American College of Radiology
ACR Appropriateness Criteria®

Recurrent Lower Urinary Tract Infections in Females

Variant: 1 Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US kidneys and bladder retroperitoneal	Usually Not Appropriate	O
US pelvis (bladder)	Usually Not Appropriate	O
Fluoroscopy voiding cystourethrography	Usually Not Appropriate	☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy cystography	Usually Not Appropriate	☢☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Not Appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US kidneys and bladder retroperitoneal	Usually Appropriate	O
CTU without and with IV contrast	Usually Appropriate	☢☢☢☢
US pelvis (bladder)	May Be Appropriate (Disagreement)	O
MRI pelvis without and with IV contrast	May Be Appropriate	O
MRU without and with IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
Fluoroscopy urethrography double-balloon	Usually Not Appropriate	☢☢
Fluoroscopy voiding cystourethrography	Usually Not Appropriate	☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy cystography	Usually Not Appropriate	☢☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢

MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Not Appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 3 Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US kidneys and bladder retroperitoneal	Usually Appropriate	O
MRI pelvis without IV contrast	May Be Appropriate (Disagreement)	O
MRU without IV contrast	May Be Appropriate (Disagreement)	O
US pelvis (bladder)	Usually Not Appropriate	O
Fluoroscopy voiding cystourethrography	Usually Not Appropriate	☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy cystography	Usually Not Appropriate	☢☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Not Appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Panel Members

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Summary of Literature Review

Introduction/Background

A urinary tract infection (UTI) is a condition that arises from the invasion of uropathogenic bacteria

into the lower urinary tract (urethra or bladder) or the upper urinary tract (kidneys and ureters) [1]. These infections typically begin in the lower tract and may then ascend to involve the renal parenchyma, leading to pyelonephritis [2]. Acute pyelonephritis is described separately in the ACR Appropriateness Criteria® topic on "Acute Pyelonephritis" [3]. Recurrent UTIs in children are also discussed separately in the ACR Appropriateness Criteria® topic on "Urinary Tract Infection-Child" [4].

UTIs occur more commonly in females than in males because of the shorter length of the female urethra, the anatomic proximity of the urethral opening to the vagina and anus, and the presence of hormonal influences that increase susceptibility to UTIs. Approximately half of all females (50%-60%) will experience at least one UTI during their lifetime, and a large proportion (30%-40%) will have a recurrent UTI, most of which will occur 30 to 60 days from the original inciting event [5-8]. *Escherichia coli* is the pathogen most commonly involved in UTIs, causing approximately 80% of cases, with *Klebsiella*, *Staphylococcus saprophyticus*, *Proteus mirabilis*, and *Enterococcus faecalis* usually responsible for the remaining 20% [9]. Urine culture remains the reference standard for diagnosing UTI, and the results of culture can be used to guide antibiotic selection.

A UTI is considered recurrent if it occurs after complete clinical resolution of the original UTI. Recurrence is generally defined as three episodes of infection within a 12-month period [2, 10, 11]. Recurrences are typically characterized by the involvement of different infectious organisms, whereas relapses involve infection by the same organism. The occurrence of a relapse suggests the presence of an untreated source of repeated seeding, such as from an abscess or infected stone. For example, repeated infection with *Proteus mirabilis* may be seen in patients with a struvite calculus [12].

Recurrent UTIs are considered uncomplicated if they occur in patients without structural or functional abnormalities that could contribute to the development of infection. Several risk factors for recurrent uncomplicated UTIs have been identified, including increased frequency of intercourse and number of partners, use of spermicides, increased age (≥15 years of age) at the time of initial UTI, and maternal history of UTI [10, 13].

In cases of complicated UTIs, the presence of anatomical abnormalities such as bladder and urethral diverticula, fistulae, urinary tract obstructions (urolithiasis, ureteral, or urethral strictures), congenital abnormalities, and polycystic kidney disease can create an environment that promotes bacterial colonization and infection [10, 14, 15]. Similarly, functional abnormalities such as cystocele, neurogenic bladder, and multiple sclerosis can impair the normal functioning of the urinary tract, making these patients more susceptible to UTIs [16, 17]. Complicating underlying comorbidities such as pregnancy, diabetes, immunosuppression, and chronic renal insufficiency can also increase the risk of UTI recurrence. Other risk factors for complicated UTIs include vesicoureteral reflux, urinary incontinence, incomplete bladder emptying, peri- or post-menopausal state, low fluid intake, a history of urinary tract surgery or trauma, abdominopelvic malignancy, urinary tract calculi, repeated pyelonephritis or diverticulitis, and the use of indwelling catheters and stents or intermittent catheterization. The presence of gross hematuria after infection resolution, urea-splitting bacteria on culture, symptoms of pneumaturia, or fecaluria should prompt further investigation for underlying or associated conditions such as malignancy, stone disease, fistulae, etc.

Recurrent UTIs during pregnancy (defined as the occurrence of ≥2 UTIs during the course of a single pregnancy) represent a distinct subgroup of complicated cases. UTIs are common among pregnant individuals, occurring in up to 8% of all pregnancies [18]. A combination of factors establishes a milieu that predisposes these individuals to UTIs, including hormonal changes that decrease bladder and ureteral tone, alterations in urine concentration due to changes in blood osmolarity, and mass effect from the gravid uterus upon the ureters [19].

It is important that clinicians recognize UTIs in pregnant individuals, as these infections can lead to potential consequences to the fetus (eg, preterm delivery and low birth weight) and to the mother (eg, anemia, acute respiratory distress syndrome, sepsis, and disseminated intravascular coagulation) if left untreated. The development of pyelonephritis is a particular risk in pregnant individuals with UTIs; in fact, pyelonephritis is one of the most common causes of pregnancy-related hospitalization. As such, performing a urine culture to screen for asymptomatic bacteriuria is typically recommended in pregnant patients early in their pregnancy care [18, 20].

Guidelines from most major United States and international societies and consensus panels recommend against the routine use of cystoscopy and imaging in the workup for UTI in patients without risk factors, as there is generally low yield in using these diagnostic procedures in cases of lower UTI (see Appendix 1) [2, 8, 13, 21-23]. For pregnant patients with recurrent UTIs, there is insufficient evidence to guide management for these patients, although the use of imaging is suggested in patients with UTIs who fail to show clinical improvement within 72 hours [18]. A subset of pregnant patients may also have coexisting complicating factors such as anatomic or functional abnormalities for which imaging may be indicated, though there are no specific recommendations to guide the use of imaging in this population [24].

Special Imaging Considerations

CT urography (CTU) is an imaging study that is tailored to improve visualization of both the upper and lower urinary tracts. Although specific parameters and timing of image acquisition may vary, CTU with and without IV contrast should include, at the very least, unenhanced images followed by intravenous (IV) contrast-enhanced images in the nephrographic and excretory phases acquired at least 5 minutes after contrast injection. Reconstruction methods commonly include maximum intensity projection or 3-D volume rendering. For the purposes of this document, we make a distinction between CTU and CT abdomen and pelvis without and with IV contrast. CT abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts and without both the precontrast and excretory phases.

MR urography (MRU) is tailored to improve imaging of the urinary system. Although specific parameters and timing of image acquisition may vary, MRU without and with IV contrast should include T2-weighted images as well as precontrast and postcontrast-enhanced T1-weighted series with images acquired during the corticomedullary, nephrographic, and excretory phase. MRU without IV contrast relies upon heavily T2-weighted imaging of the intrinsic high signal intensity from urine for evaluation of the urinary tract. For the purposes of this document, we make a distinction between MRU and MRI abdomen and pelvis without and with IV contrast. MRI abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts, without both the precontrast and excretory phases, and without heavily T2-weighted images of the urinary tract.

CT Pelvis with Bladder Contrast (CT Cystography): CT cystography is a specialized technique that involves retrograde infusion of diluted iodinated contrast into the urinary bladder followed by pelvic CT imaging at maximal bladder distention. This technique allows for detailed visualization of traumatic bladder lesions and can be complemented with IV contrast administration, particularly when there is need to evaluate for underlying neoplastic or inflammatory processes [25].

For the purposes of this document, we distinguish CT cystography from CT abdomen and pelvis without and with IV contrast. CT abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the integrity of the urinary bladder wall and without retrograde instillation of contrast into the urinary bladder, as is the case for CT cystography.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.

UTIs are considered recurrent if they occur after complete clinical resolution of the original UTI. Recurrence is generally defined as three episodes of infection within a 12-month period [2, 10, 11]. Recurrent UTIs are considered complicated if they occur in patients with structural or functional abnormalities or underlying risk factors that could contribute to the development of infection. Imaging is usually not appropriate for recurrent uncomplicated lower UTIs in a female with no known underlying risk factors.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
A. CT abdomen and pelvis with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.

B. CT abdomen and pelvis without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
C. CT abdomen and pelvis without IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
D. CT pelvis with bladder contrast (CT cystography)

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT cystography is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
E. CT pelvis with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
F. CT pelvis without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
G. CT pelvis without IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CT is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
H. CTU without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, CTU is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
I. Fluoroscopy cystography

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. A prior prospective study of findings with excretory urography, cystography, and cystoscopy in females with symptomatic UTI revealed only rare instances of abnormalities important in the treatment of UTI in this group of patients [28]. Most females with recurrent uncomplicated UTIs in the absence of risk factors have normal urinary tracts and do not routinely require imaging with fluoroscopic cystography.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
J. Fluoroscopy voiding cystourethrography

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. A prior prospective study of findings with excretory urography, cystography, and cystoscopy in females with symptomatic UTI revealed only rare instances of abnormalities important in the treatment of UTI in this group of patients [28]. Most females with recurrent uncomplicated UTIs in the absence of risk factors have normal urinary tracts and do not routinely require imaging with voiding fluoroscopic cystography.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
K. MRI abdomen and pelvis without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions[10, 14]. As such, MRI is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
L. MRI abdomen and pelvis without IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, MRI is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
M. MRI pelvis without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, MRI is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
N. MRI pelvis without IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, MRI is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
O. MRU without and with IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, MRU is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
P. MRU without IV contrast

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, MRU is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
Q. Radiography abdomen

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, abdominal radiography is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
R. Radiography intravenous urography

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. Historically, IV urography (IVU) was the imaging study of choice to evaluate the urinary tract; however, it has largely been supplanted by CTU and MRU at most institutions [17, 29]. Nonetheless, most females with recurrent uncomplicated UTIs in the absence of risk factors have normal urinary tracts and do not routinely require imaging with IVU.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
S. US kidneys and bladder retroperitoneal

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. As such, ultrasound (US) is not generally performed for evaluation of uncomplicated UTI.

Variant 1:Adult. Recurrent lower urinary tract infections in a female. Uncomplicated with no underlying risk factors. Initial imaging.
T. US pelvis (bladder)

There is no specific literature recommending imaging studies in females who have recurrent uncomplicated UTIs in the absence of known underlying medical or anatomic conditions [10, 14]. Although there is correlation with bladder debris and distention with UTI, bladder US is not routinely performed to evaluate for uncomplicated UTI [26, 27].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.

Complicated recurrent UTIs are UTIs that occur in the presence of an intrinsic anatomic or functional abnormality. These abnormalities can promote bacterial colonization and infection or impair the normal function of the urinary tract, thus making these patients more susceptible to UTIs. Complicated UTIs can be initially evaluated with a clinical evaluation including thorough

medical history and physical examination. If an underlying complicating factor is suspected, cystoscopy and imaging studies should be considered [30].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
A. CT abdomen and pelvis with IV contrast

Contrast-enhanced CT has been used effectively to evaluate a range of urinary tract abnormalities including renal masses, genitourinary trauma, and specific aspects of renal infection, including the presence of pyelonephritis, renal abscesses, and obstruction. However, a contrast-enhanced CT of the abdomen and pelvis remains a study that is not tailored for evaluation of the urothelium and therefore does not optimally evaluate the collecting systems, ureters, and bladder. Moreover, lacking an unenhanced CT component, contrast-enhanced CT of the abdomen and pelvis can be limited in characterization of enhancement within masses. Additionally, although renal calculi can be detected on contrast-enhanced CT depending on the stone size and contrast bolus timing, it is generally less sensitive than noncontrast CT [48, 49]. The addition of rectal contrast or oral contrast with delayed scanning of an enhanced CT of the abdomen and pelvis is useful to detect enterovesical fistulas and infected fistulous tracts [50], but should be reserved for patients with high clinical suspicion of such conditions. CT is the modality of choice for evaluating genitourinary fistulas, particularly in the context of pelvic malignancy [51].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

In the absence of specific known history, the addition of noncontrast phase images to a standard abdomen and pelvis, outside of a CTU or renal CT protocol, would generally not be performed for evaluation of the lower urinary tract. Although the addition of unenhanced CT can improve detection of calculi and characterization of enhancement within masses, CTU without and with contrast would be preferred over CT abdomen and pelvis without and with contrast.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
C. CT abdomen and pelvis without IV contrast

Unenhanced CT is widely used in the emergency department or urgent outpatient setting in the evaluation of acute renal colic and/or hematuria. It also serves as a valuable tool to assess extent of upper tract stone disease, which is sometimes linked with recurrent UTIs. For patients with known or suspected renal calculi, the use of dual-energy CT to assess stone composition (uric acid, calcium, and cysteine) can be useful in the management of these patients [52]. However, the usefulness of unenhanced CT is limited by its inability to provide comprehensive assessment of the collecting systems, kidneys, and bladder, highlighting the need for targeted imaging modalities.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
D. CT pelvis with bladder contrast (CT cystography)

CT cystography has largely replaced fluoroscopic cystogram for evaluation of various conditions including traumatic bladder injuries and bladder contusion [68]. Furthermore, CT cystography is also useful for diagnosing bladder fistulas and leaks such as colovesical fistulas occurring as a result of sigmoid diverticular disease [25]. Rather than as an initial test, CT cystography is generally performed as a subsequent test in patients where initial testing indicates an underlying bladder

abnormality that requires further evaluation, or in cases where there is high clinical suspicion for often-complex bladder defects, which may remain undetected on other modalities such as cystoscopy and contrast-enhanced CT.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
E. CT pelvis with IV contrast

In cases where clinical history and physical examination suggest a focused examination of the pelvis alone, CT pelvis with IV contrast can serve as an adjunct to CT abdomen and pelvis with IV contrast. This targeted approach enables detection of various anatomical abnormalities, including bladder diverticula and fistulas, which may be highlighted to varying degrees depending on the use of rectal or oral contrast [50]. However, the lack of delayed and noncontrast components limits evaluation of the urothelium and for stone disease/mass enhancement, respectively [30].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
F. CT pelvis without and with IV contrast

In the absence of specific known history, the addition of noncontrast phase images to a pelvis CT with IV contrast outside of a CT cystogram or CT urogram protocol would generally not be performed for evaluation of the lower urinary tract.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
G. CT pelvis without IV contrast

In cases where clinical history and physical examination suggest a focused examination of the pelvis alone, CT pelvis without IV contrast can serve as an adjunct to CT abdomen and pelvis without IV contrast. This targeted approach would primarily be used in patients with suspected lower urinary tract stone disease; however, the usefulness of unenhanced CT is limited by its inability to provide comprehensive assessment of the urothelium and for areas of inflammation.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
H. CTU without and with IV contrast

If there is a strong clinical concern for complication of the urinary tract, CTU is often the preferred modality, but clinical symptoms and history should guide modality selection. For example, in a patient with vaginal discharge, complex surgical history, known complication of surgery, or suspicion for urethrovaginal fistula, CTU would be the ideal modality for diagnosis [38-40].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
I. Fluoroscopy cystography

Fluoroscopic cystography is generally not used as the initial imaging modality for females with recurrent complicated UTIs. Although it can delineate bladder diverticula and vesicoenteric fistulas, CT is more widely used in lieu of fluoroscopic cystography at most institutions.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
J. Fluoroscopy urethrography double-balloon

Double-balloon urethrography can be useful for demonstration of urethral diverticula, though the

examination can be uncomfortable for the patient and technically challenging to perform. MRI has largely replaced double-balloon urethrography in the evaluation of urethral diverticulum at most institutions as MRI best assesses the structure and complexity of urethral diverticula, allowing for accurate diagnosis and improved surgical planning.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
K. Fluoroscopy voiding cystourethrography

When a bladder diverticulum is at or near a ureteral orifice, voiding cystourethrography can be considered to evaluate the possibility of vesicoureteral reflux [53]. It can also be employed for imaging of suspected bladder or urethral fistula, urethral diverticulum, or bladder prolapse, although CT or MRI may be better first-line examinations and may be better at delineating anatomic abnormalities of the bladder.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
L. MRI abdomen and pelvis without and with IV contrast

MRI, generally performed without and with IV contrast, can be a valuable diagnostic tool in the evaluation of UTI and pyelonephritis as well as interrogating many of the possible causes of recurrent UTIs, such as urethral and bladder diverticula, fistulas, urachal anomalies, as well as functional anomalies [29, 42, 43]. In patients with pelvic organ prolapse, MRI, especially when combined with a dynamic component, is an effective modality for diagnosing cystocele, a risk factor for recurrent UTI in postmenopausal females [17, 56, 57].

Recurrent UTI is seen in 30% to 50% of patients with urethral diverticula. Diverticula of the urethra can be evaluated with high sensitivity and specificity by double-balloon urethrography, voiding CT urethrography, and MRU [58-60]. However, when used in conjunction with clinical examination, MRI is often the preferred imaging modality for assessing the structure and complexity of urethral diverticula and allows for accurate diagnosis and improved surgical planning [40, 61-63]. In a study, MRI altered the surgical management in 15% of patients undergoing diverticulectomy [61], highlighting its use in this setting. MRI is also useful in differentiating urethral diverticula from other types of periurethral cysts and bulking agents [64], and may be useful in evaluating recurrent infection arising from urachal anomalies [65].

The sensitivity and specificity of MRI for evaluating vesicovaginal and enterovesicular fistulae are comparable to those of CT, although CT may offer slightly improved sensitivity and specificity in the context of pelvic malignancies [51, 66, 67].

MRI is generally limited for detection of urinary calculi relative to CT, thus MRI may serve as initial imaging in patients in whom stone disease has been previously excluded or is not suspected clinically. In most patients with unknown etiology of recurrent complicated UTI, CT may serve as an initial imaging study to also evaluate for calculi.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
M. MRI abdomen and pelvis without IV contrast

MRI is generally performed without and with IV contrast. Although MRI without IV contrast may provide some anatomic information, contrast-enhanced T1-weighted images capture the urinary

tract at various stages of enhancement, which can be critical in delineating anatomy and characterizing lesions.

MRI is generally limited for detection of urinary calculi relative to CT, and thus may serve as initial imaging in patients in whom stone disease has been excluded a priori. In most patients with unknown etiology of recurrent complicated UTI, CT may serve as an initial imaging study to also evaluate for calculi.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
N. MRI pelvis without and with IV contrast

In cases where clinical history and physical examination suggest a focused examination of the pelvis alone, MRI pelvis can be a useful modality in evaluating many of the possible causes of recurrent UTIs, such as urethral and bladder diverticula, fistulas, urachal anomalies, as well as functional anomalies [29, 42, 43].

MRI is generally limited for detection of urinary calculi relative to CT, thus MRI may serve as initial imaging in patients in whom stone disease has been previously excluded or is not suspected clinically and when a focused evaluation of the pelvis is warranted. In most patients with unknown etiology of recurrent complicated UTI, CT may serve as an initial imaging study to also evaluate for calculi.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
O. MRI pelvis without IV contrast

MRI is generally performed without and with IV contrast. Although MRI without IV contrast may provide some anatomic information, contrast-enhanced T1-weighted images capture the urinary tract at various stages of enhancement, which can be critical in delineating anatomy and characterizing lesions. MRI is generally limited for detection of urinary calculi relative to CT.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
P. MRU without and with IV contrast

MRU can be a valuable diagnostic tool in the evaluation of UTI and pyelonephritis as well as interrogating many of the possible causes of recurrent UTIs, such as urethral and bladder diverticula, fistulas, urachal anomalies, as well as functional anomalies [29, 42, 43]. The most common MRU techniques for displaying the urinary tract can be divided into two categories: static-fluid MRU and excretory MRU. Static-fluid MRU makes use of heavily T2-weighted sequences to image the urinary tract as a static collection of fluid, can be repeated sequentially (cine MRU) to better demonstrate the ureters in their entirety and to confirm the presence of fixed stenoses, and is most successful in patients with dilated or obstructed collecting systems. Excretory MRU is performed during the excretory phase of enhancement after the IV administration of gadolinium-based contrast material. Diuretic administration is integral to excretory MRU to better demonstrate nondilated systems. Static-fluid and excretory MRU can be combined with conventional MRI for comprehensive evaluation of the urinary tract [44]. MRU can be used to evaluate the urinary tract and may provide more functional information than CT provides. However, MRU is less established and less reliable, and thus results in lesser diagnostic image quality relative to CTU [45]. In comparison to CTU, it necessitates a longer examination time and is

less sensitive than CT for detecting urinary tract calculi. In a study of 149 patients, MRU demonstrated 69% sensitivity for detecting calculi versus 100% for CT [46]. Thus, CT may serve as a more robust initial imaging study to also evaluate for calculi in most patients with unknown etiology of recurrent complicated UTI. MRU has shown increased sensitivity for perirenal fluid and ureteric dilatation in comparison with CT in the setting of acute obstruction [47]. Multiplanar reconstruction images in the coronal and sagittal planes are commonly included in MRU images to improve visualization of urinary tract abnormalities [29, 44]. Additional benefits for MRU are in documenting active upper tract infection versus scar formation to determine whether therapy has been effective in the high-risk patient.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
Q. MRU without IV contrast

MRU is generally performed without and with IV contrast. Although MRU without IV contrast may provide some anatomic information using heavily weighted T2-weighted sequences, excretory sequences require the use of contrast and enable evaluation for urothelial lesions or filling defects. MRU is generally limited for detection of urinary calculi relative to CT.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
R. Radiography abdomen

Radiography of the abdomen has long been employed for the detection of calculi, intramural bladder wall calcification, gas in the wall or lumen of the urinary bladder, and/or foreign bodies that may be the etiology of a UTI. Use of digital tomosynthesis of the abdomen results in improved detection of urinary stones in general over digital radiography [54]. Bladder wall calcification, when present, is typically due to prior infection with *Schistosoma* (uncommon in the United States, but very common in some parts of the world), tuberculosis, Cytoxan cystitis, or radiation cystitis [55]. For females with recurrent UTIs; however, abdominal radiography is generally not a useful diagnostic tool as other imaging modalities have higher sensitivity and specificity in this setting.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
S. Radiography intravenous urography

CTU and MRU have supplanted the use of IVU for evaluation of urinary abnormalities at most institutions [29], and it is generally not useful for females with recurrent complicated UTIs.

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient. Initial imaging.
T. US kidneys and bladder retroperitoneal

US may be useful in females with recurrent UTIs, particularly prior to pregnancy, to evaluate for hydronephrosis and risk factors for recurrent infection. Hydronephrosis can be demonstrated as an indication of obstruction, although US may not yield a specific etiology [31-33]. US is a useful initial screening tool for obstructive uropathy and for postvoid residual volume determination to detect incomplete bladder emptying [34]. It should be noted, although US can detect larger renal stones, it is generally less sensitive than CT [35-37]. Renal abscess or perinephric collections can also be detected sonographically, and US of the bladder can be employed to evaluate for bladder diverticula [38].

Variant 2:Adult. Recurrent lower urinary tract infections in a female. Complicated patient.

Initial imaging.
U. US pelvis (bladder)

If there is a high pretest probability of bladder abnormality, bladder US could be performed to evaluate for diverticula, stones, and incomplete bladder emptying, though it is generally less sensitive than CT [34-37]. It is important to note that some of the imaging features of UTI overlap with the underlying complicating factor such as detrusor hypertrophy in neurogenic bladder, thus rendering lower specificity [41].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.

In pregnant females with recurrent uncomplicated UTIs with no risk factors, imaging is not routinely used. For pregnant patients with high suspicion of coexisting complicating factor, such as an anatomic or functional abnormality, imaging can be selectively used.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
A. CT abdomen and pelvis with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
C. CT abdomen and pelvis without IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
D. CT pelvis with bladder contrast (CT cystography)

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT cystography is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
E. CT pelvis with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
F. CT pelvis without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have

recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
G. CT pelvis without IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CT is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
H. CTU without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, CTU is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
I. Fluoroscopy cystography

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, fluoroscopic cystography is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
J. Fluoroscopy voiding cystourethrography

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, fluoroscopic voiding cystourethrography is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
K. MRI abdomen and pelvis without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, MRI is not generally performed for evaluation of UTI in this population. Furthermore, gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus[70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
L. MRI abdomen and pelvis without IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, for pregnant patients with high suspicion of coexisting complicating factor such as an anatomic or functional abnormality involving the upper or lower urinary tract, MRU without IV contrast is the preferred imaging modality over MRI abdomen and pelvis. Gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus [70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
M. MRI pelvis without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, MRI is not generally performed for evaluation of UTI in this population. Furthermore, gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus [70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
N. MRI pelvis without IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. For pregnant patients with high suspicion of coexisting complicating factor such as a functional or anatomic abnormality involving the lower urinary tract such as urethral diverticulum, MRI pelvis without IV contrast could be selectively used [24]. Gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus [70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
O. MRU without and with IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, MRU is not generally performed for evaluation of UTI in this population. Furthermore, gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus [70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
P. MRU without IV contrast

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. For pregnant patients with high suspicion of coexisting complicating factor such as an anatomic or functional abnormality involving the upper or lower urinary tract, MRU without IV contrast could be selectively used [24]. Heavily T2-weighted images performed as part of MRU without IV contrast offer an advantage over MRI without IV contrast. Static-fluid MRU makes use of noncontrast heavily weighted T2-weighted sequences to image the urinary tract as a static collection of fluid, and can be repeated sequentially (cine MRU) to better demonstrate the ureters in their entirety and to confirm the presence of fixed stenoses. This is most successful in patients with dilated or obstructed collecting systems. Gadolinium-based contrast agents are generally not administered in pregnant patients due to potential adverse effects on the fetus [70].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
Q. Radiography abdomen

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, abdominal radiography is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
R. Radiography intravenous urography

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, IVU is not generally performed for evaluation of UTI in this population.

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
S. US kidneys and bladder retroperitoneal

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. For pregnant patients with high suspicion of coexisting complicating factor such as an anatomic or functional abnormality involving the upper or lower urinary tract, US kidney and bladder could be selectively used as the initial imaging modality [69].

Variant 3:Pregnant patient. Recurrent lower urinary tract infections in a female. Initial imaging.
T. US pelvis (bladder)

There is no specific literature recommending imaging studies in pregnant females who have recurrent UTIs. As such, US pelvis is not generally performed for evaluation of UTI in this population. For pregnant patients with high suspicion of coexisting complicating factor such as an anatomic or functional abnormality involving the lower urinary tract, US kidney and bladder could be selectively used as the preferred initial imaging modality [69].

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- Variant 1: Imaging is usually not appropriate for recurrent uncomplicated lower UTIs in an adult female with no known underlying risk factors.
- Variant 2: For adult females with recurrent complicated lower UTIs, initial evaluation should begin with a thorough clinical history and physical examination, followed by targeted imaging when an anatomic or functional abnormality is suspected. Renal and bladder US is a reasonable first-line screening test to assess for obstruction, hydronephrosis, postvoid residual, large stones, or bladder diverticula. CTU is generally the preferred initial imaging modality when the etiology is unclear or complications (eg, stones, obstruction, fistula, abscess) are suspected, given its high sensitivity and broad anatomic coverage. Renal and bladder US and CTU are generally considered alternative initial imaging approaches rather than complementary studies, with selection based on clinical suspicion, patient factors, and the need for detailed anatomic evaluation. US of the pelvis/bladder only, MRI pelvis without and with IV contrast, MRU without and with IV contrast, CT abdomen and pelvis with IV contrast, and CT abdomen and pelvis without IV contrast may also be useful for initial imaging in certain clinical scenarios, whereas other modalities (VCUG, cystography, urethrography) are typically reserved for specific clinical indications or as problem-solving studies rather than routine initial imaging.
- Variant 3: In pregnant patients with recurrent lower UTIs, routine imaging is not generally recommended. If there is high clinical suspicion for a complicating anatomic or functional abnormality, renal and bladder US is the preferred initial imaging modality. MRI pelvis without IV contrast or MRU without IV contrast may be selectively used for initial evaluation based on clinical scenario, whereas CT, fluoroscopic studies, and contrast-enhanced MRI/MRU are not routinely performed in pregnant patients, particularly for initial evaluation.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI)
- ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation
- ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Manual on MR Safety

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the

		risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness

of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Appendix

Appendix 1. Risk Factors

Risk Factors, Signs, and Symptoms	Underlying Condition
1. Flank Pain	Obstruction and/or calculi
2. Infection with urea-splitting organism	Congenital abnormalities, sequelae of obstruction or infection, calculi (struvite)
3. Previous UTI or pyelonephritis	Congenital abnormalities and/or reflux
4. Fever (>38.5° C)	Infection and/or obstruction
5. History of calculi or obstruction	Congenital abnormalities, calculi, sequelae of obstruction or infection
6. Obstructive symptoms	Congenital abnormalities, calculi, sequelae of obstruction or infection
7. Elevated serum creatinine	Obstructive versus renal parenchymal disease
8. Asymptomatic bacteriuria	Calculi or foreign body
9. Severe diabetes mellitus	Renal/papillary abnormalities
10. Childhood UTI	Congenital abnormalities and/or reflux
11. Analgesic abuse	Renal/papillary abnormalities
12. Neurogenic bladder dysfunction	Stasis, bladder diverticula, reflux, calculi
13. History of genitourinary surgery	Congenital and/or postsurgical abnormalities
14. Suspected bladder diverticula	Bladder diverticula
15. Suspected urethral diverticula	Urethral diverticula
16. Suspected enterovesical fistula	Enterovesical fistula
17. Urinary incontinence	Infection, stasis
18. Pelvic floor dysfunction	Cystocele, stasis
19. Postvoid residuals	Stasis

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