THE CONSULT

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Appropriate Use of Advanced Imaging in Patients with Renal, Adrenal & Urinary Tract Conditions

Renal, Adrenal & Urinary Tract AUC Summary:

In most clinical scenarios, **CT** is the advanced imaging procedure of choice for renal/ureteral calculi and other disorders of the kidney and ureter:

- A **non-contrast CT** is generally indicated for initial imaging of suspected or known renal/ureteral calculi.
- CT urography protocols may be useful to improve imaging of the urinary system. **CT of the abdomen/pelvis without and with contrast (with urography protocols)** is the primary imaging recommendation for hematuria not due to an identified benign cause.
- CT can generally be helpful for preoperative planning, follow-up, infection that is unresponsive to therapy, or further evaluation of incidentally discovered renal or adrenal masses. The addition of contrast can be used to assess abnormalities or indeterminate findings on non-contrast CT.

MRI can be used in patients unable to receive CT contrast, such as those with renal insufficiency or contrast allergy. It is helpful for evaluating hydronephrosis, however, can be limited in its detection of smaller stones. MRI can also be used as a first line imaging modality for indeterminate renal or adrenal masses. MR urography protocols may be useful to improve imaging of the urinary system (kidneys, ureters, bladder, and surrounding structures).

Renal scintigraphy is limited to scenarios where further assessment of renal or urinary tract obstruction and/or loss of renal function is necessary.

PET or PET-CT can further characterize indeterminate adrenal lesions seen on CT in those with history of PET-sensitive primary neoplasm.

Ultrasound, while not defined as an advanced imaging modality, can be useful to identify stones, or for follow-up of patients being treated for renal or ureteral calculus. Ultrasound can also evaluate hydronephrosis in patients with renal insufficiency or allergy to iodinated contrast. Ultrasound expertise may be limited and/or not available in some practice settings.

INSIDE THIS ISSUE

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This material summarizes key elements of Appropriate Use Criteria (AUC) developed by the CDI Quality Institute's Provider Led Entity (PLE). The CDI Quality Institute PLE has been qualified by the Centers for Medicare and Medicaid Services to develop AUC to guide the ordering of advanced imaging studies. The entire AUC library is available at myCDI.com/PLE.

This edition of *The Consult* summarizes criteria developed by Dr. Kanterman and a panel of experts:

- Paul Knechtges, MD, Associate Professor of Radiology; Medical College of WI
- Thomas Gilbert, MD, MPP, CDI Chief Clinical Officer and PLE Chair
- Aaron Milbank, MD, Metro Urology; MN
- Lynne Ogawa, MD, Family Physician, Westside Community Health Services; MN
- Anthony Polcari, MD, Metro Urology; MN
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Clinical decision support (CDS) is not intended to replace clinician judgment, but rather to provide information to assist care team members in managing the complex and expanding volume of biomedical and person-specific data needed to make timely, informed, and higher-quality decisions based on current clinical science (National Academy of Medicine, 2017).

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APPROPRIATE USE CRITERIA: HOW TO USE THIS DOCUMENT

- **Primary recommendation**: A strong recommendation for initial imaging for this presentation; there is confidence that the desirable effects of imaging outweigh its undesirable effects.
- **Alternative recommendation**: A conditional recommendation for imaging; the desirable effects of imaging likely outweigh its undesirable effects, although some uncertainty may exist. The individual patient's circumstances, preferences, and values should be considered on a case-by-case basis. This may include: contraindication to the primary recommendation, specific clinical circumstances that require use of the alternative recommendation, or the primary recommendation has results that are inconclusive or incongruent with the patient's clinical diagnosis. Case-by-case indications to consider have been noted in brackets when appropriate.
- **Recommendation against imaging**: The undesirable effects of imaging outweigh any desirable effects. Additionally, the recommendation may be impractical or not feasible in the targeted population and/or practice setting(s).

SCENARIO #1: IMAGING INDICATIONS

Hematuria not due to an identified benign cause	
●	**CT abdomen/pelvis without and with IV contrast (urography protocols preferred)**
●	**MRI abdomen or abdomen/pelvis without and with IV contrast (urography protocols preferred)** *[patient unable to receive CT contrast]*
●	**MRI abdomen or abdomen/pelvis without IV contrast (urography protocols preferred)*** *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	**CT abdomen/pelvis without IV contrast**** *[patient unable to receive CT contrast and also unable to undergo MRI]*
●	**CT abdomen/pelvis with IV contrast (urography protocols preferred)** *[further evaluate findings on recent ultrasound or non-contrast-imaging]*
●	**Scintigraphy; PET; PET-CT**

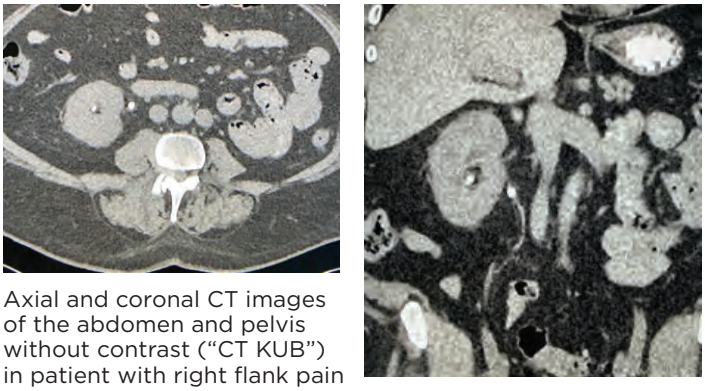
*If urography protocols are not used, consider urology consult for retrograde pyelogram.
**Consider urology consult for retrograde pyelogram.

SCENARIO #1: CLINICAL NOTES

- Patients with gross hematuria have a high incidence of malignancy (up to 30-40%) (Sharp et al *[AAFP]* 2013; Wolfman et al *[ACR]* 2020). Significant risk factors for urinary tract malignancy include male gender, age > 35 years, past or current smoker, occupational exposure to chemicals, analgesic abuse, urologic disorder or disease, irritative voiding symptoms, chronic urinary tract infection, history of pelvic irradiation and exposure to known carcinogenic agents or chemotherapy (Davis et al *[AUA]* 2012; Wolfman et al *[ACR]* 2020).
- Patients with microscopic hematuria have a low risk of malignancy (2-4%). Patients with microscopic hematuria, no risk factors, and a known benign cause such as vigorous exercise, infection, menstruation, trauma or a recent urologic procedure are unlikely to gain benefit from a complete imaging workup (Wolfman et al *[ACR]* 2020; PLE expert panel consensus opinion).
- CT urography (CTU) is tailored to improve visualization of both the upper and lower urinary tracts; it usually involves unenhanced images followed by IV contrast-enhanced images, including nephrographic and excretory phases (Wolfman et al *[ACR]* 2020).
- Split bolus technique should be considered in patients at low risk for cancer undergoing multiphasic CT or CT with IV contrast in order to limit radiation dose to the patient. The split bolus technique aims to combine the nephrographic and urographic phases of imaging into one acquisition (PLE expert panel consensus opinion).
- MR urography (MRU) is also tailored to improve imaging of the urinary system. Unenhanced MRU relies upon heavily T2-weighted imaging of the intrinsic high signal intensity from urine for evaluation of the urinary tract. IV contrast is administered to provide additional information regarding obstruction, urothelial thickening, focal lesions, and stones (Wolfman et al *[ACR]* 2019).

SCENARIO #2: IMAGING INDICATIONS

Suspected renal or ureteral calculus	
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis with IV contrast or CT abdomen/pelvis without and with IV contrast** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**MRI abdomen or abdomen/pelvis (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**Renal scintigraphy** *[further evaluate obstruction on recent ultrasound or non-contrast imaging]*
●	**PET; PET-CT**



Axial and coronal CT images of the abdomen and pelvis without contrast ("CT KUB") in patient with right flank pain and hematuria demonstrate a right lower pole renal calculus and a right proximal ureter renal calculus.

SCENARIO #2: CLINICAL NOTES

- Diagnostic imaging is recommended in patients with acute flank pain and a suspicion for a renal or ureteral stone (Moreno et al *[ACR]* 2015; Turk et al *[EAU]* 2019).
- CT without IV contrast is the preferred advanced imaging modality for stones (Moreno et al *[ACR]* 2015; Turk et al *[EAU]* 2019). Non-contrast CT has a reported median sensitivity and specificity for the detection of ureteral calculi of 98% and 97%, respectively, far superior to other imaging modalities (Fulgham et al *[AUA]* 2013; *NICE* 2019).
- Sagittal and coronal reconstructions can be utilized to increase the sensitivity and specificity of CT for ureteral calculi (PLE expert panel consensus opinion).
- MRI can be used to evaluate for obstruction of the renal collecting system in patients who cannot undergo CT with IV contrast (PLE expert panel consensus opinion).
- Ultrasound, although not an advanced imaging modality, can be used as the primary diagnostic imaging tool for stones when expertise is available. However, evidence has shown that it is not as sensitive for renal and ureteral calculi as non-contrast CT (Turk et al *[EAU]* 2019; NICE 2019).

SCENARIO #3: IMAGING INDICATIONS

Preoperative planning for known renal or ureteral calculus	
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis without and with IV contrast (urography protocols preferred)**
●	**CT abdomen/pelvis with IV contrast (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent non-contrast imaging]*
●	**MRI abdomen or abdomen/pelvis (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent non-contrast imaging]*
●	**Renal scintigraphy** *[evaluate suspected loss of renal function]*
●	**PET; PET-CT**

SCENARIO #3: CLINICAL NOTES

- Clinicians should offer reimaging to patients prior to surgery if passage of stones is suspected or if stone movement will change management. Reimaging should be focused on the region of interest, and should limit radiation exposure to uninvolved regions (Assimos et al *[AUA]* 2016).
- Use of CT for preoperative assessment in nephrolithiasis has gained widespread acceptance, as it defines stone burden and distribution, and provides information regarding collecting system anatomy, position or peri-renal structures, and relevant anatomic variants. It may also be used to predict operative outcomes and, in some instances, stone composition (Assimos et al *[AUA]* 2016).
- Enhanced CT is preferable in complex cases because it enables 3D reconstruction of the collecting system, as well as measurement of stone density and skin-to-stone distance. (Turk et al *[EAU]* 2019).
- Optimization of CT includes limiting scan protocols to an anatomical region of interest for evaluation of the distal ureter, adjusting CT parameters for tissue thickness and body habitus, and limiting contrast phases (e.g., non-contrast only or combined injection and delayed phases) to reduce total radiation exposure (Fulgham et al *[AUA]* 2013; Assimos et al *[AUA]* 2016).
- The use of ultrasonography alone to direct treatment planning should be discouraged, as ultrasound is inherently inaccurate in determination of stone size, and provides no information on stone density (Assimos et al *[AUA]* 2016).

SCENARIO #4: IMAGING INDICATIONS

Follow-up imaging during or after treatment of renal or ureteral calculus	
●	*
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis with IV contrast or CT abdomen/pelvis without and with IV contrast** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**MRI; PET; PET-CT; Scintigraphy**

*Although not considered to be an advanced imaging modality, ultrasonography (US), with or without KUB radiography, is often used for initial follow-up of patients treated for renal or ureteral calculus (Fulgham et al *[AUA]* 2013; PLE expert panel consensus opinion).

SCENARIO #4: CLINICAL NOTES

- After definitive surgical intervention for a ureteral calculus, follow-up imaging is obtained to assure complete stone removal and/or absence of obstruction (Fulgham et al *[AUA]* 2013).
- For patients who undergo ureteroscopy with stone fragmentation, follow-up imaging will document the presence of residual fragments and/or hydronephrosis (Fulgham et al *[AUA]* 2013).
- For patients undergoing medical expulsive therapy (MET) for a ureteral calculus and who have ongoing symptoms, imaging can assess stone progression as well as ongoing hydronephrosis (Fulgham et al *[AUA]* 2013).
- For patients undergoing MET in whom there is documented stone passage and resolution of symptoms, no further imaging is necessary (Fulgham et al *[AUA]* 2013).
- For patients undergoing treatment for radiolucent stones, low dose non-contrast CT can assess stone progression and degree of hydronephrosis (Fulgham et al *[AUA]* 2013).
- CT of the abdomen and pelvis without and with IV contrast may be indicated in patients with hydronephrosis seen on follow-up ultrasound to identify additional stones, residual edema, or obstruction (Fulgham et al *[AUA]* 2013).

SCENARIO #5: IMAGING INDICATIONS

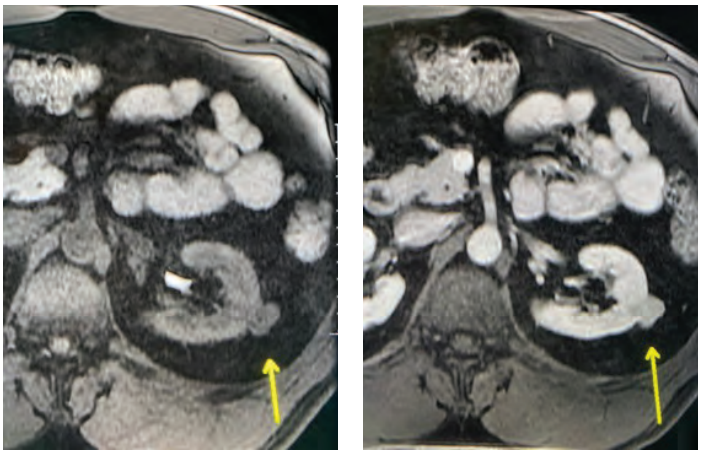
Suspected infection in any of the following: • Immunocompromised patients, • Patients with ≥ 48 hours of unsuccessful therapy, and/or • Patients with progressive, recurrent, or atypical symptoms:	
●	**CT without and/or with IV contrast**
●	**MRI abdomen or abdomen/pelvis without and with IV contrast (urography protocols preferred)** *[patient unable to receive CT contrast]*
●	**MRI abdomen or abdomen/pelvis without IV contrast (urography protocols preferred)** *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	**Scintigraphy; PET; PET-CT**

SCENARIO #5: CLINICAL NOTES

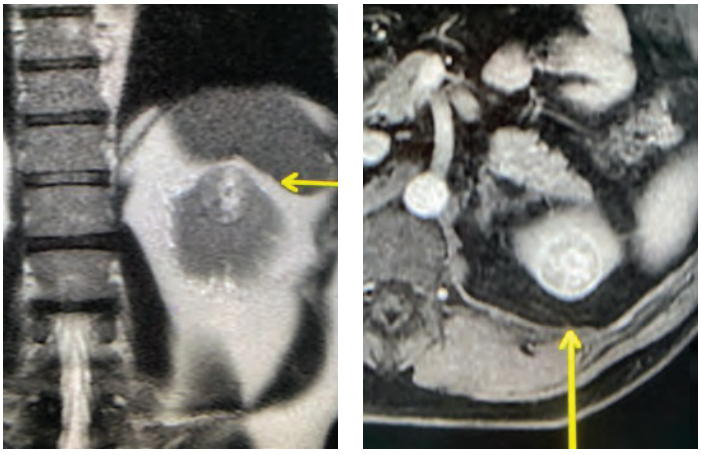
- Pyelonephritis is suggested by fever, chills, flank pain, nausea, vomiting, or costovertebral angle tenderness, with or without the typical symptoms of cystitis (Bankat et al *[EAU]* 2019).
- Advanced diagnostic imaging is usually not appropriate for initial evaluation of uncomplicated pyelonephritis (Bonkat et al *[EAU]* 2019; Nikolaidis et al *[ACR]* 2018). However, imaging should be performed without delay in atypical cases (e.g., suspicion for renal calculi, outflow obstruction, interstitial cystitis or urothelial cancer) (Bonkat et al *[EAU]* 2019) or in patients with history of diabetes or immune compromise, history of stones or obstruction, prior renal surgery, or lack of response to therapy (Nikolaidis et al *[ACR]* 2018).
- Contrast-enhanced CT has high sensitivity in detecting parenchymal changes in acute pyelonephritis, including early in the course of disease (Nikolaidis et al *[ACR]* 2018).
- CT without IV contrast can be used if contrast is contraindicated and is useful in patients with known or suspected renal or ureteral calculi, or in patients with obstruction (PLE expert panel consensus opinion).
- When expertise is available, evaluation of the upper urinary tract with ultrasound may be performed in patients with acute uncomplicated pyelonephritis to rule out urinary obstruction or renal stone disease (Bankot et al *[EAU]* 2019; PLE expert panel consensus opinion). However, ultrasound can miss subtle changes of mild pyelonephritis and underestimate the severity of renal involvement or perinephric extension (Nikolaidis et al *[ACR]* 2018).

SCENARIO #6: IMAGING INDICATIONS

Evaluation of incidental/indeterminate renal mass or complex cyst	
●	**CT abdomen without and with IV contrast**
●	**MRI abdomen without and with IV contrast**
●	**MRI abdomen without IV contrast** *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	**CT abdomen without IV contrast** *[patient unable to receive CT contrast and also unable to undergo MRI]*
●	**CT abdomen with IV contrast** *[further evaluate findings on recent ultrasound or non-contrast imaging]*
●	**Scintigraphy; PET; PET-CT**



Pre-contrast and post-contrast T1-weighted MRI images, in patient referred for further evaluation due to equivocal characterization by CT, demonstrate an enhancing left renal mass, consistent with a renal neoplasm, surgically confirmed.



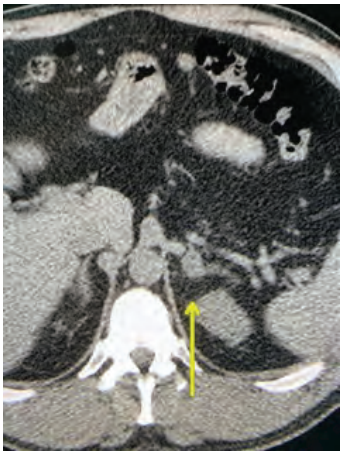
T2 sagittal and post-contrast T1 axial images demonstrate a heterogeneous, enhancing mass in the upper pole of the left kidney, consistent with solid renal neoplasm, surgically confirmed to be an oncocytoma.

SCENARIO #6: CLINICAL NOTES

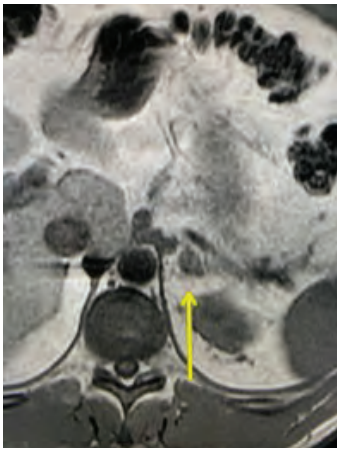
- Cystic renal lesions are typically identified incidentally on routine imaging (Richard et al *[CUA]* 2017), and cannot be diagnosed confidently as benign or malignant at the time of discovery (Wang et al *[ACR]* 2020).
- Unless there are contraindications to iodinated CT contrast or gadolinium-based MR IV contrast, characterization of a cyst should be performed without and with IV contrast using a dedicated renal mass protocol (Herts et al *[ACR]* 2018) (Herts et al [ACR] 2018; PLE expert panel consensus opinion).
- In general, any mass with density > 20 Hounsfield units (HU) and < 70 HU on unenhanced CT, as well as any heterogeneous mass, is considered indeterminate and warrants further evaluation (Wang et al *[ACR]* 2020).
- The Bosniak classification of cystic renal masses was originally described using CT imaging, but other modalities, such as MRI or ultrasound, are now also being used to help better delineate these lesions (Richard et al *[CUA]* 2017).
- MRI of the abdomen is also frequently used to characterize renal lesions (Wang et al *[ACR]* 2020). MRI is more sensitive to contrast enhancement and is recommended for renal masses with inconclusive enhancement, or for depicting enhancing nodules (Herts et al *[ACR]* 2018).
- When expertise is available, ultrasound can play an important role in detecting and characterizing renal masses, such as in patients who cannot receive iodinated contrast (Wang et al *[ACR]* 2020).

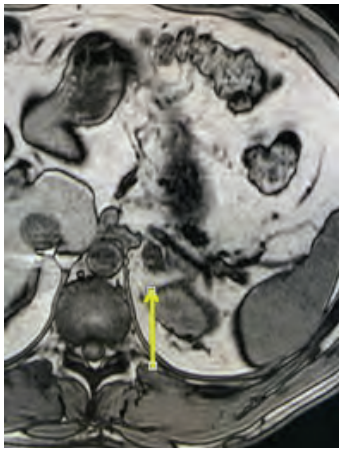
SCENARIO #7: IMAGING INDICATIONS

Evaluation of incidental/indeterminate adrenal mass or nodule (adrenal incidentaloma)	
●	CT abdomen without and/or with IV contrast
●	MRI abdomen without IV contrast
●	MRI abdomen without and with IV contrast
●	PET or PET-CT *[known PET-sensitive primary neoplasm]*
●	Scintigraphy



Non-contrast CT and non-contrast MRI T1-weighted images demonstrate a benign left adrenal adenoma. Note low density (less than 10 HU) on CT scan (above) and drop in signal between in-phase (lower left) and opposed-phase (lower right) on MRI.





Large right adrenal mass with heterogeneous increased signal on coronal T2 images and peripheral enhancement and central necrosis on post-contrast coronal T1 images, consistent with a surgically proven right adrenal pheochromocytoma.

SCENARIO #7: CLINICAL NOTES

- It is recommended that all patients found to have an adrenal incidentaloma undergo clinical, biochemical, and imaging examinations to determine the presence/absence of symptoms and signs caused by an excess of adrenal hormone and to determine whether the tumor is homogenous and lipid-rich, and therefore benign (Lee et al [*Korean Endocrine Society*] 2017; Fassnacht et al [*ESE & ENSAT]* 2016).
- It is recommended that additional diagnostic work-up be conducted only in lesions > 1 cm unless clinical signs and symptoms suggestive of adrenal hormone excess are present (Fassnacht et al [*ESE & ENSAT*] 2016).
- CT and MRI are techniques to identify benign lesions, therefore representing tools designed for the exclusion of adrenal malignancy. Conversely, FDG-PET/CT is mainly used for the detection of malignant disease (Fassnacht et al [*ESE & ENSAT*] 2016).
- A size greater than 4-6 cm on a CT scan, a tumor with an irregular margin or heterogeneity, an attenuation coefficient of > 10 HU on non-contrast CT, washout of the contrast agent after 10-15 minutes of < 40%, calcification, and/or invasion into surrounding tissue all suggest malignancy (Lee et al [*Korean Endocrine Society*] 2017).
- In many adenomas, more than 50% of the contrast agent disappears 10 to 15 minutes after its administration. Adrenal cancer, pheochromocytoma, and metastatic cancer all show less than a 50% loss. This finding has very high sensitivity and specificity (Lee et al [*Korean Endocrine Society*] 2017).
- In patients with an indeterminate adrenal mass opting not to undergo adrenalectomy following initial assessment, a non-contrast CT or MRI after 6-12 months is suggested to exclude significant growth (Fassnacht et al [*ESE & ENSAT*] 2016).
- Ultrasonography does not detect adrenal masses with the same sensitivity as CT or MRI (Terzolo et al *[AME]* 2011).

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Summary: Appropriate Use of Advanced Imaging in Patients with Renal, Adrenal & Urinary Track Conditions

● = Primary Recommendation ● = Alternative Recommendations ● = Recommendations Against Imaging

SCENARIO #1: IMAGING INDICATIONS

Hematuria not due to an identified benign cause	
●	**CT abdomen/pelvis without and with IV contrast (urography protocols preferred)**
●	**MRI abdomen or abdomen/pelvis without and with IV contrast (urography protocols preferred)** *[patient unable to receive CT contrast]*
●	**MRI abdomen or abdomen/pelvis without IV contrast (urography protocols preferred)*** *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	**CT abdomen/pelvis without IV contrast**** *[patient unable to receive CT contrast and also unable to undergo MRI]*
●	**CT abdomen/pelvis with IV contrast (urography protocols preferred)** *[further evaluate findings on recent ultrasound or non-contrast-imaging]*
●	**Scintigraphy; PET; PET-CT**

*If urography protocols are not used, consider urology consult for retrograde pyelogram.
**Consider urology consult for retrograde pyelogram.

SCENARIO #2: IMAGING INDICATIONS

Suspected renal or ureteral calculus	
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis with IV contrast or CT abdomen/pelvis without and with IV contrast** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**MRI abdomen or abdomen/pelvis (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**Renal scintigraphy** *[further evaluate obstruction on recent ultrasound or non-contrast imaging]*
●	**PET; PET-CT**

SCENARIO #3: IMAGING INDICATIONS

Preoperative planning for known renal or ureteral calculus	
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis without and with IV contrast (urography protocols preferred)**
●	**CT abdomen/pelvis with IV contrast (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent non-contrast imaging]*
●	**MRI abdomen or abdomen/pelvis (urography protocols preferred)** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent non-contrast imaging]*
●	**Renal scintigraphy** *[evaluate suspected loss of renal function]*
●	**PET; PET-CT**

SCENARIO #4: IMAGING INDICATIONS

Follow-up imaging during or after treatment of renal or ureteral calculus	
●	*
●	**CT KUB without IV contrast**
●	**CT abdomen/pelvis with IV contrast or CT abdomen/pelvis without and with IV contrast** *[further evaluate abnormalities, obstruction, or indeterminate findings on recent ultrasound or non-contrast imaging]*
●	**MRI; PET; PET-CT; Scintigraphy**

*Although not considered to be an advanced imaging modality, ultrasonography (US), with or without KUB radiography, is often used for initial follow-up of patients treated for renal or ureteral calculus (Fulgham et al *[AUA]* 2013; PLE expert panel consensus opinion).

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● = Primary Recommendation ● = Alternative Recommendations ● = Recommendations Against Imaging

SCENARIO #5: IMAGING INDICATIONS

Suspected infection in any of the following: • Immunocompromised patients, • Patients with ≥ 48 hours of unsuccessful therapy, and/or • Patients with progressive, recurrent, or atypical symptoms:	
●	CT without and/or with IV contrast
●	MRI abdomen or abdomen/pelvis without and with IV contrast (urography protocols preferred) *[patient unable to receive CT contrast]*
●	MRI abdomen or abdomen/pelvis without IV contrast (urography protocols preferred) *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	Scintigraphy; PET; PET-CT

SCENARIO #6: IMAGING INDICATIONS

Evaluation of incidental/indeterminate renal mass or complex cyst	
●	CT abdomen without and with IV contrast
●	MRI abdomen without and with IV contrast
●	MRI abdomen without IV contrast *[patient unable to receive CT contrast and also unable to receive MRI contrast]*
●	CT abdomen without IV contrast *[patient unable to receive CT contrast and also unable to undergo MRI]*
●	CT abdomen with IV contrast *[further evaluate findings on recent ultrasound or non-contrast imaging]*
●	Scintigraphy; PET; PET-CT

SCENARIO #7: IMAGING INDICATIONS

Evaluation of incidental/indeterminate adrenal mass or nodule (adrenal incidentaloma)	
●	CT abdomen without and/or with IV contrast
●	MRI abdomen without IV contrast
●	MRI abdomen without and with IV contrast
●	PET or PET-CT *[known PET-sensitive primary neoplasm]*
●	Scintigraphy