Correctly staging lung cancer is extremely important because the treatment options and the prognosis differ significantly by stage. Several noninvasive imaging studies are available to aid in identifying disease both within and outside of the chest. Chest CT scanning is useful in providing anatomic detail that better identifies the location of the tumor, its proximity to local structures, and whether or not lymph nodes in the mediastinum are enlarged. Unfortunately, the accuracy of chest CT scanning in differentiating benign from malignant lymph nodes in the mediastinum is unacceptably low. Whole-body positron emission tomography (PET) scanning provides functional information on tissue activity and has much better sensitivity and specificity than chest CT scanning for staging lung cancer in the mediastinum. In addition, metastatic disease can be detected by PET scan. Still, positive findings of PET scans can occur from nonmalignant etiologies (eg, infections), so that tissue sampling to confirm the suspected malignancy must be performed. The clinical evaluation tool, which is composed of a thorough history and physical examination, remains the best predictor of metastatic disease. If the findings from the clinical evaluation are negative, then imaging studies such as a CT scan of the head, a bone scan, or an abdominal CT scan are unnecessary, and the search for metastatic disease is complete. If signs, symptoms, or findings from the physical examination suggest the presence of malignancy, then sequential imaging, starting with the most appropriate study based on the clues obtained by the clinical evaluation, should be performed. Abnormalities detected by all of the aforementioned imaging studies are not always cancer. Unless overwhelming evidence of metastatic disease is present on an imaging study, in situations in which it will make a difference in treatment, all abnormal scan findings require tissue confirmation of malignancy so that patients are not precluded from having potentially curative surgery.

Key words: CT scan; lung cancer; mediastinum; metastases; noninvasive; positron emission tomography; staging

Abbreviations: CI = confidence interval; FDG = 18F-fluoro-deoxy-D-glucose; NSCLC = non-small cell lung cancer; PET = positron emission tomography; SPECT = single-photon emission CT

After a tissue diagnosis of lung cancer has been established or in patients in whom the clinical suspicion is high and surgery is the recommended next step, consideration must turn to the determination of the extent of disease, or stage, because this will impact directly on the management of the disease and the patient’s prognosis. The most significant dividing line is between those patients who are candidates for surgical resection and those who are inoperable but will benefit from chemotherapy, radiation therapy, or both. Staging with regard to a patient’s potential for surgical resection is most applicable to non-small cell lung cancer (NSCLC), whereas for small cell lung cancer a more simplified staging classification of limited and extensive disease is employed. Except in rare cases of surgically operable, limited-stage, small cell cancer, the implication of staging on the management of small cell lung cancer is between chemotherapy and radiation for limited-stage disease and chemotherapy alone for extensive disease.1

The basis for staging NSCLC is the TNM system.2,3 (See Table 1 for TNM descriptors and Figure 1 for stage grouping.3a) From a practical standpoint, the involvement of disease in the mediastinum,
which is reflected in the N designator in the system, most often determines the appropriateness of the patient for surgical resection. Patients with stage IA, IB, IIA, and IIB disease can benefit from surgical resection. Patients with stage IIIA, IIIB, and IV almost never meet the criteria for surgery. There is currently intense study of surgery for selected patients with stage IIIA disease in conjunction with neoadjuvant chemotherapy and radiotherapy.

Staging can be used to predict survival and to guide the patient toward the most appropriate treatment regimen or clinical trial. Even with clinical stage I, surgically resectable, potentially curable disease, the 5-year survival postsurgery is only 50%. In approximately 60% of patients, cancer recurrence is presumably from extrathoracic micrometastatic involvement at presentation, which is not currently detectable with existing diagnostic modalities. Clinical stage II patients (i.e., T1N1M0 or T2N1M0) have a 5-year survival rate after surgery of 30%. At clinical stage IIIA, the 5-year survival rate is 17%, and at clinical stage IIIB it is only 5%.

Noninvasive Staging of the Mediastinum

Imaging Modalities

Chest Radiograph: The majority of lung cancers are initially detected by plain chest radiographs. In some situations, the plain radiograph may be sufficient to detect spread of the disease to the mediastinum. For example, the presence of bulky lymphadenopathy in the superior or contralateral mediastinal areas may be considered to be adequate evidence of metastatic disease to preclude further imaging evaluation of the chest. This may be particularly true if the patient is too ill or is unwilling to undergo treatment of any kind. It is recommended, however, that tissue confirmation be obtained by the least invasive method possible. A CT scan of the chest should be performed in nearly all cases of lung cancer unless the patient is so debilitated that no further evaluation or treatment is planned. It is widely accepted that the chest radiograph is in general an insensitive measure of mediastinal lymph...
node involvement with lung cancer, and thus further noninvasive and/or invasive assessment is usually necessary.

**CT Scan of the Chest**: In the 1990s, numerous evaluations of CT scanning were performed that compared clinical staging by CT scan to the "gold standard" of mediastinoscopy or surgery. These studies demonstrated that, regardless of threshold size, CT scan findings in isolation could not be considered as conclusive evidence that lymph nodes were malignant. In other words, in all studies there are meaningful numbers of false-positive results that are detected by CT scan.

A CT scan of the chest is the most widely available and most commonly used noninvasive modality for evaluation of the mediastinum in patients with lung cancer. The vast majority of reports evaluating the accuracy of CT scanning for mediastinal lymph node staging have employed the administration of IV contrast material. IV contrast is not absolutely necessary in performing chest CT scans for this indication but is very useful in helping to distinguish vascular structures from lymph nodes as well as in delineating mediastinal invasion by centrally located tumors.

Various CT criteria have been used to define malignant involvement of mediastinal lymph nodes. The most widely used criterion is a short-axis lymph node diameter of ≥ 1 cm on a transverse CT scan. However, numerous other criteria also have been used including the following: (1) a long-axis diameter of ≥ 1 cm; (2) a short-axis diameter of ≥ 1.5 cm; (3) a short-axis diameter of ≥ 2 cm plus evidence of central necrosis or disruption of the capsule; and (4) a short-axis diameter of ≥ 2 cm regardless of

![Figure 1. TNM staging of lung cancer. Reprinted with permission from Lababede et al.](http://www.chestjournal.org/pdfaccess.ashx?url=/data/journals/chest/21988/ on 04/15/2017)
nodal morphology. The reported sensitivity and specificity rates for the identification of malignant involvement will vary depending on which criteria are used in the assessment of individual nodal stations.4,5 The majority of studies evaluating CT scan accuracy have used a short axis of ≥1 cm as the threshold for the definition of abnormal nodes. In doing so, a conscious effort has been made to err on the side of higher sensitivity at the expense of lower specificity in an understandable effort to minimize the number of false-negative evaluations.

The background article in this supplement by Toloza et al describes their study assessing the performance characteristics of noninvasive imaging procedures for staging the mediastinum, based on computerized searches of the medical literature. Twenty-three studies evaluating the accuracy of CT scanning for staging the mediastinum were identified on the basis of the following criteria: (1) publication in a peer-reviewed journal; (2) study size of >50 patients; (3) patient group not included in a subsequent update of the study; (4) histologic or cytologic confirmation of involvement of mediastinal nodes or extrathoracic sites, as well as of the primary tumor; and (5) availability of the raw data (see Table 1 in the article by Toloza et al). The combined studies yielded 4,793 evaluable patients. The pooled sensitivity of CT scanning for staging the mediastinum was 0.60 (95% confidence interval [CI], 0.51 to 0.68), and the pooled specificity for CT scanning was 0.81 (95% CI, 0.74 to 0.86). The overall positive predictive value was 53% (range, 26 to 100%), while the overall negative predictive value was 82% (range, 63 to 85%) [see evidence Table 1 in the article by Toloza et al].

CT scanning is thus an imperfect tool for staging the mediastinum. However, since CT scanning usually guides the choice of nodes for selective node biopsy by mediastinoscopy or needle aspiration, it remains an important diagnostic tool in lung cancer. Accurate noninvasive node staging is essential in that the choice of individual nodes for sampling by nonsurgical invasive techniques, including transbronchial, transthoracic, or transesophageal needle aspiration, will be directed by the findings of the CT scan. The limitation of CT scan-based mediastinal lymph node evaluation is evident in the fact that 5 to 15% of patients with clinical stage T1N0 lesions will be found to have positive lymph node involvement by surgical lymph node sampling.6

Perhaps the most important message in evaluating the accuracy of CT scanning is that approximately 40% of all nodes that are deemed malignant by CT scan criteria are actually benign, depending on the patient population. Specificity can be affected by clinical factors such as the presence of postobstruc-tive pneumonitis.7 There is no node size that can determine reliably the stage and operability of the tumor. In cases in which the CT scan criteria for the identification of a metastatic node are met, the clinician must still prove beyond reasonable doubt by biopsy or resection that the node is indeed malignant. Given the limitations of its imperfect sensitivity and specificity, it is usually inappropriate to rely solely on the CT scan to determine mediastinal lymph node status. Nonetheless, CT scanning continues to play an important and necessary role in the evaluation of patients with lung cancer. This conclusion is supported by the most recent American Thoracic Society/European Respiratory Society statement on the pretreatment evaluation of NSCLC, in which CT scanning was recommended for the evaluation of mediastinal lymph nodes in all patients with suspected NSCLC.

**Recommendations**

1. For patients with either a known or suspected lung cancer who are eligible for treatment, a CT scan of the chest should be performed. Level of evidence, fair; benefit, substantial; grade of evidence, B

2. In patients with enlarged mediastinal lymph nodes seen on CT scans (ie, >1 cm in the short axis), further evaluation of the mediastinum should be performed prior to surgical resection of the primary tumor. Level of evidence, fair; benefit, substantial; grade of evidence, B

**Positron Emission Tomography:** Positron emission tomography (PET) scanning is an imaging modality based on the biological activity of neoplastic cells. Lung cancer cells demonstrate increased cellular uptake of glucose and a higher rate of glycolysis when compared to normal cells.8 The radiolabeled glucose analog 18F-fluoro-deoxy-D-glucose (FDG) undergoes the same cellular uptake as glucose but, after phosphorylation, is not further metabolized and becomes trapped in cells.9 Accumulation of the isotope then can be identified using a PET camera. PET scanning is thus a metabolic imaging technique based on the function of a tissue rather than on its anatomy. The specific criterion for an abnormal PET scan is either a standard uptake value of >2.5 or uptake in the lesion that is greater than the background activity of the mediastinum. It has proved useful in differentiating neoplastic from normal tissues. However, the technique is not infallible as certain nonneoplastic processes, including granulomatous and other inflammatory diseases as well as infections, also may demonstrate positive PET imag-
ing findings. Furthermore, size limitations are also an issue, with the lower limit of resolution of the study being approximately 1 to 1.2 cm, depending on the intensity of uptake of the isotope in abnormal cells.10

A burgeoning number of studies in the last several years have reported on the utility of FDG-PET scanning in the assessment of the mediastinum in patients with lung cancer. Increasing the availability of the technology now allows PET scanning to be used widely as a diagnostic tool. It should be noted that PET scanning is primarily a metabolic examination and has limited anatomic resolution. It is possible by PET scanning to identify lymph node stations but not individual lymph nodes. CT scanning provides much more anatomic detail but lacks the functional information provided by PET scanning. The background article by Toloza et al evaluates the performance characteristics of PET scanning for staging the mediastinum, based on computerized searches of the medical literature. Nineteen studies were identified that met the following criteria: (1) publication in a peer-reviewed journal; (2) study size of >20 patients; (3) patient group not included in a subsequent update of the study; (4) histologic or cytologic confirmation of mediastinal nodes or extrathoracic sites, as well as the primary tumor; and (5) availability of the raw data. All of these studies were interpreted in conjunction with the findings of patients’ CT scans so that correlation of the findings on PET scanning was put in context with the anatomic location of the lesion on the CT scan. In all studies, FDG was the radiopharmaceutical that was used for imaging. The combined studies yielded 1,111 evaluable patients. The pooled sensitivity was 0.85 (95% CI, 0.79 to 0.89), and the pooled specificity was 0.88 (95% CI, 0.82 to 0.92). The overall positive predictive value was 0.78 (range, 0.40 to 1.00), and the negative predictive value was 0.93 (range, 0.75 to 1.00) [see evidence Table 2 in background article by Toloza et al].

Thus, it appears that PET scanning has both higher sensitivity and specificity for the evaluation of mediastinal lymph nodes than does CT scanning. This imaging technique will almost certainly assume an increasingly important role in the evaluation of patients with lung cancer. However, like CT scanning, PET scanning is also imperfect. While a negative result of a mediastinal PET scan may obviate the need for mediastinoscopy prior to thoracotomy, a positive result of a mediastinal PET scan should not negate further evaluation or the possibility of resection. In the latter case, mediastinoscopy or lymph node sampling still should be pursued, as the possibility of a false-positive PET scan result cannot be ignored.

**Recommendations**

3. For patients who are candidates for surgery, where available, a whole-body FDG-PET scan is recommended to evaluate the mediastinum. Level of evidence, fair; benefit, substantial; grade of evidence, B

4. In patients with abnormal FDG-PET scan findings, further evaluation of the mediastinum with sampling of the abnormal lymph node should be performed prior to surgical resection of the primary tumor. Level of evidence, fair; benefit, substantial; grade of evidence, B

**Other Imaging Modalities:** In many places, the clinical utility of FDG-PET scanning is limited because of the lack of availability of a PET camera or the radiopharmaceutical FDG. There is a growing interest in other noninvasive nuclear imaging techniques that also take advantage of altered biological characteristics of malignant tissues. One such technique is based on the increased avidity with which various neoplasms bind somatostatin. Such tissues also will bind somatostatin peptide analogs such as depreotide or octreotide, which, when complexed with radionuclides such as ⁹⁹ᵐTc, can be imaged by single-photon emission CT (SPECT) scanning. SPECT technology is widely available and less expensive than PET scanning. Initial results suggest that the sensitivity and specificity of SPECT scanning with ⁹⁹ᵐTc depreotide (NeoTect; Berlex Imaging; Montville, NJ) may be comparable to those of FDG-PET scanning. Preliminary results also suggest that other radiopharmaceutical agents may be of potential use with SPECT scanning in the identification of malignant neoplasms. However, experience with SPECT imaging for lung cancer is still very limited, and thus SPECT scanning should not be considered as an alternative to FDG-PET scanning.

**MRI:** Like CT scanning, MRI is an anatomic study. Experience evaluating MRI in the detection of mediastinal lymph nodes in patients with lung cancer is minimal. Thus, a comparison of the test characteristics between MRI and CT scanning cannot be performed. Two reports also suggest that the use of contrast enhancement may improve the accuracy of MRI in the evaluation of mediastinal lymph nodes. However, most centers continue to rely on CT scanning as the noninvasive anatomic study of choice for evaluating the potential mediastinal spread of lung cancer. MRI can be useful in evaluating superior sulcus tumors, especially with regard to possible invasion of the brachial plexus, and for vertebral invasion.

www.chestjournal.org
Recommendation

5. For patients with either a known or suspected lung cancer who are eligible for treatment, an MRI examination of the chest should not be performed for staging the mediastinum but should be performed in patients with NSCLC involving the superior sulcus to evaluate the brachial plexus or for vertebral body invasion.

Level of evidence, fair; benefit, substantial; grade of evidence, B

The Search for Metastatic Disease

This section should reinforce the concept that the clinician should only search for metastatic disease if there is a compelling reason to do so. The purpose of extrathoracic scanning in patients with NSCLC is usually to detect metastatic disease at common metastatic sites such as the adrenal glands, liver, brain, and skeletal system, thereby sparing the patient fruitless surgical intervention.21 The preferred scans for staging patients with NSCLC in 2002 are a CT scan of the chest, a CT scan or MRI with contrast of the brain, and 99mTc nuclear imaging of the skeletal system. The use of whole-body PET scans for extrathoracic staging is just beginning, and initial studies22–24 suggest that PET scanning can disclose non-CNS metastatic disease that has not been detected by standard methods in 10 to 20% of cases.

It is well-established that abnormal symptoms, physical findings, and routine blood test results in the initial clinical evaluation of patients with NSCLC are associated with a significant yield (around 50%) of abnormal scan findings.21 Moreover, a rough semiquantitative relationship has been demonstrated in some studies between the number of abnormal “clinical factors” and the frequency of abnormal scan results.21,25 On the other hand, in the absence of all clinical factors, the scan yield is much lower, giving rise to the recommendation that scans be omitted in this setting.25–31 Other important variables focus on the primary lesion, since more scan abnormalities are associated with advanced thoracic lesions (ie, T and N factors).32,33 This is particularly true for stage N2 disease in which asymptomatic metastases have been documented at a higher rate than would have been expected.33 There has been some controversy with regard to cell type and the incidence of asymptomatic metastases. Several studies have documented a higher incidence of brain metastases with adenocarcinomas as opposed to squamous cell cancers,34,35 but the largest single series of patients with stage I and II lung cancer found no difference.30

Several important caveats must be mentioned at the outset. First is the issue of false-positive scan findings. Clinical entities that frequently give rise to false-positive scan findings include adrenal adenomas (present in 2 to 9% of the general population), hepatic cysts, degenerative joint disease, old fractures, and a variety of nonmetastatic space-taking brain lesions. When clinically indicated, additional imaging studies and/or biopsies are performed to establish the diagnosis, but the complications and costs resulting from such subsequent investigations have received insufficient attention.36 A second problem is that of false-negative scan findings, that is, cases in which metastases are present but are not picked up by current scanning techniques. This was demonstrated convincingly by Pagani,37 who found metastatic NSCLC in 12% of radiologically normal adrenal glands by percutaneous biopsy. A third difficulty is that most studies fail to carefully specify exactly which elements comprise the prescan clinical evaluation or use differing clinical indicators. Organ-specific findings such as headache and nonorgan-specific complaints such as weight loss are both important.25,38 The current preferred “expanded” clinical evaluation includes evaluation of organ-specific and constitutional signs and symptoms, along with the performance of simple laboratory tests (Table 2).21 Furthermore, Guyatt et al39 have shown that careful delineation and quantification of historical features using a 5-point scale of severity can importantly affect the subsequent scan yield and ultimately the incidence of metastases after lung cancer surgery. A fourth issue is an ascertainment problem, since abnormal scan findings in many studies were not followed up with definitive biopsy proof of metastatic disease. This may relate to anatomic factors, the overall debility or refusal of the patient, or a variety of other cogent clinical concerns. Fifth, it must be noted that even biopsy proof of metastatic disease does not dictate a certain clinical management pathway. Carefully selected patients with localized lung cancers in the thorax, accessible solitary metastases to the brain or adrenal glands, and other favorable clinical features may obtain long-term survival with an aggressive treatment approach, including surgical extirpation of both the primary and metastatic site.40,41 Finally, the lack of prospective randomized trials and outcome studies in the area of extrathoracic scanning is striking. One retrospective study42 showed that scanning asymptomatic patients with early-stage NSCLC did not help to predict recurrences postoperatively or to improve survival. The only prospective randomized trial43 showed no statistical difference in recurrence rates or survival in a group randomized to bone scintigraphy and CT scanning of the head, liver, and adrenal glands compared with a group assigned to
CT scanning of the chest and mediastinoscopy, followed by thoracotomy when appropriate.

Specific Considerations

Adrenal and Hepatic Imaging: It is relatively common to encounter adrenal masses on routine CT scans, but many of these lesions are probably unrelated to the malignant process. Until now, partial liver imaging and inclusion of the adrenal glands on chest CT scans have been routine. The calculated summary estimate for the negative predictive value of the clinical evaluation is 95% (95% CI, 93 to 96%), if CT imaging of the adrenal glands and liver is employed to attempt to disclose occult metastases (see evidence Table 5 in the background article by Toloza et al). A unilateral adrenal mass in a patient with NSCLC is more likely to be a metastasis than a benign lesion according to some studies, but not others. In the presence of clinical stage T1N0 NSCLC, adenomas predominate, whereas adrenal metastases are frequently associated with large intrathoracic tumors or other extrathoracic metastases. Many studies have suggested that the size of a unilateral adrenal abnormality as seen on a CT scan is an important predictor of metastatic spread, but this is not a universal finding. Lesions that are > 3 cm in size are more likely to signify metastases, but benign disease is still possible. Four possible approaches to distinguishing between malignant and benign processes have been proposed, as follows: evaluation by CT scan or MRI criteria; evaluation with subsequent imaging; evaluation by percutaneous biopsy; and evaluation by adrenalectomy. Well-defined, low-attenuation (fatty) lesions with a smooth rim on unenhanced CT scans are more likely to be benign adenomas, but the CT scan appearance of many lesions is insufficiently distinctive. Follow-up scanning with repeat CT scans, serial ultrasounds, or MRI (especially with chemical shift and dynamic gadolinium-enhanced techniques), or 131-iodomethylodoholesterol scanning can sometimes help with the critical distinction between metastatic disease and adenoma. Percutaneous adrenal biopsy is a relatively safe and effective means of achieving a definitive diagnosis in doubtful cases and is especially important when the histology of the adrenal mass will dictate subsequent management. However, this procedure may be nondiagnostic or unfeasible due to anatomic constraints. When insufficient material results from a biopsy, repeat aspiration or even the performance of an adrenalectomy should be considered.

Most liver lesions are benign cysts and hemangiomas, but contrast CT scanning (or ultrasound) often is required to establish a likely diagnosis. A percutaneous biopsy can be performed when diagnostic certainty is required. One meta-analysis that specifically reviewed hepatic studies derived a pooled yield of 3% for liver metastases in asymptomatic patients with NSCLC.

Brain Imaging: In most studies, the yield of CT scanning/MRI of the brain in NSCLC patients with negative clinical examination results is 0 to 10%, possibly rendering the test cost-ineffective. The calculated summary estimate of the negative predictive value in this setting is 95% (range, 91 to 96%) [see evidence Table 4 in the background article by Toloza et al].

An association of positive findings between brain metastases with stage N2 disease in the chest and the presence of adenocarcinoma has been described. The false-negative rate wherein patients return with brain metastases within 12 months of the original scan is reported to be 3%. False-positive scan results can be a problem in up to 11% of patients due to brain abscesses, gliomas, and other lesions. Therefore, biopsy may be essential in patients in whom disease management is critically dependent on the histology of the brain lesion.

MRI is more sensitive than CT scanning of the

---

Table 2—Clinical Findings Suggesting Metastatic Disease*

<table>
<thead>
<tr>
<th>Testing</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms elicited in history</td>
<td>Constitutional: weight loss &gt;10 lb</td>
</tr>
<tr>
<td></td>
<td>Musculoskeletal: focal skeletal pain</td>
</tr>
<tr>
<td></td>
<td>Neurologic: headaches, syncope, seizures, extremity weakness, recent change in mental status</td>
</tr>
<tr>
<td>Signs found on physical examination</td>
<td>Lymphadenopathy (&gt;1 cm)</td>
</tr>
<tr>
<td></td>
<td>Hoarseness, superior vena cava syndrome</td>
</tr>
<tr>
<td></td>
<td>Bone tenderness</td>
</tr>
<tr>
<td></td>
<td>Hepatomegaly (&gt;13-cm span)</td>
</tr>
<tr>
<td></td>
<td>Focal neurologic signs, papilledema</td>
</tr>
<tr>
<td></td>
<td>Soft-tissue mass</td>
</tr>
<tr>
<td>Routine laboratory tests</td>
<td>Hematocrit, &lt;40% in men and 35% in women</td>
</tr>
<tr>
<td></td>
<td>Elevated alkaline phosphatase, GGT, SGOT, and calcium levels</td>
</tr>
</tbody>
</table>

*GGT = gamma-glutamyltransferase; SGOT = serum glutamic-oxaloacetic transaminase.
brain and picks up more lesions and smaller lesions, but in some studies this has not translated into a clinically meaningful difference in terms of survival. While studies show that MRI can identify additional lesions in patients with metastases, there are no studies showing that MRI is able to identify more patients with metastases from lung cancer compared to CT scanning. Therefore, CT scanning is an acceptable modality for evaluating patients for metastatic disease. If the primary lesion is more advanced than stage T1N0M0, MRI with contrast can identify asymptomatic, verifiable metastases to the brain in 22% of patients with NSCLC and surgically resectable thoracic disease. However, the use of routine MRI in staging NSCLC patients with negative clinical evaluations has not been studied adequately to date.

**Bone Imaging:** The problem of false-positive scan abnormalities in radionuclide bone scintigraphy is particularly nettlesome, owing to the frequency of degenerative and traumatic skeletal damage and the difficulty in obtaining a definitive diagnosis via follow-up imaging or biopsy. False-positive bone imaging also occurs with MRI, which may be no more accurate than nuclear bone imaging. The calculated summary estimate of the negative predictive value in this setting is 90% (95% CI, 86 to 93%) for radionuclide bone imaging with a negative clinical assessment (see evidence Table 6 in the background article by Toloza et al.). The relatively high frequency of unsuspected positive scan results has led some to recommend routine bone scanning in all preoperative patients. Unfortunately, not all patients had biopsy-proven metastatic disease, and thus false-positive scan results may have accounted for some of the abnormalities. False-negative scan results also can be a problem, and in one series 6% of patients with initially negative bone scan findings developed skeletal metastases within 1 year.

In summary, the noninvasive clinical staging of lung cancer relies on the clinical evaluation and a number of readily available staging studies. The clinician must be wary of abnormal scan results that may falsely suggest metastatic disease to the mediastinum and distant sites. Tissue confirmation by whatever means necessary is the rule rather than the exception prior to deciding on the correct stage and the most appropriate treatment.

**Recommendations**

6. For patients with either a known or suspected lung cancer, a thorough clinical evaluation similar to that listed in Table 2 should be performed. Level of evidence, good; benefit, substantial; grade of evidence, A

7. Patients with abnormal clinical evaluations should undergo imaging for extrathoracic metastases. Site-specific symptoms warrant directed evaluation of that site with the most appropriate study (eg, head CT scan, bone scan, or abdominal CT scan). Level of evidence, good; benefit, substantial; grade of evidence, A

8. Patients with clinical stage I or II lung cancer and normal results of a clinical evaluation require no further imaging for detection of extrathoracic disease. Level of evidence, good; benefit, substantial; grade of evidence, A

9. Patients with stage IIIA and IIIB disease should have routine imaging studies for the detection of extrathoracic metastases (eg, head CT scan, bone scan, and abdominal CT scan). Level of evidence, poor; benefit, substantial; grade of evidence, C

10. Patients with abnormal imaging study results should not be excluded from potentially curative surgery without tissue confirmation or overwhelming clinical and radiographic evidence of metastases. Level of evidence, good; benefit, substantial; grade of evidence, A

**Summary of Recommendations**

1. For patients with either a known or suspected lung cancer who are eligible for treatment, a CT scan of the chest should be performed. Level of evidence, fair; benefit, substantial; grade of evidence, B

2. In patients with enlarged mediastinal lymph nodes on CT scans (<1 cm on the short axis), further evaluation of the mediastinum should be performed prior to surgical resection of the primary tumor. Level of evidence, fair; benefit, substantial; grade of evidence, B

3. For patients who are operative candidates, where available, a whole-body FDG-PET scan is recommended to evaluate the mediastinum. Level of evidence, fair; benefit, substantial; grade of evidence, B

4. In patients with abnormal results of FDG-PET scanning, further evaluation of the mediastinum with sampling of the abnormal lymph node should be performed prior to surgical resection of the primary tumor. Level of evidence, fair; benefit, substantial; grade of evidence, B

5. For patients with either a known or suspected lung cancer who are eligible for treatment, an MRI of the chest should not be performed for staging the mediastinum but should be performed in patients with NSCLC involving the
superior sulcus for evaluation of the brachial plexus or for evaluation of vertebral body invasion. Level of evidence, fair; benefit, substantial; grade of evidence, B.

6. For patients with either a known or suspected lung cancer, a thorough clinical evaluation similar to that listed in Table 2 should be performed. Level of evidence, good; benefit, substantial; grade of evidence, A.

7. Patients with abnormal clinical evaluations should undergo imaging for extrathoracic metastases. Site-specific symptoms warrant directed evaluation of that site with the most appropriate study (e.g., head CT scan, bone scan, and abdominal CT scan). Level of evidence, good; benefit, substantial; grade of evidence, A.

8. Patients with clinical stage I or II lung cancer and a normal clinical evaluation require no further imaging for extrathoracic disease. Level of evidence, good; benefit, substantial; grade of evidence, A.

9. Patients with stage IIIA and IIIB disease should have routine imaging for the detection of extrathoracic metastases (e.g., head CT scan, bone scan, and abdominal CT scan). Level of evidence, poor; benefit, substantial; grade of evidence, C.

10. Patients with abnormal imaging study results should not be excluded from potentially curative surgery without tissue confirmation or overwhelming clinical and radiographic evidence of metastases. Level of evidence, good; benefit, substantial; grade of evidence, A.

REFERENCES


associated with the diagnosis and staging of non-small-cell lung cancer. Jpn Thorac Cardiovasc Surg 2001; 49:1–10
64 Ferrigno D, Buccheri G. Cranial computed tomography as a part of the initial staging procedures for patients with non-small cell lung cancer. Chest 1994; 106:1025–1029