**Variant 1:** Nonmuscle invasive bladder cancer (NMIBC), no symptoms or risk factors. Post-treatment surveillance.

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<tr>
<th>Procedure</th>
<th>Appropriateness Category</th>
<th>Relative Radiation Level</th>
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<tr>
<td>CT abdomen and pelvis without and with IV contrast</td>
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<td>Radiography intravenous urography</td>
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<td>MRI abdomen and pelvis without and with IV contrast</td>
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<td>FDG-PET/CT skull base to mid-thigh</td>
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<td>MRI abdomen and pelvis without IV contrast</td>
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<tr>
<td>US pelvis (bladder)</td>
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**Variant 2:** Nonmuscle invasive bladder cancer (NMIBC), with symptoms or risk factors. Post-treatment surveillance.

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<td>MRI abdomen and pelvis without and with IV contrast</td>
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<td>Radiography chest</td>
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<td>CT abdomen and pelvis with IV contrast</td>
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**Variant 3:** Muscle-invasive bladder cancer (MIBC) with or without cystectomy. Post-treatment surveillance.

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<tr>
<td>CT abdomen and pelvis without and with IV contrast</td>
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<td>Fluoroscopy abdomen loopogram</td>
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<td>CT abdomen and pelvis with IV contrast</td>
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POST-TREATMENT SURVEILLANCE OF BLADDER CANCER

Expert Panel on Urologic Imaging: Brian C. Allen, MD; Aytekin Oto, MD; Oguz Akin, MD; Lauren F. Alexander, MD; Jaron Chong, MD; Adam T. Froemming, MD; Pat F. Fulgham, MD; Shane Lloyd, MD; Jodi K. Maranchie, MD; Rekha N. Mody, MD; Bhavik N. Patel, MD, MBA; Nicola Schieda, MD; Ismail B. Turkbey, MD; Neha Vapiwala, MD; Aradhana M. Venkatesan, MD; Carolyn L. Wang, MD; Don C. Yoo, MD; Mark E. Lockhart, MD, MPH.

Summary of Literature Review

Introduction/Background

Urothelial carcinoma (UC), previously known as transitional cell carcinoma, accounts for more than 90% of all urinary bladder cancers in the United States and is the second most common cancer, and cause of cancer death, related to the genitourinary tract [1]. The American Cancer Society estimated that there will be 81,190 new cases of bladder cancer and 17,240 deaths related to bladder cancer in 2018 [1]. Bladder cancer staging is based on the American Joint Committee on Cancer Tumor, Node, Metastasis (TNM) system, and T-stage (depth of invasion) is used to differentiate patients into 2 groups: nonmuscle-invasive bladder cancer (NMIBC) and muscle-invasive bladder cancer (MIBC) [2]. NMIBC accounts for 75% of bladder cancers and consists of a heterogeneous group of tumors including superficial papillary tumors (Ta), carcinoma in situ (Tis), and tumors invading the lamina propria (T1), all with different rates of recurrence and progression [2]. MIBC consists of tumors invading the muscularis propria (T2) and beyond, and these tumors have a significantly higher rate of recurrence and progression after treatment. The 5-year survival rate for all stages of UC of the urinary bladder combined is 78% [1]. For NMIBC stages 0 and 1, the 5-year survival rates are 96% and 75%, respectively; 5-year survival rates drop for MIBC at stages 2, 3, and 4 to 70%, 35%, and 5%, respectively [1].

The goals of surveillance imaging after the treatment of UC of the urinary bladder are to detect new or previously undetected urothelial tumors (both in the upper [collecting system and ureters] and lower [bladder and urethra] urinary tract), to identify metastatic disease, and to evaluate for complications of therapy. For surveillance, patients can be stratified into 1 of 3 groups: 1) NMIBC with no symptoms or additional risk factors, treated with local therapy; 2) NMIBC with symptoms or additional risk factors, treated with local therapy; and 3) MIBC, generally treated with cystectomy, although there are bladder-preserving treatment protocols available.

The American Urological Association and Society of Urologic Oncology Joint Guidelines recommends stratifying patients with NMIBC into low-, intermediate-, or high-risk categories for disease recurrence and progression based on the following risk factors [3]:

1. **Tumor size**: Tumors measuring ≥3 cm are associated with decreased time to first recurrence and time to progression compared with tumors measuring <3 cm [4-6].

2. **Tumor focality**: Multiple tumors are identified in >40% of cases and are associated with higher rates of recurrence and decreased time to first recurrence [4,5,7].

3. **Tumor grade**: The World Health Organization (WHO)/International Society of Urological Pathology (ISUP) 2004 grading system is used to classify tumor grade (I–III). Patients with higher-grade tumors have decreased recurrence-free intervals and increased rates of progression [4,5,7].

4. **Tumor stage**: Most urothelial carcinomas of the bladder are superficial (75%), although NMIBC consists of a heterogeneous group including Ta (70%), T1 (20%), and Tis (10%) lesions. Overall, most superficial tumors

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*Panel Vice-Chair, Duke University Medical Center, Durham, North Carolina. /Panel Chair, University of Chicago, Chicago, Illinois. Memorial Sloan Kettering Cancer Center, New York, New York. /Mayo Clinic, Jacksonville, Florida. McGill University, Montreal, Quebec, Canada. /Mayo Clinic, Rochester, Minnesota. /Urology Clinics of North Texas, Dallas, Texas; American Urological Association. Huntsman Cancer Hospital, Salt Lake City, Utah. /UPMC, Pittsburgh, Pennsylvania; American Urological Association. Cleveland Clinic, Cleveland, Ohio. Stanford University Medical Center, Stanford, California. /Ottawa Hospital Research Institute and the Department of Radiology, The University of Ottawa, Ottawa, Ontario, Canada. /National Institutes of Health, Bethesda, Maryland. University of Pennsylvania, Philadelphia, Pennsylvania. /The University of Texas MD Anderson Cancer Center, Houston, Texas. /University of Washington, Seattle Cancer Care Alliance, Seattle, Washington. /Rhode Island Hospital/The Warren Alpert Medical School of Brown University, Providence, Rhode Island. Specialty Chair, University of Alabama at Birmingham, Birmingham, Alabama. The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

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remain superficial, with only a minority progressing to MIBC; however, patients with Tis and T1 tumors have a high rate of recurrence and an increased rate of progression to MIBC compared with Ta tumors [4,6].

5. **Lymphovascular invasion:** Studies have demonstrated an increased risk of lymph node metastases, recurrence, and decreased survival with the presence of lymphovascular invasion [8,9].

6. **Prostatic urethral invasion:** Involvement of the prostatic urethra increases risk of urethral recurrence [10].

7. **Variant histology:** Patients with variant histology (squamous, glandular, micropapillary, nested, plasmacytoid, neuroendocrine, sarcomatoid) have a higher incidence of locally advanced disease and poor outcomes [11-13].

8. **Poor response to Bacillus Calmette-Guérin therapy:** Patients with persistent or recurrent disease following intravesical Bacillus Calmette-Guérin (BCG) therapy for NMIBC are at increased risk for disease progression [14,15].

The American Urological Association/Society of Urologic Oncology (AUA/SUO) and National Comprehensive Cancer Network (NCCN) guidelines differ slightly in imaging recommendations following treatment for NMIBC. The NCCN guidelines recommend upper-tract surveillance imaging for low- or intermediate-risk patients as clinically indicated and scheduled upper-tract imaging every 1 to 2 years for high-risk patients [16]. The AUA/SUO guidelines recommend upper-tract surveillance imaging for both intermediate- and high-risk patients at 1 to 2 year intervals [3]. For the purposes of this manuscript, NMIBC has been divided into 2 categories: NMIBC without symptoms or risk factors and NMIBC with symptoms or risk factors. Local practice patterns (NCCN versus AUA/SUO) should determine whether upper-tract surveillance should be considered in patients with intermediate risk and no symptoms.

**Special Imaging Considerations**

**Laboratory Tests and Chromosomal Abnormalities**

Urine cytological analysis and cystoscopy are performed routinely in the setting of NMIBC [3,17,18]. As urine cytology lacks sensitivity and cystoscopy is relatively invasive, noninvasive urine-based biomarkers have been developed as potential alternatives to cystoscopy for the identification of recurrent disease [19]. A recent meta-analysis of urinary biomarkers approved by the FDA, including nuclear matrix protein 22, bladder tumor antigen, fluorescence in situ hybridization, and fluorescent immunohistochemistry has demonstrated that sensitivities range from 57% to 82% and specificities range from 74% to 88% [19]. Urinary biomarkers may therefore miss a substantial portion of patients with bladder cancer, and false-positive tests are common. At the current time, no biomarker assay can replace or eliminate the need for surveillance cystoscopy.

**Cystoscopic and Virtual Cystoscopic Surveillance**

Patients with NMIBC undergo routine surveillance cystoscopy to assess for recurrence and progression to MIBC [3]. As cystoscopy is a relatively invasive procedure, there was previous interest in developing virtual cystoscopic or cystographic techniques using CT or MRI, particularly for problem solving and for cases where conventional cystoscopy is difficult, such as for the evaluation of narrow-necked diverticula. CT cystography, following the instillation of air into the urinary bladder via a Foley catheter, has been shown to be accurate at identifying masses >0.5 cm [20]. MRI evaluation of the urinary bladder with virtual cystoscopy (3-D fly through) and cystography (T2-weighted turbo spin-echo imaging) has a sensitivity of 90.7% and specificity of 94.0% for bladder tumors (mean size 2.5 cm; 0.4–9.1 cm) [21]. However, these procedures are not commonly performed and do not eliminate the need for conventional cystoscopy.

**Discussion of Procedures by Variant**

**Variant 1: Nonmuscle invasive bladder cancer (NMIBC), no symptoms or risk factors. Post-treatment surveillance.**

In patients with NMIBC without symptoms or risk factors, metastatic disease is uncommon, thus screening for distant metastatic disease is not recommended. Bladder recurrence is common following treatment for NMIBC. In a study of 190 patients with low-grade, Ta disease, bladder recurrence was identified in 43.2% (82 of 190) of patients; however, progression to MIBC was seen in only 2 patients [22]. The incidence of upper-tract UC (UTUC) in this patient population is 0.6% to 0.9% [23,24]. Routine surveillance of the upper urinary tract in asymptomatic, low-risk patients is not recommended. Urine cytological evaluation and cystoscopy are felt to be sufficiently accurate for the diagnosis of bladder recurrence in this patient population.
Radiography Chest
Chest radiography is generally not appropriate for patients with NMIBC without symptoms or risk factors.

Radiography intravenous urography
CT urography and, to a lesser extent, MR urography have replaced intravenous urography (IVU) for the evaluation of the upper urinary tract. IVU does not have a current role in surveillance of NMIBC.

US Pelvis (Bladder)
Because cystoscopy is relatively invasive and time consuming, there is interest in noninvasive and effective imaging modalities to identify recurrent bladder cancer. In a small prospective study, transabdominal ultrasound (US) was found to have a sensitivity of 78.5% and specificity of 100% for the diagnosis of recurrent UC of the urinary bladder, with cystoscopy as the reference standard [25]. In this study, US accurately diagnosed bladder cancer in 78.6% (11 of 14) of patients, missing 2 tumors <3 mm and 1 lesion located in a diverticulum. In another study, the combination of grayscale US, multiplanar reconstruction, and 3-D virtual US had a sensitivity of 96.4% and specificity of 88.8% compared with conventional cystoscopy [26]. Despite these results, it is generally understood that US has limited ability to identify MIBC in clinical practice and is sparingly used. As cystoscopy allows identification of recurrent neoplasm, concurrent biopsy, and local staging, US has not replaced the need for conventional cystoscopic surveillance for patients with NMIBC.

CT Abdomen and Pelvis
In patients with NMIBC without risk factors or symptoms, screening for distant metastatic disease with cross-sectional imaging is not recommended. Although bladder recurrence is common, CT is not recommended to screen for bladder recurrence, and it is generally felt that urine cytological evaluation and cystoscopy are sufficiently accurate for the diagnosis of bladder recurrence in this patient population.

Routine surveillance of the upper urinary tract in asymptomatic, low-risk patients is also not recommended. The incidence of UTUC in this patient population is 0.6% to 0.9% [23,24]. In addition, in a study of 935 patients with history of NMIBC, only 29% (15 of 51) of UTUCs were diagnosed on routine imaging, whereas the remaining UTUCs were diagnosed once patients became symptomatic, for an overall imaging efficacy of 0.49% (15 UTUC out of 3,074 CT examinations) [27].

CT Chest
Chest CT is generally not appropriate for patients with NMIBC without symptoms or risk factors.

MRI Abdomen and Pelvis
In patients with NMIBC without risk factors or symptoms, screening for distant metastatic disease with cross-sectional imaging is not recommended. MRI urography has been used to evaluate the urinary bladder following transurethral resection of bladder tumor (TURBT). In a study including 47 patients with recurrent bladder cancer, MRI demonstrated a sensitivity of 67% and 73% and specificity of 81% and 62% for 2 readers, respectively; and false-negatives included low-grade Ta lesions [28]. In another study, diffusion-weighted imaging (DWI) had a sensitivity of 100% and specificity of 81.8% for recurrent tumor in 11 patients [29]. At this time, however, it is generally felt that urine cytological evaluation and conventional cystoscopy are sufficiently accurate for the diagnosis of bladder recurrence in this patient population.

Currently, routine surveillance of the upper urinary tract in asymptomatic, low-risk patients is not recommended. Although MR urography has been shown to have a sensitivity of 63% and specificity of 91% in a small study of 35 patients with suspected UTUC, the incidence of UTUC in this patient population is only 0.6% to 0.9% [23,24,30].

FDG-PET/CT Skull Base to Mid-Thigh
Imaging with PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)/CT is generally not appropriate for patients with NMIBC without symptoms or risk factors. The risk of metastatic disease is extremely low. FDG is excreted by the kidneys, and activity obscures evaluation of the upper and lower urinary tract for recurrent disease.

Variant 2: Nonmuscle invasive bladder cancer (NMIBC), with symptoms or risk factors. Post-treatment surveillance.

Patients with NMIBC and risk factors require frequent surveillance for recurrent bladder cancer, which is generally done with conventional cystoscopy. In intermediate-risk patients with history of TURBT and
intravesical chemotherapy, recurrent bladder cancer is identified in up to 57% (413 of 724) of patients [7]. In high-risk patients, 59.6% (2,694 of 4,521) of patients developed multiple recurrences within 2 years of initial treatment [31]. In addition, progression to MIBC is seen in 8.6% to 15% of patients with high-risk disease [32-34].

**Radiography Chest**
Metastatic disease in patients with NMIBC is uncommon; however, chest radiography may be appropriate in patients with NMIBC with symptoms or risk factors.

**Radiography intravenous urography**
CT urography and, to a lesser extent, MR urography have replaced IVU for the evaluation of the upper urinary tract. IVU does not have a current role in surveillance of NMIBC.

**US Pelvis (Bladder)**
In a small prospective study, transabdominal US was found to have a sensitivity of 78.6% and specificity of 100% for the diagnosis of recurrent UC of the urinary bladder, with cystoscopy as the reference standard [25]. In this study, US accurately diagnosed bladder cancer in 78.6% (11 of 14) of patients, missing 2 tumors <3 mm and 1 lesion located in a diverticulum. In another study, the combination of grayscale US, multiplanar reconstruction, and 3-D virtual US had a sensitivity of 96.4% and specificity of 88.8% compared with conventional cystoscopy [26]. Despite these results, US has limited ability to identify MIBC or nodal metastatic disease. As cystoscopy allows identification of recurrent neoplasm, concurrent biopsy, and local staging, US has not replaced the need for cystoscopic surveillance for patients with NMIBC.

**CT Abdomen and Pelvis**
In patients with NMIBC, screening for distant metastatic disease with cross-sectional imaging (CT abdomen and pelvis without or with IV contrast) is not recommended. Although CT urography (CT abdomen and pelvis without and with IV contrast) has not replaced cystoscopy, CT performs well in identifying recurrent bladder cancer following TURBT. In a study of CT urography in 121 patients at risk for urothelial recurrence after TURBT (with symptoms or positive urine cytology), 59 bladder recurrences were identified in 38 patients. The authors found that overall accuracy was better in the urinary bladder during the nephrographic phase compared with pyelographic/excretory phase (91.7% [354 of 386] versus 83.2% [321 of 386], \(P = .038\)) [35]. In another study of patients with history of UC, CT urography had a sensitivity of 77.8% (63 of 81) and specificity of 77.9% (60 of 77) for the detection of bladder cancer [36].

CT urography for the evaluation of the upper urinary tract is effective in patients with symptoms, particularly in the setting of a negative cystoscopy. In a study of CT urography in 121 patients at risk for urothelial recurrence after TURBT (with symptoms or positive urine cytology), 19 upper-tract recurrences were identified in 13 patients. In this study, accuracy for upper-tract recurrence was better in the nephrographic phase compared with the pyelographic phase (86.7% [260 of 300] versus 80.0% [240 of 300], \(P = .028\)) [35].

**CT Chest**
Chest CT without or with IV contrast is generally not appropriate for patients with NMIBC with symptoms or risk factors, unless an abnormality is identified with chest radiography.

**MRI Abdomen and Pelvis**
In patients with NMIBC, screening for distant metastatic disease with cross-sectional imaging is not recommended.

Although MRI has not replaced cystoscopy, MRI can be used for local staging of bladder cancer. On T2-weighted images, the normal urinary bladder wall is of low signal intensity and bladder cancer is of intermediate signal intensity. In a study by Takeuchi et al [37], the accuracy of T2-weighted imaging alone was 67%, but when DWI and contrast-enhanced imaging were included, accuracy for local staging increased to 92%. In another study of 106 patients with bladder tumors, T2-weighted imaging had an accuracy of 39.6%, whereas DWI had an accuracy of 63.6% in differentiating NMIBC from MIBC [38]. For evaluation of the urinary bladder following TURBT, Rosenkrantz et al [28] evaluated 47 patients with recurrent bladder cancer and demonstrated a sensitivity of 67% and 73% and specificity of 81% and 62% for 2 readers, respectively. In this study, false-positives were seen in patients who underwent BCG therapy, and false-negatives included low-grade Ta lesions. Wang et al [29] found that DWI had a sensitivity of 100% and specificity of 81.8% for recurrent tumor in 11 patients and the authors
found that DWI outperformed dynamic contrast-enhanced imaging in the differentiation of tumor from postoperative inflammation or fibrosis.

MR urography can also be used to evaluate for UTUC and may be useful in the setting of negative cystoscopy. In a study of 91 examinations in 88 patients with suspected UTUC, MR urography had a sensitivity of 72.4% to 86.2% and specificity of 97.9% to 99.5% for 2 readers, respectively [39]. There is no relevant literature regarding the use of MRI of the abdomen and pelvis without IV contrast in the evaluation of the upper urinary tract. MRI without and with IV contrast is acceptable for evaluation of the upper urinary tracts to help differentiate enhancing tumor from nonenhancing material.

FDG-PET/CT Skull Base to Mid-Thigh
FDG-PET/CT is generally not appropriate for patients with NMIBC. The risk of metastatic disease is extremely low and FDG is excreted by the kidneys and activity obscures evaluation of the upper and lower urinary tract for recurrent disease.

Variant 3: Muscle-invasive bladder cancer (MIBC) with or without cystectomy. Post-treatment surveillance.

Following radical cystectomy for MIBC, 5-year recurrence-free survival is approximately 58%; risk factors for recurrence include: advanced tumor stage, lymph node involvement, lymphovascular invasion, high tumor grade, and positive surgical margins [9,40-42]. Recurrences can be described as pelvic relapse; surgical bed recurrence; internal and external iliac or obturator lymph node involvement or distant metastatic disease; and osseous, pulmonary, hepatic, extrapelvic lymphadenopathy, peritoneal, and brain metastases. Most recurrences occur within the first 2 years following cystectomy and most recurrences are distant metastatic disease [43]. Pelvic relapse is seen in 34% of patients, and the 2-year risk of local failure exceeds 30% [44]. In a study of 1,110 patients following radical cystectomy, recurrences were identified in 29.2% (324 of 1,110) of patients and 61.7% (200 of 324) of recurrences were single-site recurrences with 43 local (22 cystectomy bed and 21 pelvic lymph node) and 138 distant (36 lung, 19 liver, 52 bone, 17 extrapelvic lymph node, 7 peritoneal, 4 brain, 3 other) [45]. In a smaller study of 343 patients, 46% (158) of patients developed recurrence; 30% (104) were distant, 6% (21) were distant and local, and 10% (33) were only local. Eighty-four percent of recurrences were identified within 2 years. Following cystectomy, patients are also at risk of developing UTUC, which is found in up to 3.7% of patients [46,47]. As recurrence can involve the entire urinary tract, the urethra also needs to be screened, often with urethral wash cytology, although urethral recurrence may occasionally be identified on cross-sectional imaging. The risk of urethral recurrence is 2.7% to 3.8%, and risk factors include prostatic involvement of the MIBC [46-48].

Radiography Chest
All patients with MIBC require imaging of the thorax. Chest radiography is an effective screening examination and should be performed at regular intervals. Any abnormality identified at radiography should be followed with a CT examination for improved characterization.

Fluoroscopy Abdomen Loopogram
Abdominal radiography can be useful in the early postoperative setting to evaluate for ureteral stent location and to evaluate patients with abdominal distention and postoperative ileus. A fluoroscopic loopogram, in which water-soluble contrast is instilled into an ileal conduit in a retrograde fashion, can be used to evaluate for leak in the early postoperative period and to confirm patent ureteral anastomoses in the setting of hydronephrosis and declining renal function following urinary diversion. Abdominal radiography and fluoroscopic examinations are not useful for detection of tumor recurrence.

Radiography intravenous urography
CT urography and, to a lesser extent, MR urography have replaced IVU for the evaluation of the upper urinary tract. In a study of 128 patients at high risk for UTUC, in whom 46 patients were diagnosed with UTUC, excretory urography had a per-patient sensitivity of 80.4% (37 of 46) and a specificity of 81.0% (47 of 58), whereas CT urography had a sensitivity of 93.5% (43 of 46) and a specificity of 94.8% (55 of 58) [49]. IVU is not recommended for detection of tumor recurrence. However, IVU could be used to assess for ureteral anastomotic patency if reflux cannot be demonstrated on a loopogram.
US Pelvis (Bladder)
Following cystectomy, the acoustic window is limited and US is of little clinical use for the identification of local recurrence or nodal metastatic disease. Given the high incidence of recurrent disease (up to 46% of patients) following cystectomy for MIBC, surveillance imaging with CT or MRI is recommended [42]. US may be useful to assess the kidneys for hydronephrosis in the setting of declining renal function, regardless of whether the urinary bladder has been resected or not.

CT Abdomen and Pelvis
There is no relevant literature regarding the use of CT abdomen and pelvis without or with IV contrast for the evaluation of metastatic bladder cancer; however, IV contrast is generally indicated to improve sensitivity for the identification of metastatic disease. As described earlier, recurrences can be described as pelvic relapse; surgical bed recurrence; internal and external iliac and obturator lymph node involvement or distant metastatic disease; and osseous, pulmonary, hepatic, extrapelvic lymphadenopathy, peritoneal, and brain metastases.

CT urography (CT abdomen and pelvis without and with IV contrast) is generally used to evaluate the upper urinary tract. In 1 study, accuracy of CT urography for UTUC was better in the nephrographic phase compared with the pyelographic phase for upper-tract recurrences (86.7% [260 of 300] versus 80.0% [240 of 300], \(P = .028\)), although the 2 phases are complementary [35].

CT Chest
All patients with MIBC require imaging of the thorax. In the setting of bladder cancer, there is a lack of data comparing the utility of chest radiography and chest CT. Chest radiography is an effective screening examination and should be performed at regular intervals. Any abnormality identified at radiography should be followed with a CT examination for improved characterization. Depending on local practice pattern, chest CT may be performed concurrently with CT abdomen and pelvis, particularly in the setting of known metastatic disease. There is no relevant literature regarding the use of CT without or with IV contrast in the evaluation of bladder cancer metastases to the thorax; however, CT with IV contrast is often performed at the time of staging CT abdomen and pelvis.

MRI Abdomen and Pelvis
MRI performs well for identifying metastatic disease within the abdomen and pelvis, and nodal disease is largely based on size criteria. There is no relevant literature regarding the use of MRI of the abdomen and pelvis without IV contrast in the evaluation of metastatic urothelial cancer. Given the improved soft-tissue contrast of MRI compared with CT, MRI of the abdomen and pelvis without IV contrast may be acceptable for the identification of metastatic disease; however, MRI without and with IV contrast is preferred to improve sensitivity.

Although MRI can be used for local staging of bladder cancer, the presence of inflammation and fibrosis affect the accuracy of MRI following neoadjuvant chemoradiation, when accuracy drops to only 30% [50]. However, DWI may help distinguish inflammation and fibrosis from tumor; in a small study of 20 patients who underwent low-dose neoadjuvant chemoradiation, MRI had accuracy for determining pathologic response of 44% for T2-weighted imaging alone, 33% for dynamic contrast-enhanced imaging, and 80% for DWI [51].

In a study of 91 examinations in 88 patients with suspected UTUC, MR urography had a sensitivity of 72.4% to 86.2% and specificity of 97.9% to 99.5% for UTUC for 2 readers, respectively [39]. There is no relevant literature regarding the use of MRI of the abdomen and pelvis without IV contrast in the evaluation of the upper urinary tract. MRI without and with IV contrast is acceptable for evaluation of the upper urinary tracts, to help differentiate enhancing tumor from nonenhancing material.

FDG-PET/CT Skull Base to Mid-Thigh
FDG-PET/CT in the setting of MIBC is typically used to resolve equivocal findings identified on other imaging tests, but there is increasing evidence that FDG-PET/CT alters patient management and has prognostic value compared with other staging examinations.

Kibel et al [52] evaluated FDG-PET/CT prior to cystectomy for MIBC and found that FDG-PET/CT had a sensitivity of 70% (7 of 10) and specificity of 94% (30 of 32) for metastatic disease. However, occult metastatic disease was found in 7 of 42 patients with FDG-PET/CT compared with CT alone. In another study of 44 patients with MIBC, FDG-PET/CT demonstrated a sensitivity of 57% for pelvic lymph node involvement, compared with 33% for CT, and FDG-PET/CT identified all bone lesions that were detected by scintigraphy [53]. Given FDG
activity in excreted urine, pelvic staging may be difficult. One group of authors found that with diuretics and oral hydration there was improved assessment of locally recurrent disease [54].

In a recently published study that included 41 patients with suspected recurrent bladder cancer after primary treatment that underwent FDG-PET/CT, authors found that FDG-PET/CT had a sensitivity of 87% and specificity of 94% for recurrent/metastatic bladder cancer following treatment [55]. In this study, metastatic disease was found in abdominal and pelvic lymph nodes, including suprarenal lymph nodes; pulmonary and osseous metastatic disease was also identified. Perhaps more importantly, the results of the FDG-PET/CT changed the treatment decision in 40% of patients and had prognostic value in determining overall survival and progression-free survival. In another study of the National Oncologic PET Registry, authors found that FDG-PET/CT changed management in approximately 35% of patients and had a large impact on chemotherapy monitoring [56].

Although not widely available, there is increasing interest in \(^{11}\)C-choline-PET. In a study of 27 patients with either MIBC or recurrent NMIBC that failed TURBT and intravesical therapy, the presence of residual bladder cancer was detected in 84% (21 of 25) of patients with CT and 96% (24 of 25) of patients with \(^{11}\)C-choline PET, and lymph node involvement was identified correctly in 50% (4 of 8) of patients with CT and 62% (5 of 8) of patients with PET [57].

**Summary of Recommendations**

- **Variant 1:** Imaging is not recommended for the post-treatment surveillance in patients with NMIBC without symptoms or risk factors.

- **Variant 2:** CT abdomen and pelvis without and with IV contrast is usually appropriate for the post-treatment surveillance in patients with NMIBC with symptoms or risk factors.

- **Variant 3:** CT abdomen and pelvis without and with IV contrast, CT abdomen and pelvis with IV contrast, or MRI abdomen and pelvis without and with IV contrast is usually appropriate for post-treatment surveillance in patients with NMIBC with or without cystectomy. These procedures are equivalent alternatives and are complementary to chest radiography. Fluoroscopy abdomen loopogram is usually appropriate to evaluate for a leak in the early postoperative period and to confirm patent ureteral anastomoses in the setting of hydronephrosis and declining renal function following urinary diversion, but is not useful for the identification of locally recurrent or metastatic disease.

**Supporting Documents**

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

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).
### Appropriateness Category Names and Definitions

<table>
<thead>
<tr>
<th>Appropriateness Category Name</th>
<th>Appropriateness Rating</th>
<th>Appropriateness Category Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually Appropriate</td>
<td>7, 8, or 9</td>
<td>The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.</td>
</tr>
<tr>
<td>May Be Appropriate</td>
<td>4, 5, or 6</td>
<td>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.</td>
</tr>
<tr>
<td>May Be Appropriate (Disagreement)</td>
<td>5</td>
<td>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.</td>
</tr>
<tr>
<td>Usually Not Appropriate</td>
<td>1, 2, or 3</td>
<td>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.</td>
</tr>
</tbody>
</table>

### 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 [58].

<table>
<thead>
<tr>
<th>Relative Radiation Level*</th>
<th>Adult Effective Dose Estimate Range</th>
<th>Pediatric Effective Dose Estimate Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>☞</td>
<td>0 mSv</td>
<td>0 mSv</td>
</tr>
<tr>
<td>☞</td>
<td>&lt;0.1 mSv</td>
<td>&lt;0.03 mSv</td>
</tr>
<tr>
<td>☞</td>
<td>0.1-1 mSv</td>
<td>0.03-0.3 mSv</td>
</tr>
<tr>
<td>☞</td>
<td>1-10 mSv</td>
<td>0.3-3 mSv</td>
</tr>
<tr>
<td>☞</td>
<td>10-30 mSv</td>
<td>3-10 mSv</td>
</tr>
<tr>
<td>☞</td>
<td>30-100 mSv</td>
<td>10-30 mSv</td>
</tr>
</tbody>
</table>

*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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

### References


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.