ACR Appropriateness Criteria
Non-invasive Clinical Staging of Bronchogenic Carcinoma

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In order to appropriately manage patients with lung cancer, it is necessary to properly stage the tumor. The ACR Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed every 3 years by a multidisciplinary expert panel. The guideline development and review include an extensive analysis of current medical literature from peer-reviewed journals and the application of a well-established consensus methodology (modified Delphi) to rate the appropriateness of imaging and treatment procedures by the panel. In those instances in which evidence is lacking or not definitive, expert opinion may be used to recommend imaging or treatment.

Key Words: Appropriateness Criteria, lung cancer, FDG-PET/CT, CT

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SUMMARY OF LITERATURE REVIEW
Non-Small-Cell Lung Carcinoma

Staging. Staging of any tumor is done to determine the extent of disease. Staging information is important for 2 reasons: to determine prognosis and to select patients for surgical intervention and/or a different modality. The TNM staging system is widely used to classify lung tumors. In 2007, it was revised after epidemiologic evidence demonstrated differences in survival of several tumor features that warranted reclassification [1]. In the TNM classification, T indicates the features of the primary tumor, N indicates metastasis to regional lymph nodes, and M refers to the presence or absence of distant metastases. The most recent revision was performed by the International Association for the Study of Lung Cancer (IASLC).

The current IASLC 7th-edition classification consists of 4 stages [1]. Stage I has been divided into 2 groups: IA and IB. Data have consistently shown a better outcome for patients with stage IA disease—that is, T1N0M0—than for any other subset. Median survival time is 59 months for stage IA compared with 48 months for stage IB. Stage IB is defined as patients with T2a tumors. Stage II is also subdivided into A and B groups. Median survival time for patients with stage IIA disease—that is, T1 or T2a lesions with involved hilar nodes or T2b lesions without hilar nodes—is higher than for those with stage IIB disease (T2bN1M0 or T3N0M0).

Stage III is divided into IIIA and IIB, where IIB is considered unresectable disease, (i.e., T4 and/or N3). In the current classification, tumors >7 cm or with invasion of the chest wall (T3) are considered to be potentially resectable in the absence of mediastinal adenopathy and provided that vital structures in the mediastinum, such as the great vessels, heart, and

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The ACR 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.

Jeffrey P. Kanne, MD, is a consultant to PTC Therapeutics.
Variant 1. Non–small-cell lung carcinoma

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>Relative Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT chest without contrast</td>
<td>9</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
<tr>
<td>CT chest with contrast</td>
<td>9</td>
<td>Through adrenal glands. See text. There are pros and cons to the use of IV contrast. There is no strong scientific evidence to support the use of IV contrast.</td>
<td></td>
</tr>
<tr>
<td>FDG-PET/CT skull base to mid-thigh</td>
<td>9</td>
<td>If a diagnostic chest CT has not yet been performed, obtain FDG-PET skull base to mid-thigh and CT chest with or without contrast. Can omit for staging pure ground-glass neoplasms.</td>
<td></td>
</tr>
<tr>
<td>MRI head without and with contrast</td>
<td>7</td>
<td>If neurological symptoms are present or asymptomatic with adenocarcinoma histology greater than 3 cm in size or mediastinal adenopathy. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td></td>
</tr>
<tr>
<td>MRI head without contrast</td>
<td>5</td>
<td>May be useful as a baseline comparison to help detect complications of therapy and other non–tumor related disease in follow-up.</td>
<td></td>
</tr>
<tr>
<td>X-ray chest</td>
<td>5</td>
<td>可能有用作为基线比较来帮助检测并发症的治疗和其他非肿瘤相关的疾病在随访中。</td>
<td></td>
</tr>
<tr>
<td>CT abdomen with contrast</td>
<td>5</td>
<td>If MRI is contraindicated and neurological symptoms are present.</td>
<td></td>
</tr>
<tr>
<td>CT head with contrast</td>
<td>5</td>
<td>No necessary if PET has been done.</td>
<td></td>
</tr>
<tr>
<td>Tc-99m bone scan whole body</td>
<td>5</td>
<td>Not necessary if PET has been done.</td>
<td></td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>3</td>
<td>Useful for evaluating chest wall invasion, cardiac invasion, and for local staging of superior sulcus tumors.</td>
<td></td>
</tr>
<tr>
<td>MRI chest without and with contrast</td>
<td>3</td>
<td>Useful for evaluating chest wall invasion, cardiac invasion, and for local staging of superior sulcus tumors. If gadolinium contraindicated.</td>
<td></td>
</tr>
<tr>
<td>MRI chest without contrast</td>
<td>2</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen without contrast</td>
<td>1</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen without and with contrast</td>
<td>1</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>1</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
<tr>
<td>CT chest without and with contrast</td>
<td>1</td>
<td>Through adrenal glands.</td>
<td></td>
</tr>
</tbody>
</table>

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate. FDG = fluorine-18-2-fluoro-2-deoxy-D-glucose.

A number of imaging modalities have been used in staging lung cancer (see Variants 1 and 2). These have included standard and conventional tomography, as well as CT, MRI, and fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) PET. In all cases, histologic confirmation of the tumor is mandatory, and in most cases, the histologic proof should be confirmed for the lesion that established the highest stage of disease (an exception would be clear-cut evidence of multiple sites of metastatic disease). Any potential solitary metastatic lesion must be confirmed histologically prior to deeming a patient unresectable.

Chest Radiographs. The vast majority of primary lung cancers are initially detected on routine chest radiographs; however, there is little need for a chest radiograph when a tumor has been detected incidentally on CT examination performed for other purposes.

CT. CT is the major imaging modality of choice in the initial evaluation of patients with suspected bronchogenic carcinoma. Numerous studies have shown that its value in staging is limited, because there are no morphologic criteria that would allow distinction between benign and malignant lymph nodes, but it does provide the anatomic basis to determine the most appropriate steps for diagnosis and management.
Traditionally, chest CT for staging of lung cancer is extended into the abdomen to include the adrenal glands. Whether this extension requires intravenous contrast material is debatable and has not been definitively addressed. For some, the addition of contrast improves evaluation of the mediastinum. Although it would appear advantageous to have contrast enhancement of the liver, it is rarely the sole site of disease at diagnosis and is often visible with liver windows. At the same time, unenhanced CT has the advantage of definitively characterizing incidental adrenal nodules. Much of this debate has been rendered moot by the use of FDG-PET/CT, and thus the use of intravenous contrast material is debatable and has not been definitively addressed.

**Evaluation of Primary Tumor (the T Factor)**

**CT.** The distinction between T1 and T2 lesions is generally based on size and rarely affects the choice of therapy. Imaging cannot reliably determine the presence of visceral pleural invasion for peripheral tumors. Confirming T3 or T4 status based on imaging alone, however, can be quite difficult. Features such as discrete bone destruction, rib erosion, or tumor adjacent to a mediastinal structure without associated fat plane are diagnostic of chest wall or mediastinal invasion. CT features of chest wall invasion include: >3 cm of contact with the pleural surface, pleural thickening, absent fat planes, and obtuse angle of tumor with the chest wall [3]. The specificity of any of these signs is relatively poor, as pleural reaction and inflammation may mimic neoplastic involvement, and localized chest pain remains a much more specific determinant of invasion [3-5]. Using thin collimation with coronal and sagittal reformations improves accuracy for both chest wall and mediastinal invasion [6]. In the absence of definitive signs of invasion, surgery may be necessary to confirm or exclude direct invasion.

**MRI.** MRI can aid in problem solving and is superior to CT for detecting involvement of the neural foramina, spinal canal, and brachial plexus in superior sulcus tumors. Surgery is contraindicated by local extension if the brachial plexus is involved above the level of T1, if more than 50% of a vertebral body is invaded, or if there is invasion of the trachea or esophagus. Invasion of the subclavian, common carotid, and vertebral arteries, less than 50% vertebral body invasion, and extension into the neural foramina should be considered relative contraindications to surgery [7]. MRI can be useful in excluding chest wall involvement. When using cine MRI during free breathing, a finding of sliding between the tumor and mediastinum or chest wall has been shown to be diagnostic of lack of invasion. The converse, however, is not necessarily indicative of invasion, as adherence and local inflammatory changes may also restrict tumor motion [8-10].

**Evaluation of Nodal Metastasis (the N Factor)**

**CT.** Because size is the main criteria for malignancy, CT is a rather inaccurate modality for staging the mediastinum. A lymph node >1 cm in short-axis diameter is generally considered “positive” [11]. Although no lower threshold guarantees freedom from disease,
overall chance that a node harbors malignancy is influenced by size. For example, the prevalence of metastatic disease in lymph nodes is approximately 30% for nodes 10-15 mm in diameter, and 67% for nodes >15 mm in diameter [12]. Among 43 studies conducted from 1991 to 2005, the sensitivities of CT for nodal disease ranged from 26% to 86%, and specificity ranged from 31% to 97%; a pooled sensitivity and specificity from a total of 5,111 patients in whom the prevalence of nodal disease was 28% were 51% and 86%, respectively [13]. CT does, however, provide anatomic relationships critical for interpreting FDG-PET studies and allows for selection of the most appropriate pathway for biopsy.

The location of the primary tumor has a strong and relatively predictable influence on the likely location of metastatic nodes. Right upper-lobe tumors most often drain to right paratracheal nodes (2R and 4R), whereas right, middle, and lower lobe tumors most frequently drain to lower right paratracheal and subcarinal nodes (4R and 7R). On the left, the common sites for nodal metastases for the left upper lobe include the aortopulmonary window and prevascular nodes (5L and 6L) and prevascular and subcarinal (6L and 7L) for the left lower lobe [14]. For lower lobe tumors, the frequency of upper mediastinal lymph node involvement (levels 2, 4, 5, and 6) is greater for tumors in the superior segment (64%) versus basal segments (36%) [15].

The preoperative detection of N2 disease generally renders a patient unsuitable for primary surgery treatment. Depending on the extent of N2 disease and other factors, patients may receive either neoadjuvant therapy in an attempt to clear the mediastinal disease prior to surgery or primary chemotheraphy and radiation therapy with curative intent. The choice should be guided by histologic confirmation, and an enlarged mediastinal lymph node alone by CT is insufficient to make a patient inoperable. Although FDG-PET/CT is becoming the mainstay of preoperative staging (discussed later), if it is not performed and a negative CT alone is used, up to 30% of patients will eventually be shown to have positive mediastinal lymph nodes [16,17].

**MRI.** MRI is not typically used for mediastinal staging, although abnormal lymph nodes can be detected using this technique. A lack of standardization of protocols, however, makes comparison of results difficult. Most protocols use a short-tau inversion recovery (STIR) sequence, and with it, MRI may approach the accuracy of FDG-PET/CT for detecting nodal metastases [18]. In another study, quantitative analysis of STIR images using a lymph node saline ratio was found to be more sensitive and specific compared to PET/CT [19]. Studies using diffusion-weighted sequences have mixed results [20,21]. Overall, the number of studies and subjects is too small to determine if MRI has any relevant role in mediastinal staging.

**PET/CT.** Integrated FDG-PET/CT imaging outperforms CT alone, FDG-PET alone, conventional visual correlation, or superimposition of CT and FDG-PET acquired individually [22-25]. Pooling all FDG-PET studies (many without the CT component) resulted in a sensitivity of 74% and a specificity of 85% in 2,865 patients with a prevalence of mediastinal disease of 29% [13]. In particular, specificity may be further degraded in areas endemic for granulomatous disease [26]. Even when the results of CT and FDG-PET are negative, the false negative rate in the mediastinum ranges from 8% to 16% [27,28]. Much of the large variance in studies is due to the lack of a reproducible cut-off for benign and malignant nodes across studies. Sensitivity is often enhanced when qualitative evaluation is used, whereas it tends to suffer when quantitative measures are used.

For lung neoplasms presenting as a pure ground-glass nodule, adding FDG-PET/CT to the staging evaluation does not seem to create additional benefit. For part-solid nodules, the value of FDG-PET/CT is generally related to the size of the solid core and is suggested for part-solid nodules ≥8 mm [29]. In a recent study of part solid nodules with >50% ground-glass component, no true positive mediastinal nodes or distant disease was detected by FDG-PET/CT [30]. Further research is needed to determine whether the indication for FDG-PET/CT staging should be based on percentage of ground glass or absolute diameter of the solid core.

Although FDG-PET is not an endpoint in the staging workup, FDG-PET scans can decrease the number of futile thoracotomies by 20% [31-33]. The PLUS study [33] randomized stage I-III patients who were potentially operable to FDG-PET or no PET and showed a reduction in the “futile” thoracotomy rate (thoracotomy performed in patients with unresectable disease) by 20% (41% without FDG-PET versus 21% with FDG-PET). This finding was confirmed in the randomized controlled trial by Fischer et al [31], in which the addition of FDG-PET/CT to conventional staging reduced the rate of futile thoracotomies by 17% (52% without FDG-PET/CT compared to 35% with FDG-PET/CT). However, for clinical IA patients, the yield of FDG-PET in preventing nontherapeutic pulmonary resection appears to be <10% [34]. Thus, the ultimate success of FDG-PET in the mediastinum may be to spare advanced-stage patients extensive surgery.

It is clear that FDG-PET must be interpreted in the context of CT findings to maximize utility. The value of FDG-PET in staging the mediastinum depends on the CT findings [35,36]. If the CT scan was positive by CT criteria, sensitivity increased to 100%, and specificity decreased to 78%. In the setting of a negative CT scan, FDG-PET showed 82% sensitivity and 93% specificity [35]. Modeling for size in combination with FDG-PET, the likelihood of malignancy in an FDG-PET negative node is 5% when it is 10-15 mm in diameter, and 21% when it is >15 mm in diameter. Conversely, the
likelihood of malignancy in an FDG-PET positive node is 62% when it is 10-15 mm in diameter and 90% when it is >15 mm in diameter [12]. Moreover, the use of FDG-PET combined with CT can be critical in defining the most appropriate site for hilar and mediastinal lymph node biopsy.

For the FDG-PET negative mediastinum, several caveats can guide the decision about whether further mediastinal staging is necessary. A retrospective study of FDG-PET false negative results found that occult metastases were more likely to occur with increasing T-stage, central tumors, adenocarcinoma histology, and higher primary tumor standard uptake volume (SUV; >6), although the actual number of false negative lymph nodes in this study was small (n=16) [37]. Other groups have found that in addition to these features, upper-lobe tumors and those with N1 positive disease also have a relatively high rate of occult disease in the mediastinum with histologic staging [38,39].

To summarize, an FDG-PET negative mediastinum has an extremely high negative predictive value in small (T1a), peripheral tumors with a low primary tumor SUV and no significant activity in the hilar lymph nodes. Under these conditions, it seems reasonable to proceed to surgery without prior pathological staging of the mediastinum.

**Evaluation of Distant Metastasis (the M Factor)**

**Adrenal Glands.** Adrenal nodules are a common incidental finding in the general population and in patients with lung cancer, but a density measurement of <10 Hounsfield units (HU) virtually assures the diagnosis of benign adenoma [40]. If the measurement is >10 HU, or if the initial study was performed with intravenous contrast, several techniques may be used to potentially rule out benignity. These include evaluating CT washout criteria, CT histogram analysis, MRI with in-phase and out-of-phase imaging, and FDG-PET/CT [41,42]. Although all these techniques can potentially rule in a benign lesion, their specificity is insufficient to rule in malignancy. Thus, when the adrenal is the sole potential site of metastatic disease, biopsy is necessary to confirm its presence.

**Liver.** The liver is rarely the sole site of metastatic disease at the time of diagnosis, occurring in approximately 3% of cases [43]. As most chest CT scans will cover the majority of the liver, dedicated hepatic imaging is generally not indicated. Although FDG-PET has not been formally evaluated for imaging of liver metastasis related to lung cancer, experience in other malignancies suggests that it can accurately detect liver metastases by focal uptake greater than the background of the liver [44]. When findings are discordant or indeterminate, MRI and biopsy are appropriate strategies to evaluate liver lesions.

**Bone.** Although bone scintigraphy is quite sensitive for detecting osseous metastases, the false-positive rate approaches 40%. Because fewer than 5% of lung cancer patients have occult bone metastases at presentation [45], routine bone scintigraphy is probably not warranted. Several studies have shown FDG-PET to have a similar sensitivity and accuracy, with improved specificity and negative predictive value [46-48]. Thus, if whole-body FDG-PET has already been performed, bone scintigraphy should be considered unnecessary.

**Central Nervous System.** In the absence of neurological symptoms, cerebral metastases are unusual, and the routine staging of subjects with a normal clinical examination yields positive findings in less than 10% of patients [49-51]. Of the various histologic subtypes, adenocarcinoma and large-cell carcinoma are most frequently associated with asymptomatic cerebral metastases [52]. Cerebral imaging is therefore used more effectively in patients with neurologic symptoms or prior to resection of T2 tumors or planned resection of IIIA disease.

**Small-Cell Lung Carcinoma**

Small-cell lung carcinoma (SCLC) is an aggressive neoplasm of neuroendocrine cell origin with a distinct biologic behavior and is therefore grouped separately from other primary lung neoplasms. SCLC represents about 15%-25% of all lung cancers and tends to occur in patients younger than those with other lung cancers. SCLC mostly originates in the submucosa of proximal airways such as the lobar bronchi, or main bronchi, and a small percentage (<5%) originate in the peripheral areas of the lung. The tumor itself is highly cellular and has a limited fibrotic or inflammatory response. Consequently, the tumor spreads rapidly through the lymphatics and blood vessels at an early stage, resulting in early nodal and distant metastatic deposits [53,54]. From a practical standpoint, SCLC may be thought of as a “systemic” disease at the time of diagnosis.

Historically, SCLC was stratified by a 2-stage system as defined by the IASLC. The first stage included patients with the disease restricted to one hemithorax with regional lymph node metastases, including ipsilateral hilar, ipsilateral and contralateral mediastinal, ipsilateral and contralateral supraclavicular, and ipsilateral pleural effusion independent of cytology [55]. The second stage comprised patients with more extensive disease. The practical effect of this was to divide patients into one of two treatment groups: chemotherapy and radiotherapy for limited disease, and chemotherapy alone for extensive disease. Based on further analysis of resected small-cell carcinomas, the IASLC has found sufficient prognostic variability using the TNM system to warrant replacing the previous staging system [56]. For surgically resected SCLC (n=349), there is a marked survival enhancement
The overall 5-year survival rate for all surgically resected lesions is 57%. Because of this high frequency, a dedicated CT of the abdomen with contrast should also be obtained as part of routine staging. CT of the chest and abdomen, FDG-PET, and imaging of the central nervous system, preferably with MRI, is appropriate, particularly for single-site suspected nodal or extra-thoracic disease.

### Summary
- For non–small-cell lung cancer, minimum staging should include a CT scan of the thorax and FDG-PET.
- Imaging of the central nervous system should be performed in symptomatic and high-risk cases of non–small-cell lung cancer.
- For small-cell lung cancer, staging should consist of CT of the chest and abdomen, FDG-PET, and imaging of the central nervous system, preferably with MRI.
- Histologic confirmation of the highest radiologic stage is appropriate, particularly for single-site suspected nodal or extra-thoracic disease.

### Anticipated Exceptions
Nephrogenic systemic fibrosis is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It seems to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (ie, <30 mL/min/1.73m²), and almost never in other patients. The literature regarding this disorder is growing. Although some controversy and lack of clarity remain, consensus has been reached that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients, unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated glomerular filtration rates <30 mL/min/1.73m2. For more information, please see the ACR Manual on Contrast Media.

### Relative Radiation Level Information
Potential adverse health effects of radiation exposure are important to consider when selecting the appropriate imaging procedure. Because a wide range of radiation exposures are 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, both because of 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 compared with those specified for adults (see Table 1). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria. For additional information on ACR Appropriateness Criteria, refer to www.acr.org/ac.

### Table 1. Relative Radiation Level Designations

<table>
<thead>
<tr>
<th>Relative Radiation Level</th>
<th>Relative Dose Estimate Range(mSv)</th>
<th>Adult Effective Dose Estimate Range (mSv)</th>
<th>Pediatric Effective Dose Estimate Range (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0.1-1</td>
<td>0.03-0.3</td>
<td>0.03-0.3</td>
</tr>
<tr>
<td>2</td>
<td>1-10</td>
<td>0.3-3</td>
<td>0.3-3</td>
</tr>
<tr>
<td>3</td>
<td>10-30</td>
<td>3-10</td>
<td>3-10</td>
</tr>
<tr>
<td>4</td>
<td>30-100</td>
<td>10-30</td>
<td>10-30</td>
</tr>
</tbody>
</table>

*Relative radiation level 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 levels for these examinations are designated as “Varies.”

(>2 years) for both stage T1a and N0 cases compared with other surgically resected SCLCs [56]. Moreover, the 5-year survival rate for resected stage I tumors is 57%. The overall 5-year survival rate for all surgically resected “limited disease” is 34.5%, compared to the 12%—25% for traditional chemoradiotherapy [53].

CT is generally the first study performed in the evaluation of suspected SCLC on chest radiograph. The use of intravenous contrast may be helpful in evaluating the extent of disease and the relationship to mediastinal vascular structures. Although this will not necessarily change the staging, it may help determine the need for palliative radiation therapy in patients with distant metastatic disease. When metastatic disease is present, abdominal organs are involved in up to 60% of cases, with the adrenal gland and liver being the most frequent sites of disease [57,58]. Because of this high frequency, a dedicated CT of the abdomen with contrast should also be obtained as part of routine staging [59].

FDG-PET/CT is often helpful during the staging process. Its main value lies in its ability to upstage patients with extensive disease to stage II and thus spare them from unnecessary therapy. Studies have shown that FDG-PET/CT results in a stage shift of up to 17% of cases [60]. In prospective series, this shift results in approximately 8% of subjects upstaged by the detection of metastatic disease when compared to traditional staging [61,62]. Additionally, detection of additional involved nodes may allow for the appropriate adjustment of the radiation therapy plan in up to 25% of cases [63,64].

Due to the high incidence of brain metastases, routine imaging of the central nervous system is warranted. Cerebral metastases have been said to be present in up to 10% of individuals at the time of diagnosis [65,66]. Bone is considered to be the most common site of metastatic disease overall (35% of cases), and therefore bone scintigraphy has generally been part of the initial staging evaluation [67]. Bone scintigraphy can be omitted from staging when FDG-PET/CT is performed.

Potential adverse health effects of radiation exposure are important to consider when selecting the appropriate imaging procedure. Because a wide range of radiation exposures are 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, both because of 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 compared with those specified for adults (see Table 1). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria. For additional information on ACR Appropriateness Criteria, refer to www.acr.org/ac.
REFERENCES


