American College of Radiology
ACR Appropriateness Criteria®
Hematuria

Variant: 1 Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
US kidneys and bladder retroperitoneal	Usually Not Appropriate	O
Arteriography kidney	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	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
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 and with IV contrast	Usually Not Appropriate	☢☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CTU without and with IV contrast	Usually Appropriate	☢☢☢☢
US kidneys and bladder retroperitoneal	May Be Appropriate	O
MRU without and with IV contrast	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Arteriography kidney	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	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
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢

Variant: 3 Microhematuria. Pregnant patient. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US kidneys and bladder retroperitoneal	Usually Appropriate	O
MRU without IV contrast	May Be Appropriate	O
Arteriography kidney	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	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

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 abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 4 Gross hematuria. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRU without and with IV contrast	Usually Appropriate	O
CTU without and with IV contrast	Usually Appropriate	☢☢☢☢
US kidneys and bladder retroperitoneal	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without 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	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Arteriography kidney	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢

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Summary of Literature Review

Introduction/Background

Hematuria has a prevalence rate of 2% to 31% in the population [1] and is therefore a common reason patients are referred for imaging of the urinary tract. This document summarizes the initial imaging approach for these patients. Follow-up of normal or abnormal initial imaging findings is beyond the scope of this document. All patients diagnosed with microhematuria should undergo a thorough history, physical examination, urinalysis, and serologic testing prior to any initial imaging. Further, many patients should undergo cystoscopy in addition to any imaging evaluation [2]. For children with hematuria, see the ACR Appropriateness Criteria® topic on "Hematuria-Child" [3].

Hematuria is characterized as either microhematuria or gross hematuria. Microhematuria is defined by the American Urological Association as 3 or more red blood cells per high power field on microscopic evaluation of urinary sediment from "one properly collected, noncontaminated urinalysis with no evidence of infection for which a combination of microscopic urinalysis and dipstick excludes other abnormalities such as pyuria, bacteriuria, and contaminants" [4]. Gross hematuria is defined as hematuria visible to the physician or patient.

Causes of hematuria can arise from anywhere along the urinary tract and are generally divided into nephrogenic and urogenic causes. Renal parenchymal disease is the most common benign nephrogenic cause of hematuria [1]. Common benign urogenic causes of hematuria include urolithiasis, infection, and benign prostatic hypertrophy [1]. Malignant causes can occur anywhere in the urinary tract and are the main entity that must be excluded during the imaging evaluation of hematuria.

The most common factors associated with development of a urinary malignancy include gross hematuria, male gender, age >35 years, smoking, occupational exposure to chemicals, analgesic abuse, history of urologic disease, irritative voiding symptoms, history of pelvic irradiation, chronic urinary tract infection, exposure to known carcinogenic agents or chemotherapy, and chronic indwelling foreign body [1,2].

Gross hematuria has a high association with malignancy of up to 30% to 40%, and therefore all patients with gross hematuria should have a full urologic workup [1]. Conversely, patients with microhematuria have a low risk of malignancy ranging from 2.6% to 4%, and, in most patients with asymptomatic microhematuria, a cause is never found [1,2].

Patients without risk factors and with an identified benign cause of microhematuria including vigorous exercise, infection, trauma, menstruation, or recent urologic procedure are unlikely to gain any benefit from a complete imaging workup of microhematuria [1,2,5,6]. Patients with suspected urinary tract infection as a cause of microhematuria should have urine cultures performed, preferably before antibiotic therapy, to confirm an infection [1,2]. Patients with a suspected cause of microhematuria, including interstitial cystitis or benign prostatic hyperplasia, should have the appropriate clinical workup before undertaking imaging, including a pelvic examination in women, a rectal examination in men, and cystoscopy [1,2,6]. Interstitial cystitis, in particular, should be considered in women with chronic pelvic pain along with microhematuria, because this diagnosis is prevalent but often difficult to diagnose [6]. Patients with renal parenchymal disease (glomerulonephritis, glomerulonephropathy, acute tubular necrosis, and acute kidney injury) should undergo a concurrent nephrology evaluation, but this should not preclude further evaluation of microhematuria [1,2]. Use of anticoagulant therapy does not alter the urologic evaluation of microhematuria [1,2].

Special Imaging Considerations

CT urography (CTU) is an imaging study that is tailored to improve visualization of both the upper and lower urinary tracts. There is variability in the specific parameters, but it usually involves unenhanced images followed by intravenous (IV) contrast-enhanced images, including nephrographic and excretory phases, acquired at least 5 minutes after contrast injection. Alternatively, a split-bolus technique uses an initial loading dose of IV contrast and then obtains a combined nephrographic-excretory phase after a second IV contrast dose; some sites include arterial phase. CTU should use thin-slice acquisition. 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 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. A contrast-enhanced T1-weighted series should include corticomedullary, nephrographic, and excretory phase. Thin-slice acquisition and multiplanar imaging should be obtained. 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.

Discussion of Procedures by Variant

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.

Patients without risk factors and with a known benign cause of microhematuria are unlikely to gain any benefit from a complete imaging workup of microscopic hematuria. Multiple studies have shown that patients in this category do not derive any benefit from imaging [1,2,6,7].

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging. A. Arteriography Kidney

Arteriography is not used as a first-line imaging modality for the evaluation of microhematuria. There is no relevant literature regarding the use of arteriography for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging. B. CT Abdomen and Pelvis

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.

CT without IV contrast may be a reasonable option in the setting of microhematuria in patients <50 years of age [8]. There is no relevant literature regarding the use of CT with IV contrast for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging. C. CTU

CTU is not useful as a first-line imaging modality for the evaluation of microhematuria in patients with no known risk factors and with an identified benign cause of microhematuria. Lisanti et al [7] found that in 442 patients <40 years of age and without risk factors, no patient had a

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.

D. MRU

MRU is not useful as a first-line imaging modality for the evaluation of microhematuria in patients with no known risk factors and with an identified benign cause of microhematuria. There is no relevant literature regarding the use of MRU for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.
E. MRI Abdomen and Pelvis

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. There is no relevant literature regarding the use of MRI for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.
F. Radiography Abdomen and Pelvis

Conventional radiographs of the abdomen and pelvis (KUB) are not used as a first-line imaging modality for the evaluation of hematuria. There is no relevant literature regarding the use of radiography for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.
G. Radiography Intravenous Urography

IV urography (IVU) is no longer used as a first-line imaging modality for the evaluation of hematuria. There is no relevant literature regarding the use of IVU for the initial evaluation of microhematuria.

Variant 1: Microhematuria. No risk factors, or history of recent vigorous exercise, or presence of infection, or viral illness, or present or recent menstruation. Initial imaging.
H. US Kidneys and Bladder Retroperitoneal

Ultrasound (US) is not useful as a first-line imaging modality for the evaluation of microhematuria with no known risk factors and with an identified benign cause of microhematuria.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.
A. Arteriography Kidney

Arteriography is not used as a first-line imaging modality for the evaluation of microhematuria. There is no relevant literature regarding the use of arteriography for the initial evaluation of microhematuria.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

B. CT Abdomen and Pelvis

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.

There is no relevant literature regarding the use of CT with IV contrast or CT without IV contrast in this patient population with microhematuria. Initial studies compared CTU with other modalities but without direct comparison to conventional contrast-enhanced CT. However, in current practice, CTU has replaced conventional CT in this situation because of improved detection of urothelial lesions on CTU.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

C. CTU

CTU has been shown to be the imaging study of choice for the evaluation of microhematuria because it can evaluate both nephrogenic and urogenic causes of hematuria [1,2,9-12].

In a meta-analysis, CTU proved to be a very sensitive and specific method for the detection of urothelial malignancy with pooled sensitivity of 96% and pooled specificity of 99% and was superior in direct comparison to IVU in terms of sensitivity and specificity [10].

For the detection of upper tract lesions (kidneys and ureters), CTU has been shown to be superior to IVU with an accuracy of 99.6% compared with 84.9% for IVU [12].

CTU has also been shown to be useful for the detection of lower tract lesions (bladder) [11,13]. In one study of 242 patients with microhematuria, the specificity and accuracy of CTU for the detection of lower tract lesions was 98.8% and 97.2%, respectively [11].

In comparison with MRU, one study showed that CTU provided better visibility of the urothelial structures and improved diagnostic confidence [14].

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

D. MRU

MRU has decreased spatial resolution compared with CTU. Also, small nonobstructive renal calculi and other calcifications as well as small urothelial lesions may be difficult to detect at MRU [15]. However, MRI has shown comparable accuracy to CT in the detection and characterization of renal masses [16].

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.

E. MRI Abdomen and Pelvis

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. There is no relevant literature regarding the use of routine MRI with IV contrast in this patient population with microhematuria.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.
F. Radiography Abdomen and Pelvis

Conventional radiographs of the abdomen and pelvis (KUB) are not used as a first-line imaging modality for the evaluation of hematuria. There is no relevant literature regarding the use of radiographs for the initial evaluation of microhematuria.

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.
G. Radiography Intravenous Urography

IVU is no longer used as a first-line imaging modality for the evaluation of hematuria. Multiple studies have shown that IVU has a low sensitivity for the detection of renal masses and urinary tract abnormalities in general compared with CT [9,10].

Variant 2: Microhematuria. Patients with risk factors, without any of the following: history of recent vigorous exercise, or presence of infection or viral illness, or present or recent menstruation, or renal parenchymal disease. Initial imaging.
H. US Kidneys and Bladder Retroperitoneal

US is not used as a first-line imaging modality for the evaluation of microhematuria. One study of 141 patients showed US had a lower sensitivity for the detection of urinary tract abnormalities compared with both CTU and MRU [17]. However, a recent large prospective study suggests that kidney and bladder US may be adequate for initial evaluation of microhematuria [18]. In this study, urinary cancer was diagnosed in 0.4% of patients who presented with microscopic hematuria, and all the patients had a renal carcinoma [18].

Variant 3: Microhematuria. Pregnant patient. Initial imaging.

Pregnant patients present with microhematuria at a rate similar to nonpregnant patients, and the rate of malignancy in this group is low [2,19].

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
A. Arteriography Kidney

Arteriography is not used as a first-line imaging modality for the evaluation of microhematuria in pregnancy. There is no relevant literature regarding the use of arteriography for the initial evaluation of microhematuria.

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
B. CT Abdomen and Pelvis

CT is not used as a first-line imaging modality for the evaluation of microhematuria in pregnant patients secondary to the risks of radiation exposure to the fetus. The incidence of asymptomatic microhematuria in pregnant women is similar to nonpregnant women, and the rate of malignancy in this group is low [2].

Variant 3: Microhematuria. Pregnant patient. Initial imaging.

C. CTU

CTU is not used as a first-line imaging modality for the evaluation of microhematuria in pregnant patients secondary to the risks of radiation exposure to the fetus. The incidence of asymptomatic microhematuria in pregnant women is similar to nonpregnant women, and the rate of malignancy in this group is low [2].

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
D. MRU

MRU without and with IV contrast is not used as a first-line imaging modality for the evaluation of microhematuria in pregnant patients. The incidence of asymptomatic microhematuria in pregnant women is similar to nonpregnant women, and the rate of malignancy in this group is low [2]. MRU without IV contrast during pregnancy is a reasonable choice with a full workup after delivery once gynecologic bleeding and other benign causes (such as infection) have been excluded [2].

MRI with IV contrast should be avoided in pregnant patients because of uncertainty of effects of gadolinium contrast on the fetus. See the Safety Considerations in Pregnant Patients section below.

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
E. MRI Abdomen and Pelvis

The incidence of asymptomatic microhematuria in pregnant women is similar to nonpregnant women, and the rate of malignancy in this group is low [2]. MRI abdomen and pelvis with and without IV contrast is not used as a first-line imaging modality for the evaluation of microhematuria in pregnant patients. MRI abdomen and pelvis without IV contrast is not used as a first-line imaging modality because of the absence of heavily T2-weighted images of the urinary tract.

MRI with IV contrast should be avoided in pregnant patients because of the uncertainty of effects of gadolinium contrast on the fetus. See the Safety Considerations in Pregnant Patients section below.

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
F. Radiography Abdomen and Pelvis

Conventional radiographs of the abdomen and pelvis (KUB) are not used as a first-line imaging modality for the evaluation of hematuria in pregnancy. There is no relevant literature regarding the use of radiographs for the initial evaluation of microhematuria.

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
G. Radiography Intravenous Urography

IVU is not used as a first-line imaging modality for the evaluation of microhematuria in pregnancy. There is no relevant literature regarding the use of IVU for the initial evaluation of microhematuria.

Variant 3: Microhematuria. Pregnant patient. Initial imaging.
H. US Kidneys and Bladder Retroperitoneal

The incidence of asymptomatic microhematuria in pregnant women is similar to nonpregnant women, and the rate of malignancy in this group is low [2]. US during pregnancy is a reasonable choice with a full workup after delivery once gynecologic bleeding and other benign causes (such as infection) have been excluded [2,19].

Variant 4: Gross hematuria. Initial imaging.

Variant 4: Gross hematuria. Initial imaging.
A. Arteriography Kidney

Arteriography is not used as a first-line imaging modality for the evaluation of gross hematuria. There is no relevant literature regarding the use of arteriography for the initial evaluation of gross hematuria.

Variant 4: Gross hematuria. Initial imaging.
B. CT Abdomen and Pelvis

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.

There is no relevant literature regarding the use of CT with IV contrast or CT without IV contrast in the evaluation of gross hematuria.

Variant 4: Gross hematuria. Initial imaging.
C. CTU

The usefulness of CTU in the evaluation of gross hematuria has been mixed [11,13,20-23]. In one study of 150 patients, the sensitivity and specificity of CTU for the detection of bladder malignancy was 61.5% and 94.9% using cystoscopy as the reference standard [21]. However, in another study of 435 patients, CTU performed comparably to cystoscopy for the detection of bladder malignancy with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 87%, 99%, 91%, and 98%, compared with 87%, 100%, 98%, and 98%, respectively, for cystoscopy [22]. The recent DETECT (Detecting Bladder Cancer Using the UroMark Test) 1 study recommends CTU for gross hematuria because of an upper tract tumor rate of 0.8% [18].

Variant 4: Gross hematuria. Initial imaging.
D. MRU

There is no relevant literature regarding the use of MRU in patients with gross hematuria. Direct comparison of MRI and CTU sensitivity for evaluation of urothelial lesions in gross hematuria is not available in the literature.

Variant 4: Gross hematuria. Initial imaging.
E. MRI Abdomen and Pelvis

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.

MRI without contrast may be helpful for the evaluation of gross hematuria. In one study of 130 patients, MRI had a sensitivity of 98.5% and PPV of 100% for determining the cause of gross hematuria, using cystoscopy and histopathology as the reference standards [24]. There is no relevant literature regarding the use of MRI with IV contrast in patients with gross hematuria.

Variant 4: Gross hematuria. Initial imaging.

F. Radiography Abdomen and Pelvis

Conventional radiographs of the abdomen and pelvis (KUB) are not used as a first-line imaging modality for the evaluation of gross hematuria. There is no relevant literature regarding the use of radiography for the evaluation of gross hematuria.

Variant 4: Gross hematuria. Initial imaging.
G. Radiography Intravenous Urography

IVU is not used as a first-line imaging modality for the evaluation of gross hematuria. There is no relevant literature regarding the use of IVU for the evaluation of gross hematuria.

Variant 4: Gross hematuria. Initial imaging.
H. US Kidneys and Bladder Retroperitoneal

US, including contrast-enhanced US (CEUS), is not used as first-line imaging modality for the evaluation of gross hematuria. In a study of 95 patients, US had a sensitivity, specificity, PPV, and NPV of 35.3%, 89.9%, 46.2%, and 84.9%, respectively, when using cystoscopy as the reference standard [25]. In a multicenter trial for the diagnosis of bladder cancer, US had a sensitivity, specificity, PPV, and NPV of 50.7%, 99.3%, 84.3%, and 96.5%, respectively, using cystoscopy as the reference standard and, compared with CT, had a sensitivity, specificity, PPV, and NPV of 80.5%, 97.0%, 79.3%, and 97.2%, respectively [18]. Diagnostic accuracy of US in bladder tumor detection could be significantly improved by CEUS, which allows the detection of enhancing tumors, as opposed to nonenhancing hematomas [26]. In 35 patients with cystoscopy and biopsy as the reference standard, CEUS correctly assessed tumor presence or absence in 88% of cases [27].

Summary of Recommendations

- **Variant 1:** CT abdomen and pelvis without IV contrast may be appropriate for the initial imaging of microhematuria in patients with no risk factors or history of recent vigorous exercise, or presence of infection, viral illness, or present or recent menstruation.
- **Variant 2:** CTU without and with IV contrast is usually appropriate for the initial imaging of microhematuria in patients with risk factors, without any of the following: history of recent vigorous exercise, presence of infection or viral illness, present or recent menstruation, or renal parenchymal disease.
- **Variant 3:** US kidneys and bladder retroperitoneal is usually appropriate for the initial imaging of microhematuria in pregnant patients.
- **Variant 4:** CTU without and with IV contrast or MRU without and with IV contrast is usually appropriate for the initial imaging of gross hematuria. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

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

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."

References

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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.

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