Hematuria
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. McDonald MM, Swagerty D, Wetzel L. Assessment of microscopic hematuria in adults. *Am Fam Physician.* 2006;73(10):1748-1754.	Review/Other-Dx	N/A	To review the assessment of microscopic hematuria in adults.	No results stated in abstract.	4
2. Sing RI, Singal RK. What is significant hematuria for the primary care physician? *Can J Urol.* 2012;19 Suppl 1:36-41.	Review/Other-Dx	N/A	A review on significant hematuria.	No results stated in abstract.	4
3. Yun EJ, Meng MV, Carroll PR. Evaluation of the patient with hematuria. *Med Clin North Am.* 2004;88(2):329-343.	Review/Other-Dx	N/A	To review current literature and propose the optimal, modern evaluation for patients presenting with hematuria.	No results stated in abstract.	4
4. Davis R, Jones JS, Barocas DA, et al. Diagnosis, evaluation and follow-up of asymptomatic microhematuria (AMH) in adults: AUA guideline. *J Urol.* 2012;188(6 Suppl):2473-2481.	Review/Other-Dx	191 articles	To provide a clinical framework for the diagnosis, evaluation and follow-up of asymptomatic microhematuria.	Guideline statements are provided for diagnosis, evaluation and follow-up. The panel identified multiphasic CT as the preferred imaging technique and developed guideline statements for persistent or recurrent asymptomatic microhematuria as well as follow-up.	4
5. Dooley RE, Pietrow PK. Ureteroscopy for benign hematuria. *Urol Clin North Am.* 2004;31(1):137-143.	Review/Other-Dx	N/A	A review on ureteroscopy for benign hematuria.	No results stated in abstract.	4
6. Edwards TJ, Dickinson AJ, Natale S, Gosling J, McGrath JS. A prospective analysis of the diagnostic yield resulting from the attendance of 4020 patients at a protocol-driven haematuria clinic. *BJU Int.* 2006;97(2):301-305; discussion 305.	Review/Other-Dx	4,020 patients	To clarify the prevalence of disease as determined by age, sex and the degree of hematuria at presentation, and to ascertain the merits of using US, IVU or both when imaging the upper urinary tract, in a prospective cohort of patients attending a protocol-based hematuria clinic.	In all, 2,627 men and 1,393 women presented with microscopic (53.2%) or macroscopic hematuria (46.8%). The overall prevalence of malignant disease was 12.1%, but for macroscopic hematuria it was 18.9% and for microscopic hematuria 4.8%. Age and sex also influenced the observed rates of disease. Of the upper tract tumors, 70 were identified after abnormal US, with 3 cases of transitional cell carcinoma identified on IVU after a normal US.	4

Hematuria
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
7. Stanford EJ, Mattox TF, Parsons JK, McMurphy C. Prevalence of benign microscopic hematuria among women with interstitial cystitis: implications for evaluation of genitourinary malignancy. *Urology*. 2006;67(5):946-949.	Review/Other-Dx	100 women	To assess the prevalence of benign microscopic hematuria among a cohort of women with clinical interstitial cystitis.	The mean age +/- standard deviation was 37 +/- 15 years, with no difference noted in those with or without microscopic hematuria (P=0.71). Microscopic hematuria was present in 24 (24%) of the 100 women. No patient had gross hematuria, positive urine culture, or cystoscopic findings suspicious for malignancy. The mean Pelvic Pain and Urgency/Frequency score was 17 +/- 6. The potassium sensitivity test was positive in 92 (92%) of 100 women, and 8 patients had only cystoscopic findings diagnostic of IC. The likelihood of a positive potassium sensitivity testor positive cystoscopic findings among patients with microscopic hematuria was similar to that of patients without microscopic hematuria. The potassium sensitivity test results correlated with the cystoscopic findings (P<0.001). Of 36 patients with positive cystoscopic findings, 28 (78%) had a positive potassium sensitivity test, and 28 (30%) of 92 with a positive potassium sensitivity test had positive cystoscopy findings.	4
8. American College of Radiology. ACR Appropriateness Criteria®: Suspected Lower Urinary Tract Trauma. Available at: https://acsearch.acr.org/docs/69376/Narrative/. Accessed November 26, 2014.	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.	N/A	4

Hematuria
EVIDENCE TABLE

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9. Blick CG, Nazir SA, Mallett S, et al. Evaluation of diagnostic strategies for bladder cancer using computed tomography (CT) urography, flexible cystoscopy and voided urine cytology: results for 778 patients from a hospital haematuria clinic. *BJU Int.* 2012;110(1):84-94.	Observational-Dx	778 patients	To evaluate and compare the diagnostic accuracy of CTU with flexible cystoscopy and voided urine cytology for diagnosing bladder cancer. To evaluate diagnostic strategies using CTU as: (i) an additional test or (ii) a replacement test or (iii) a triage test for diagnosing bladder cancer in patients referred to a hospital hematuria rapid diagnosis clinic.	The prevalence of bladder cancer in the clinical cohort was 20% (156/778). For the diagnostic strategy using CTU as an additional test for diagnosing bladder cancer, when scores of 1 were classified as negative and scores of 2 and 3 as positive, sensitivity was 1.0 (95% CI, 0.98–1.00), specificity was 0.94 (95% CI, 0.91–0.95), the PPV was 0.80 (95% CI, 0.73–0.85) and the NPV was 1.0 (95% CI, 0.99–1.00). For the diagnostic strategy using CTU as a replacement test for flexible cystoscopy for diagnosing bladder cancer, (using scores as above), sensitivity was 0.95 (95% CI, 0.90–0.97), specificity was 0.83 (95% CI, 0.80–0.86), the PPV was 0.58 (95% CI, 0.52–0.64), and the NPV was 0.98 (95% CI, 0.97–0.99). Similarly using flexible cystoscopy for diagnosing bladder cancer, (using scores as above), sensitivity was 0.98 (95% CI, 0.94–0.99), specificity was 0.94 (95% CI, 0.92–0.96), the PPV was 0.80 (95% CI, 0.73–0.85) and the NPV was 0.99 (95% CI, 0.99–1.0). For using CTU and flexible cystoscopy as a triage test for rigid cystoscopy and follow-up (option 1), patients with a positive CTU score are referred directly for rigid cystoscopy, and patients with an equivocal or normal score were referred for flexible cystoscopy. Sensitivity was 1.0 (95% CI, 0.98–1.0), specificity was 0.94 (95% CI, 0.91–0.95), the PPV was 0.80 (95% CI, 0.73–0.85), and the NPV was 1.0 (95% CI, 0.99–1.0). 0.98 (95% CI, 0.97–0.99), the PPV was 0.93 (95% CI, 0.87–0.96), and the NPV was 0.99 (95% CI, 0.97–0.99). For voided urine cytology, if scores of 0-3 were classified as negative and 4-5 as positive for bladder cancer, sensitivity was 0.38 (95% CI, 0.31–0.45), specificity was 0.98 (95% CI, 0.97–0.99), the PPV was 0.82 (95% CI, 0.72–0.88) and the NPV was 0.84 (95% CI, 0.81–0.87).	3

Hematuria
EVIDENCE TABLE

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10. Turney BW, Willatt JM, Nixon D, Crew JP, Cowan NC. Computed tomography urography for diagnosing bladder cancer. *BJU Int.* 2006;98(2):345-348.	Observational-Dx	200 patients	To evaluate the use of CTU for diagnosing bladder tumors in patients with macroscopic hematuria and aged >40 years.	The prevalence of bladder tumors was 24%; when CTU was compared with the histopathological findings, there was 1 false-positive and 3 false-negative diagnoses, indicating a sensitivity of 0.93 and a specificity of 0.99, with a 0.98 positive and 0.97 NPV for detecting bladder cancer. A review of the 3 false-negative cases showed that one was missed on original CTU reporting, the second had the appearance of prostate cancer on CTU and the third was a squamous metaplasia.	3
11. Park SB, Kim JK, Lee HJ, Choi HJ, Cho KS. Hematuria: portal venous phase multi detector row CT of the bladder--a prospective study. *Radiology.* 2007;245(3):798-805.	Observational-Dx	118 patients	To prospectively determine the accuracy of portal venous phase helical multidetector row CT for bladder lesion evaluation in patients with hematuria by using cystoscopy as the reference standard.	Multidetector row CT showed excellent per lesion (kappa = 0.839) and per patient (kappa = 0.881) agreement between the 2 reviewers. Respective per lesion and per patient agreement between the CT and cystoscopic findings was also excellent in the first (kappa = 0.866 and kappa = 0.881) and second (kappa = 0.802 and kappa = 0.863) reviewers. The sensitivity and specificity of multidetector row CT were 89%–92% and 88%–97%, respectively, in the per lesion analysis and 95% and 91%–93%, respectively, in the per patient analysis for both reviewers. All statistical parameters of diagnostic accuracy were similar between the 2 reviewers (P>.05).	2
12. Sadow CA, Silverman SG, O'Leary MP, Signorovitch JE. Bladder cancer detection with CT urography in an Academic Medical Center. *Radiology.* 2008;249(1):195-202.	Observational-Dx	838 CT urograms in 779 patients	To evaluate the performance characteristics of CTU for the detection of bladder cancer in patients at risk for the disease.	The overall sensitivity, specificity, accuracy, PPV, and NPV for bladder cancer detection were 79% (117/149), 94% (649/689), 91% (766/838), 75% (117/157), and 95% (649/681) for CTU and 95% (142/149), 92% (634/689), 93% (776/838), 72% (142/197), and 99% (634/641) for cystoscopy. The NPV of CTU was higher in patients evaluated for hematuria alone (98%, 589/603). However, the accuracy of CTU was considerably lower in patients with a prior urothelial malignancy (78%, 123/158).	3

Hematuria
EVIDENCE TABLE

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13. Rodgers M, Nixon J, Hempel S, et al. Diagnostic tests and algorithms used in the investigation of haematuria: systematic reviews and economic evaluation. *Health Technol Assess.* 2006;10(18):iii-iv, xi-259.	Review/Other-Dx	118 studies	To determine the most effective diagnostic strategy for the investigation of microscopic and macroscopic hematuria in adults.	There are insufficient data currently available to derive an evidence-based algorithm of the diagnostic pathway for hematuria. A hypothetical algorithm based on the opinion and practice of clinical experts in the review team, other published algorithms and the results of economic modelling is presented in this report. This algorithm is presented, for comparative purposes, alongside current U.S. and UK guidelines. The ideas contained in these algorithms and the specific questions outlined should form the basis of future research. Quality assessment of the diagnostic accuracy studies included in this review highlighted several areas of deficiency.	4
14. Coakley FV, Yeh BM. Invited Commentary. *Radiographics.* 2003;23(6):1455-1456.	Review/Other-Dx	N/A	Commentary on an article by Joffe S.A. et al. Article reviewed multidetector row CTU in the evaluation of patients with hematuria.	No results stated in abstract.	4
15. Joffe SA, Servaes S, Okon S, Horowitz M. Multi-detector row CT urography in the evaluation of hematuria. *Radiographics.* 2003;23(6):1441-1455; discussion 1455-1446.	Review/Other-Dx	N/A	To review multidetector row CT technique in patients with hematuria. The authors also discuss and illustrate a variety of entities that are frequently associated with hematuria, including calculi, renal masses, papillary and caliceal abnormalities, renal pelvic and ureteral disease, bladder disease, and congenital anomalies. In addition, they briefly discuss the role of other imaging modalities in the evaluation of hematuria patients.	No results stated in abstract.	4
16. Gray Sears CL, Ward JF, Sears ST, Puckett MF, Kane CJ, Amling CL. Prospective comparison of computerized tomography and excretory urography in the initial evaluation of asymptomatic microhematuria. *J Urol.* 2002;168(6):2457-2460.	Observational-Dx	115 patients	To prospectively compare the diagnostic yield of CT to excretory urography in the initial evaluation of asymptomatic microhematuria.	Radiographic abnormalities were noted on CT or excretory urography in 38 patients. Sensitivity was 100% for CT and 60.5% for excretory urography, and specificity 97.4% for CT and 90.9% for excretory urography. CT accuracy was 98.3% compared to excretory urography accuracy which was 80.9% ($P<0.001$). A total of 40 nonurological diagnoses were made by CT, including 3 abdominal aortic aneurysms and 1 iliac artery aneurysm. No additional diagnoses were made by excretory urography. Fewer additional radiographic studies were recommended after CT than after excretory urography.	2

Hematuria
EVIDENCE TABLE

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17. Albani JM, Ciaschini MW, Streem SB, Herts BR, Angermeier KW. The role of computerized tomographic urography in the initial evaluation of hematuria. *J Urol*. 2007;177(2):644-648.	Observational-Dx	259 patients compared to 253 patients	To determine the usefulness of CTU for the initial evaluation of patients with hematuria as an alternative to excretory urography.	A source of hematuria was identified in 107 patients (41.3%) in the CTU cohort and in 103 patients (40.7%) in the excretory urography cohort. CTU alone identified a source of hematuria in 25.5% of these patients with the most commonly diagnosed lesions being renal calculi (18.9%), ureteral calculi (2.7%) and renal pelvic masses (2.3%) in the upper tract (0.94 sensitivity), and bladder masses (8.1%), prostatic abnormalities (5.4%) and inflammatory disorders (3.5%) in the lower tract (0.40 sensitivity, 0.99 specificity). The overall detection rate (19.5%), most commonly diagnosed lesions, and lower urinary tract sensitivity and specificity were similar in the excretory urography cohort. However, excretory urography exhibited a markedly lower sensitivity in detecting upper tract lesions (0.50).	3
18. Kulkarni NM, Eisner BH, Pinho DF, Joshi MC, Kambadakone AR, Sahani DV. Determination of renal stone composition in phantom and patients using single-source dual-energy computed tomography. *J Comput Assist Tomogr*. 2013;37(1):37-45.	Observational-Dx	a phantom and 11 patients	To characterize the urinary tract stones in phantom and patients using single-source dual-energy CT.	Of the 59 verified stones (phantom, 20; patients, 39; mean size, 6 mm), there were 16 uric acid and 43 non-uric acid type. The material density images were 100% sensitive and accurate in detecting uric acid and non-uric acid stones. The Zeff accurately stratified struvite, cystine, and calcium (calcium oxalate monohydrate) stones in the phantom. In patients, Zeff identified 83% of calcium stones (n = 24), and in stones of mixed type, it resembled dominant composition. The Hounsfield unit measurements alone were 71% sensitive and 69% accurate in detecting the uric acid stones.	3

Hematuria
EVIDENCE TABLE

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19. Toepker M, Kuehas F, Kienzl D, et al. Dual energy computerized tomography with a split bolus-a 1-stop shop for patients with suspected urinary stones? *J Urol.* 2014;191(3):792-797.	Observational-Dx	81 patients	To evaluate the dual energy, split bolus CT protocol that provides virtual noncontrast, parenchymal and urographic phases in a single scan. The authors assessed the sensitivity of the virtual noncontrast phase using this protocol to detect urinary stones compared to the gold standard of the true noncontrast phase.	Of the 350 stones noted on the true noncontrast phase the authors found 289 on the virtual noncontrast phase as well as 13 false-positive and 66 false-negative stones. Sensitivity was 98.4%, 89.8% and 82.6% per patient, segment and stone, respectively. The diameter measured on the virtual noncontrast phase corresponded to a mean +/- SD 92.5% +/- 31.6% of the diameter on the true noncontrast phase. The mean effective dose was 4.8 +/- 1.8 and 10.5 +/- 3.7 mSv for the true and virtual noncontrast phases, respectively.	1
20. Cauberg EC, Nio CY, de la Rosette JM, Laguna MP, de Reijke TM. Computed tomography-urography for upper urinary tract imaging: is it required for all patients who present with hematuria? *J Endourol.* 2011;25(11):1733-1740.	Observational-Dx	841 patients	To define in which patients who present with microscopic or macroscopic hematuria CTU is indicated as an imaging mode for the upper urinary tract.	From the total of 841 patients, lesions that might account for hematuria could not be identified in 462 (54.9%), whereas in 250 (29.7%) and 124 (14.7%) patients, hematuria was from benign and malignant disease, respectively. Cross-sectional urography revealed relevant upper urinary tract lesions in 73/525 (13.9%) patients. Only result of US (OR 7.7, 95% CI, 4.0–14.9), P<0.001) and type of hematuria (OR 2.6, 95% CI, 1.3–5.1, P=0.01) were significant predictors for cross-sectional urography result. In 44/456 (9.6%) patients with no abnormalities on US, CTU/MRU revealed that these were false negatives, with most lesions missed being stones. In 253/309 (81.9%) patients with macroscopic hematuria, no lesions were detected in the upper urinary tract on CTU/MRU, in contrast to 199/216 patients (92.1%) with microscopic hematuria.	3
21. Sandhu KS, LaCombe JA, Fleischmann N, Greston WM, Lazarou G, Mikhail MS. Gross and microscopic hematuria: guidelines for obstetricians and gynecologists. *Obstet Gynecol Surv.* 2009;64(1):39-49.	Review/Other-Dx	N/A	To summarize existing literature regarding the evaluation, differential diagnosis, and treatment of hematuria in women, with special emphasis on pregnancy and the diagnosis and treatment of microscopic hematuria.	No results stated in abstract.	4

Hematuria
EVIDENCE TABLE

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22. Unsal A, Caliskan EK, Erol H, Karaman CZ. The diagnostic efficiency of ultrasound guided imaging algorithm in evaluation of patients with hematuria. *Eur J Radiol.* 2011;79(1):7-11.	Observational-Dx	141 patients	To assess the efficiency of the following imaging algorithm, including IVU or CTU based on US selection, in the radiological management of hematuria.	US and IVU results of 97 cases were congruent in group 1. 8 simple cysts were detected with US and 1 nonobstructing ureter stone was detected with IVU in remaining 9 patients. The only discordant case in clinical comparison was found to have urinary bladder cancer on conventional cystoscopy. US and CTU results were congruent in 30 cases. Additional lesions were detected with CTU (3 ureter stones, 1 ureter TCC, 1 advanced RCC) in remaining 5 patients. US + CTU combination results were all concordant with clinical diagnosis. Except 1 case, radio-clinical agreement was achieved.	2
23. Moghazi S, Jones E, Schroepple J, et al. Correlation of renal histopathology with sonographic findings. *Kidney Int.* 2005;67(4):1515-1520.	Observational-Dx	207 patients	To retrospectively compare sonographic parameters (length, quantitative echogenicity, cortical thickness, and parenchymal thickness) to biopsy findings of glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation.	Echogenicity showed the strongest correlation with all 4 histologic parameters (r= 0.28-0.35). Renal size was significantly correlated with glomerular sclerosis (r=-0.26) and tubular atrophy (r= 0.20). Parenchymal thickness, but not cortical thickness, correlated with tubular atrophy (r=-0.23). By multivariate analysis, tubular atrophy and interstitial inflammation, but not interstitial fibrosis, were significant determinants of cortical echogenicity. Severe chronic disease (>50% sclerosed glomeruli or a score of 3 out of 5 or greater for tubular atrophy or interstitial fibrosis) was present in 69% and 47% of patients with combined renal length <20 cm and >20 cm, respectively (P=<0.05). For cortical echogenicity >1.0 (>liver echogenicity) and ≤1.0, the proportions of severe disease were 66% and 30%, respectively (P<0.001). Severe disease was present in 86% of patients with combined renal length <20 cm and cortical echogenicity >1.0.	3

Hematuria
EVIDENCE TABLE

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24. Mitterberger M, Pinggera GM, Neuwirt H, et al. Three-dimensional ultrasonography of the urinary bladder: preliminary experience of assessment in patients with haematuria. *BJU Int.* 2007;99(1):111-116.	Observational-Dx	42 patients	To assess the value of 3D vs 2D US in the diagnostic evaluation of the urinary bladder in patients with hematuria.	In 21/42 patients (50%) cystoscopy with bladder biopsy revealed bladder cancer. Overall, 3D-US gave a correct diagnosis for 36/42 patients (86%). All 21 bladder cancers were correctly diagnosed, and 15 (71%) of the 21 benign bladder lesions were correctly identified. By contrast, 2D-US findings gave suspected bladder cancer in all patients.	3
25. Kawashima A, Glockner JF, King BF, Jr. CT urography and MR urography. *Radiol Clin North Am.* 2003;41(5):945-961.	Review/Other-Dx	N/A	To describe the evaluation of hematuria and review developing concepts and evolving techniques of CT and MRU.	No results stated in abstract.	4
26. Nambirajan T, Sohaib SA, Muller-Pollard C, Reznek R, Chinegwundoh FI. Virtual cystoscopy from computed tomography: a pilot study. *BJU Int.* 2004;94(6):828-831.	Observational-Dx	18 patients	To assess the feasibility of virtual cystoscopy reconstructed from helical CT obtained using an IV contrast agent, and to correlate the findings with flexible and rigid cystoscopy in patients with bladder tumors.	At flexible cystoscopy, virtual cystoscopy and rigid cystoscopy, 32, 34 and 36 lesions were identified, respectively; 33 (92%) of the abnormal lesions at rigid cystoscopy were correctly identified at virtual cystoscopy. At virtual cystoscopy, all lesions of >4 mm were identified but only 1 of 3 <4 mm was seen. There were 2 false-positive finding at virtual cystoscopy; virtual cystoscopy correctly identified 17 (94%) of 18 abnormal bladders. Only 25% of the ureteric orifices were seen. Carcinoma in situ and urethral tumors were not visualized.	3
27. Chlapoutakis K, Theocharopoulos N, Yarmenitis S, Damilakis J. Performance of computed tomographic urography in diagnosis of upper urinary tract urothelial carcinoma, in patients presenting with hematuria: Systematic review and meta-analysis. *Eur J Radiol.* 2010;73(2):334-338.	Review/Other-Dx	5 articles	To review and meta-analyze published literature, in order to evaluate the performance of CTU for the detection of upper urinary tract urothelial tumors.	CTU proved to be a very sensitive and specific method for the detection of urothelial malignancy, with sensitivity ranging between 88% and 100%, and specificity between 93% and 100%. Pooled sensitivity was 96% (95% CI: 88%–100%) and pooled specificity was 99% (95% CI: 98%–100%). Direct comparison of the method with IVU, confirmed the superiority of CTU over IVU in terms of sensitivity and specificity. Major drawbacks of CTU are increased radiation risk, injection of iodinated contrast media which may potentially be accompanied by serious side effects and increased cost, estimated as roughly 3 times that of IVU.	4

Hematuria
EVIDENCE TABLE

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28. Maheshwari E, O'Malley ME, Ghai S, Staunton M, Massey C. Split-bolus MDCT urography: Upper tract opacification and performance for upper tract tumors in patients with hematuria. *AJR Am J Roentgenol.* 2010;194(2):453-458.	Observational-Dx	200 patients	To assess upper urinary tract opacification and the performance of split-bolus multidetector CTU for upper tract tumors in patients with hematuria.	For reviewers 1 and 2, 85.1% and 84.5% of segments were at least 50% opacified, respectively. Final diagnoses for hematuria were no cause, 123 (61.5%); urothelial cancer, 27 (13.5%); nonmalignant, 46 (23%) and indeterminate, 4 patients (2%). There were 9 upper tract cancers. Sensitivity, specificity, and accuracy for upper tract cancers for prospective interpretation, reviewer 1 and reviewer 2, were 100%, 99%, 99%; 100%, 99.5%, 99.5%; and 88.9%, 99.0%, 98.5%, respectively.	2
29. Wang LJ, Wong YC, Huang CC, Wu CH, Hung SC, Chen HW. Multidetector computerized tomography urography is more accurate than excretory urography for diagnosing transitional cell carcinoma of the upper urinary tract in adults with hematuria. *J Urol.* 2010;183(1):48-55.	Observational-Dx	60 patients	To compare accuracy measures of excretory urography and multidetector CTU for diagnosing upper urinary tract transitional cell carcinoma in adult patients presenting with hematuria.	Of 34 men and 26 women with hematuria (mean age 60.73 +/- 12.95 years) 19 (31.7%) had a final diagnosis of 24 upper urinary tract transitional cell carcinomas. The sensitivity, specificity and accuracy of excretory urography were 0.750, 0.860 and 0.849, respectively. In contrast, the sensitivity, specificity and accuracy of multidetector CTU were 0.958, 1.000 and 0.996, respectively. Overall the area under the receiver operating characteristic curve for multidetector CTU was significantly larger than that for excretory urography (0.978 vs 0.815, P=0.005).	2
30. Silverman SG, Leyendecker JR, Amis ES, Jr. What is the current role of CT urography and MR urography in the evaluation of the urinary tract? *Radiology.* 2009;250(2):309-323.	Review/Other-Dx	N/A	To describe the current role of urography in the postintravenous urography era and provide expository summaries of CTU and MRU, while addressing the rationale, techniques, effectiveness, indications, and vulnerabilities of these newer modalities that have now become primary in imaging the urinary tract.	No results stated in abstract.	4

Hematuria
EVIDENCE TABLE

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31. Shokeir AA, El-Diasty T, Eassa W, et al. Diagnosis of noncalcareous hydronephrosis: role of magnetic resonance urography and noncontrast computed tomography. *Urology.* 2004;63(2):225-229.	Observational-Dx	108 patients	To evaluate the role of MRU and noncontrast CT in the diagnosis of noncalcareous hydronephrosis when excretory urography (IVU) is either contraindicated or inconclusive.	Of the 108 patients, 5 had bilateral obstruction and the remaining 103 had unilateral obstruction. Of the latter group, 5 had a solitary kidney; therefore, the total number of renal units was 211 (113 obstructed and 98 normal units). Ureteral strictures were identified by noncontrast CT in 15 (28%) of 54 and by MRU in 45 (83%) of 54 patients. Bladder, ureter, or prostate tumors causing ureteral obstruction could be diagnosed in one half of the 54 patients with such tumors by noncontrast CT (27/54) and in all but 2 patients by MRU (52/54). Both noncontrast CT and MRU could identify all extraurinary causes of obstruction. Overall, of the 113 kidneys with noncalculus obstruction, the cause could be identified by MRU in 102 (sensitivity of 90%) and by noncontrast CT in 47 (sensitivity of 42%), a difference of statistically significant value in favor of MRU (P <0.001). The specificity of T2-weighted MRU and noncontrast CT was 100% and 99%, respectively (not a statistically significant difference). The overall accuracy of T2-weighted MRU and noncontrast CT was 95% and 68%, respectively (P<0.001).	2
32. Leyendecker JR, Barnes CE, Zagoria RJ. MR urography: techniques and clinical applications. *Radiographics.* 2008;28(1):23-46; discussion 46-27.	Review/Other-Dx	N/A	To review the most common MRI techniques used to image the urinary tract and discuss special considerations (pediatric patients, pregnant patients, renal insufficiency, imaging at 3-T) related to MRU. In addition, the authors discuss and illustrate potential clinical applications of MRU with respect to urolithiasis, urinary tract obstruction unrelated to urolithiasis, hematuria, congenital anomalies, and pre- and postoperative assessment. The authors also describe various pitfalls and artifacts associated with this modality.	When properly performed, MRU can be a valuable means of noninvasively assessing the urinary tract.	4

Hematuria
EVIDENCE TABLE

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33. Abou-El-Ghar ME, El-Assmy A, Refaie HF, El-Diasty T. Bladder cancer: diagnosis with diffusion-weighted MR imaging in patients with gross hematuria. *Radiology.* 2009;251(2):415-421.	Observational-Dx	130 patients	To prospectively evaluate the usefulness of diffusion-weighted MRI for the detection of bladder neoplasms in patients with gross hematuria of lower urinary tract origin.	The consensus diagnostic performance of diffusion-weighted MRI for identification of bladder tumors was: sensitivity, 98.1% (104/106); specificity, 92.3% (24/26); PPV, 100% (104/104); NPV, 92.3% (24/26); and accuracy, 97.0% (128/132). 2 cases were falsely negative on T2-weighted MRI but were correctly diagnosed by using diffusion-weighted MRI. The agreement between diffusion-weighted MRI results and cystoscopic findings was excellent (kappa = 0.94) for identification of bladder neoplasm. Diffusion-weighted MRI had a sensitivity and PPV of 98.5% (128/130) and 100% (128/128), respectively, for determining the cause of hematuria.	2
34. Israel GM, Hindman N, Bosniak MA. Evaluation of cystic renal masses: comparison of CT and MR imaging by using the Bosniak classification system. *Radiology.* 2004;231(2):365-371.	Observational-Dx	69 renal masses in 59 patients	To compare CT and MRI in the evaluation of cystic renal masses by using the Bosniak classification system.	On CT images, there were 15 category I, 16 category II, 10 category IIF, 19 category III, and 9 category IV lesions. Findings on CT and MRIs were similar in 56 (81%) lesions; in 13 (19%) lesions, there were differences. In 8 (12%) lesions, MRI depicted more septa than did CT, which resulted in an upgrade of the classification at MRI in 2 cases. In 7 (10%) lesions, MRI depicted increased wall and/or septa thickness compared with CT, resulting in a classification upgrade in 6 cases. Three lesions had both increased numbers of septa and thickening of the wall and/or septa. In 2 (3%) lesions, enhancement characteristics at CT and MRI were different. One of these lesions also had an increased number of septa. Overall, MRI results led to a cyst classification upgrade of 7 lesions, from category II to IIF (n = 2), IIF to III (n = 3), or III to IV (n = 2). Pathologic correlation in 25 lesions revealed 20 malignant and five benign lesions.	3
35. Nikken JJ, Krestin GP. MRI of the kidney-state of the art. *Eur Radiol.* 2007;17(11):2780-2793.	Review/Other-Dx	N/A	To review MRU technique and applications as well as the role of MRI in the evaluation of potential kidney donors. Furthermore the advances in functional MRI of the kidney are highlighted.	MRI has the advantage of superior soft-tissue contrast, which provides a powerful tool in the detection and characterization of renal lesions.	4

Hematuria
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Zhang Z, Yang M, Song L, Tong X, Zou Y. Endovascular treatment of renal artery aneurysms and renal arteriovenous fistulas. *J Vasc Surg.* 2013;57(3):765-770.	Observational-Tx	15 patients	The authors describe their experience with the treatment of renal artery aneurysms and renal arteriovenous fistulas by transcatheter techniques with special consideration given to indications, technical options, and complications.	The lesion was asymptomatic in 7 patients and symptomatic in 8 patients, including ruptures in 2 patients. The most common comorbidity and associated risk factor was hypertension (n = 8). The technical success rate was 100%. There was no periprocedural mortality or major complications. The only complication was postembolization syndrome in 9 patients. Mean clinical follow-up was 24.7 months, and mean imaging follow-up was 16.3 months. During the imaging follow-up, partial renal infarcts were detected in six patients, with no evidence of renal insufficiency. No recurrence was observed.	3

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.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

CI = Confidence interval

CT = Computed tomography

CTU = Computed tomography urography

IVU = Intravenous urography

MRI = Magnetic resonance imaging

MRU = Magnetic resonance urography

NPV = Negative predictive value

OR = Odds ratio

PPV = Positive predictive value

US = Ultrasound