vesicoureteral reflux. <i>J Pediatr Urol.</i> 2014;10(2):344-351.	Observational-Dx	25 patients	To compare the accuracy of dimercaptosuccinic acid (DMSA) renal scan to magnetic resonance urography (MRU) in the identification of renal parenchyma defects (RPD).	The ultimate consensus diagnosis was 18 kidneys with RPDs in 15 patients, of which five were classified as mild RPDs, six as moderate RPDs, and seven as severe RPDs. Although DMSA scan and MRU were similar in their ability to diagnose RPDs, MRU was considered to represent the true diagnosis in 11 of the 12 discordant cases in consensus review by four pediatric radiologists. MRU showed a much higher inter-observer agreement with a weighted kappa of 0.96 for both kidneys compared to 0.71 for the right kidney and 0.86 for the left kidney by DMSA scan.	3

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23. Kovanlikaya A, Okay N, Cakmakci H, Ozdogan O, Degirmenci B, Kavukcu S. Comparison of MRI and renal cortical scintigraphy findings in childhood acute pyelonephritis: preliminary experience. Eur J Radiol. 2004; 49(1):76-80.	Observational-Dx	20 children	To compare MRI and renal cortical scintigraphy findings in childhood acute pyelonephritis and to determine pyelonephritic foci in the acute phase.	Sensitivity and specificity of MRI in the detection of pyelonephritic lesions were found to be 90.9% and 88.8%, respectively. There is no statistically significant difference in lesion detection between the two diagnostic modalities (P>0.05). Post-gadolinium MRI show significant correlation with renal cortical scintigraphy in the determination of renal pathology. Moreover, the ability of discriminating acute pyelonephritic foci and renal scar in early stages of disease is the superiority of MRI.	1
24. Grattan-Smith JD, Little SB, Jones RA. Evaluation of reflux nephropathy, pyelonephritis and renal dysplasia. Pediatr Radiol. 2008; 38 Suppl 1:S83-105.	Review/Other-Dx	N/A	Review evaluation of reflux nephropathy, pyelonephritis and renal dysplasia with MRU.	Characteristic imaging features of renal dysplasia include small size, subcortical cysts, disorganized architecture, decreased and patchy contrast enhancement as well as a dysmorphic pelvicalyceal system. Because of the ability of MRU to subdivide and categorize this heterogeneous group of disorders, it seems inevitable that MRU will replace DMSA renal scintigraphy as the gold standard for assessment of pyelonephritis and renal scarring. MRU will contribute to the understanding of renal dysplasia and its relationship to reflux nephropathy.	4

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25. De Pascale A, Piccoli GB, Priola SM, et al. Diffusion-weighted magnetic resonance imaging: new perspectives in the diagnostic pathway of non-complicated acute pyelonephritis. <i>Eur Radiol.</i> 2013;23(11):3077-3086.	Observational-Dx	279 patients	To compare DW-MRI with GE-MRI to test its diagnostic accuracy in APN.	Two hundred and forty-four patients were diagnosed as having APN; 35 were negative. One hundred and sixty-three APN cases were considered non-complicated and selected for the study. Among the 414 MR examinations, comparing DW-MRI with GE-MRI, positive correlation was found in 258 cases, negative in 133. There were 14 false-negatives and 9 false-positives. DW-MRI achieved sensitivity 95.2 %, specificity 94.9 %, positive predictive value 96.9 %, negative predictive value 92.3 % and accuracy 94.6 %.	3
26. 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 (CEMR) and diffusion-weighted (DWI) magnetic resonance imaging in diagnosing acute pyelonephritis (APN) and to assess ADC measurement reliability in differentiating among normal renal parenchyma, APN and abscesses.	Agreement between CEMR and DWI was 94.3 % (83/88 patients; $P < 0.05$). In the APN group, DWI was awarded the highest visibility score compared to CEMR ($P = 0.05$), while in the abscess group CEMR had the highest score ($P = 0.04$). The difference between ADC values of the APN-healthy parenchyma and abscess-APN groups was significant ($P < 0.05$). The area under the ROC curve of ADC values of the APN-healthy and abscess-APN groups were found to be 0.94 (95 % CI; cutoff value = 2) and 0.78 (95 % CI; cutoff value = 1.2) respectively.	3

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27. Faletti R, Cassinis MC, Gatti M, et al. Acute pyelonephritis in transplanted kidneys: can diffusion-weighted magnetic resonance imaging be useful for diagnosis and follow-up?. <i>Abdom Radiol.</i> 41(3):531-7, 2016 Mar.	Observational-Dx	22 patients, 24 controls for ADC in healthy parenchyma.	To assess reliability of diffusion-weighted magnetic resonance imaging (DW-MRI) in the management of acute pyelonephritis (APN) foci in transplanted kidneys.	Forty-six APN foci were found in 22/24 patients. At the acute stage, the difference in ADC between healthy parenchyma and APN foci was significant (2.06 ± 0.16 vs. $1.43 \pm 0.32 \times 10^{-3}$ mm ² /s; $p < 0.0001$). The performance of ADC as APN indicator was tested by the receiving operating characteristics (ROC) curve: the area under curve AUC = 0.99 witnessed an excellent discriminatory ability, with threshold APN/normal parenchyma 1.9×10^{-3} mm ² /s. At the 1-month follow-up 43/46 APN foci were no longer visible, with ADC values significantly higher than at the acute stage; all laboratory data were physiological, with WBC significantly reduced from the acute phase ($5.2 \pm 1.6 \times 10^9$ /L vs. $10.6 \pm 4.8 \times 10^9$ /L; $p < 0.0001$). The other 3 patients underwent further therapy and exams, including a third MR.	3
28. Chan JH, Tsui EY, Luk SH, et al. MR diffusion-weighted imaging of kidney: differentiation between hydronephrosis and pyonephrosis. <i>Clin Imaging.</i> 2001; 25(2):110-113.	Observational-Dx	12 patients	To evaluate the capability and reliability of the DWI MRI in differentiation between hydronephrosis and pyonephrosis.	On DWI, the pelvicalyceal system of the hydronephrotic kidney was hypointense while the pelvicalyceal system of the pyonephrotic kidney was markedly hyperintense. The mean ADCs of the hydronephrotic and pyonephrotic renal pelvis were $2.98 \pm 0.65 \times 10^{-3}$ and $0.64 \pm 0.35 \times 10^{-3}$ mm ² /s, respectively. The extremely low ADC of the renal pelvis of the pyonephrotic kidney accounted for its signal hyperintensity on DWI as well as signal hypointensity on ADC maps. The DWI MRI may be a reliable tool to differentiate pyonephrosis from hydronephrosis.	3

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29. Thoeny HC, De Keyzer F, Oyen RH, Peeters RR. Diffusion-weighted MR imaging of kidneys in healthy volunteers and patients with parenchymal diseases: initial experience. <i>Radiology</i> . 2005; 235(3):911-917.	Observational-Dx	18 healthy volunteers and 15 patients	To prospectively evaluate feasibility of DWI MRI in assessment of renal function in healthy volunteers and patients with various renal abnormalities and to prospectively evaluate reproducibility of DWI MRI in volunteers.	In all volunteers, ADC(avg) and ADC(high) were significantly higher in the cortex than in the medulla (P<.001). No difference between the cortex and medulla could be observed for ADC(low). Patients with renal failure had significantly lower ADC(avg) (P<.001, P=.004), ADC(low) (P=.02, P=.03), and ADC(high) (P=.02, P=.04) of cortex and medulla, respectively, than did volunteers. In the patient with pyelonephritis, all ADC values of cortex and medulla were substantially lower compared with the contralateral side, whereas patients with ureteral obstruction showed varying degrees of difference in all ADC values compared with the contralateral side. No statistically significant changes were found in the repeat study of the volunteers. DWI MRI is feasible and reproducible in the assessment of renal function.	4
30. 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 diffusion-weighted imaging (DWI) against the reference standard of gadolinium-enhanced T1-weighted imaging (Gd-T1-WI) in children.	Thirty-two kidneys (41 %) had hypo-enhancing areas on Gd-T1-W images. The sensitivity and specificity of DWI were 100 % (32/32) and 93.5 % (43/46). DWI demonstrated excellent agreement (kappa = 0.92,) with Gd-T1-W, with no significant difference (P = 0.25) in detection of abnormal lesions. Interobserver reproducibility was excellent with DWI (kappa = 0.79).	2
31. Piccirillo M, Rigsby CM, Rosenfield AT. Sonography of renal inflammatory disease. <i>Urol Radiol</i> . 1987; 9(2):66-78.	Review/Other-Dx	N/A	Review role of US in the diagnostic and therapeutic management of patients with renal inflammatory disease.	No results stated in abstract.	4
32. Fontanilla T, Minaya J, Cortes C, et al. Acute complicated pyelonephritis: contrast-enhanced ultrasound. <i>Abdom Imaging</i> . 2012;37(4):639-646.	Review/Other-Dx	48 patients	To describe in detail the contrast-enhanced US findings in APN, and to determine if abscess and focal pyelonephritis may be distinguished.	No results stated.	4

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33. Yoo JM, Koh JS, Han CH, et al. Diagnosing Acute Pyelonephritis with CT, Tc-DMSA SPECT, and Doppler Ultrasound: A Comparative Study. Korean J Urol. 2010; 51(4):260-265.	Observational-Dx	207 patients	Retrospective study to compare the sensitivity of the three renal imaging techniques (enhanced CT, DMSA scintigraphy, and Doppler US) for the detection and localization of acute pyelonephritis by use of strict clinical criteria as the standard of reference.	CT was performed in 199 patients, Doppler US was performed in 163 patients, and DMSA scintigraphy was performed in 157 patients. CT and Doppler US were performed in 147 patients (Group 1), Doppler US and DMSA were performed in 150 patients (Group 2), and CT and DMSA were performed in 147 patients (Group 3). CT showed significantly superior sensitivity compared with that of Doppler US (81.0% vs 33.3%, respectively, n=147). DMSA scintigraphy also showed significantly superior sensitivity compared with that of Doppler US (74.7% vs 33.3%, respectively, n=150). Compared with DMSA scintigraphy, CT showed superior sensitivity, but the difference was not statistically significant (81.0% vs 74.8%, respectively, n=147, P=0.163). For cases of clinically suspected acute pyelonephritis, CT and DMSA scintigraphy appear to be equally sensitive and reliable for detecting acute Pyelonephritis, although CT is more practical in various fields. Doppler US was significantly less sensitive.	2
34. Kim B, Lim HK, Choi MH, et al. Detection of parenchymal abnormalities in acute pyelonephritis by pulse inversion harmonic imaging with or without microbubble ultrasonographic contrast agent: correlation with computed tomography. J Ultrasound Med. 2001; 20(1):5-14.	Observational-Dx	30 patients with acute pyelonephritis and 10 healthy volunteers	Comparison of pulse inversion harmonic imaging with or without contrast agent with US and tissue harmonic imaging to evaluate the ability of pulse inversion harmonic imaging with or without microbubble US contrast agent in depicting renal parenchymal changes in acute pyelonephritis.	The detection and conspicuity of renal parenchymal abnormalities in acute pyelonephritis on tissue harmonic imaging, pulse inversion harmonic imaging, and contrast-enhanced pulse inversion harmonic imaging were significantly better than those on conventional US. In 2 of 10 healthy volunteers all 4 techniques yielded false-positive diagnoses of parenchymal abnormalities. Tissue harmonic imaging and pulse inversion harmonic imaging is significantly better than conventional US.	3

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<p>35. Mitterberger M, Pinggera GM, Colleselli D, et al. Acute pyelonephritis: comparison of diagnosis with computed tomography and contrast-enhanced ultrasonography. <i>BJU Int.</i> 2008; 101(3):341-344.</p>	<p>Observational-Dx</p>	<p>100 patients</p>	<p>To assess the value of contrast-enhanced US with the contrast pulse-sequence technique for detecting renal parenchymal changes in acute pyelonephritis, compared with contrast-enhanced CT as the reference standard.</p>	<p>On contrast CT, 84 patients (84%) had renal parenchymal changes suggestive of acute pyelonephritis; on contrast US, 82/84 (98%) showed renal parenchymal changes, and acute pyelonephritis was correctly diagnosed. 76 patients (90%) had unilateral and 8 (10%) had bilateral acute pyelonephritis, and in two (2%) with acute pyelonephritis the diagnosis could not be confirmed by US/contrast pulse-sequence (false-negative). No false-positive findings were detected on US/contrast pulse-sequence, which had a sensitivity of 98%, a specificity of 100%, a PPV of 100%, and NPV of 89%. Contrast pulse-sequence US is accurate for detecting parenchymal changes in acute pyelonephritis; it is very sensitive and specific, and allows small renal parenchymal changes to be detected with no radiation exposure.</p>	<p>2</p>

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36. Lee MD, Lin CC, Huang FY, Tsai TC, Huang CT, Tsai JD. Screening young children with a first febrile urinary tract infection for high-grade vesicoureteral reflux with renal ultrasound scanning and technetium-99m-labeled dimercaptosuccinic acid scanning. J Pediatr. 2009; 154(6):797-802.	Observational-Dx	699 children	To evaluate the predictive value of renal US scanning and DMSA scintigraphy for high-grade VUR in young children with a first UTI.	Of 699 children, high-grade VUR (grades III-V) was diagnosed in 119 (17.0%). Signs of renal hypodysplasia (OR, 16.15), cyclic dilatation of pelvicaliceal system (OR, 11.73), hydroureter (OR, 4.00) with renal US scanning, and renal hypodysplasia (OR, 8.78), acute pyelonephritis (OR, 2.76) with DMSA scanning were associated with high-grade VUR. The sensitivities for high-grade VUR of US scanning alone (67.2%) or DMSA scanning alone (65.5%) were not as good as that of a both-test strategy, which had a sensitivity rate of 83.2%. The NPV of the both-test strategy was 91.5%. Renal US scanning and DMSA scanning both should be routinely performed in children with a first febrile UTI. VCUG is only indicated when abnormalities are apparent on either US scanning or DMSA scanning or both.	3
37. 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? Clin Nucl Med. 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

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
38. 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	Comparative study to determine if power Doppler US is as sensitive as radionuclide scans in detecting childhood pyelonephritis.	Power Doppler US had sensitivity of 87% and specificity of 92.3%. It does not require radiation; therefore, it may be a practical tool for the diagnosis of acute pyelonephritis in children.	1
39. Sattari A, Kampouridis S, Damry N, et al. CT and 99mTc-DMSA scintigraphy in adult acute pyelonephritis: a comparative study. <i>J Comput Assist Tomogr.</i> 2000; 24(4):600-604.	Review/Other-Dx	36 patients	Prospective study to evaluate the relative value of CT and Tc-99m-DMSA scintigraphy in the diagnosis of acute pyelonephritis in adult patients suspected of having UTI.	12 patients with clinical and biological signs of UTI had no CT or Tc-99m-DMSA scintigraphy abnormalities. Among these patients, lower UTI was found in 10 patients and 2 patients had ureteral obstruction. In the 24 remaining patients, the diagnosis of acute pyelonephritis was made. Among these patients, a correlation was found between CT and Tc-99m-DMSA scintigraphy in 11 cases. In two cases, both examinations were normal, and in 9 cases, both were abnormal. In 11 cases of the 13 remaining patients, abnormal CT was found with normal Tc-99m-DMSA scintigraphy, whereas the 2 last cases had normal CT and abnormal Tc-99m-DMSA scintigraphy results. In two cases, bilateral lesions found on CT manifested as unilateral abnormalities on Tc-99m-DMSA scintigraphy images. Authors conclude that CT is more accurate than Tc-99m-DMSA scintigraphy in the detection of acute pyelonephritis lesions in adult patients.	4
40. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf .	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	No results stated in abstract.	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.
- Meta-analysis
 - a. *Good quality* – the study design, methods, analysis, and results are valid and the conclusion is supported.
 - b. *Inadequate quality* – the study design, analysis, and results lack the methodological rigor to be considered a good meta-analysis study.

Abbreviations Key

Dx = Diagnostic

Tx = Treatment