The Usefulness of Positron Emission Tomography in Evaluating Patients for Pulmonary Malignancies*

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Study objective: Positron emission tomography (PET) can contribute to diagnosing and staging lung cancer, but it has not been determined whether this information influences patient care. Design: We reviewed the effects of thoracic PET scan results during an 11-month period. For each patient, physicians ordering these scans reported how PET specifically altered management, and graded the ease of interpretation and overall usefulness of PET on a 5-point scale. In addition, to appraise general attitudes about PET, we surveyed 488 national American Thoracic Society (ATS) members and 44 physicians at our comprehensive cancer center.

Results: One hundred twenty-six questionnaires regarding patients were mailed to 37 ordering physicians, and 98 responses (78%) were returned, primarily by cardiothoracic surgeons (35%) and pulmonologists (47%). Respondents reported that PET provided new information in 83 patients (85%) and altered patient management in 64 cases (65%). Major effects on management included decisions regarding biopsy (n = 16), surgery (n = 16), and palliative treatment (n = 16). Chest clinicians found PET to be more helpful (4.4 vs 3.9, p = 0.007) and easier to interpret (4.2 vs 3.7, p = 0.025) than other specialists. Among 139 ATS members (28%) responding to the general survey, 51 members (39%) had access to PET. PET was more frequently available to university-based (49%) than community-based (27%) physicians (p = 0.016). The majority of physicians without current access to PET (69%) indicated that they would like to have it available. ATS members with access to PET reported that PET results generally affect decisions regarding biopsy or surgery most often, but found the procedure less helpful than physicians at our center (2.77 vs 3.56, p = 0.003) and ordered it less often for lung cancer staging (60% vs 96%, p = 0.002).

Conclusion: PET scanning is useful in the management of patients with suspected thoracic malignancies, but impressions about its roles vary, with PET regarded more highly where, as at our center, it is used more often. Whether PET alters patient outcomes requires investigation.

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Key words: attitude of health personnel; biopsy, needle; bronchoscopy; carcinoma, non-small cell lung; lung neoplasms; physician's practice patterns; tomography, emission-computed

Abbreviations: ATS = American Thoracic Society; FDG = 18-flourodeoxyglucose; PET = positron emission tomography; WFUBMC = Wake Forest University Baptist Medical Center

Positron emission tomography (PET) scanning has been applied increasingly to patient care. Recent investigations of PET indicate its overall potential as an excellent tool in diagnosing and staging of patients with thoracic malignancies.1–17 In this setting, using 18-fluorodeoxyglucose (FDG) uptake as an indicator of cancer activity, PET provides anatomic as well as metabolic information, and has been demonstrated to be a sensitive and a specific modality.1–8 In addition, PET has been shown to be superior to CT in evaluating potential chest malignancies and confirming mediastinal disease.1,8–17

Despite its feasibility, increasing availability, and overall promising test performance characteristics, the therapeutic implications of PET scan results in patient management remain to be clarified. Little is known about how chest clinicians use this new technology and whether it influences their ap-
approaches toward patients with lung cancer. To further address these issues, we reviewed the effects of PET scan results on management of patients with lung cancer at our comprehensive cancer center. In addition, we surveyed a random sample of American Thoracic Society (ATS) members about their attitudes and practice habits as they relate to PET.

**Materials and Methods**

We appraised the effects of PET scan results in patients with lung cancer and, in addition, surveyed physicians about their general attitudes regarding this procedure.

**Group I: Patient-Focused Survey Data**

All patients undergoing thoracic PET scans at Wake Forest University Baptist Medical Center (WFUBMC) Comprehensive Cancer Center between April 1, 1998, and February 28, 1999, were identified using a radiology database listing their names and ordering physicians. These physicians were then mailed a survey regarding each patient. The surveys were mailed within an average of 21 days of the PET scan. Physicians were asked to identify their specialty; to indicate the primary reason for ordering the test (diagnosis vs staging of known malignancy); to specify whether new information was provided by the test and the ease of interpretation of the dictated test results (on a 0- to 5-point scale, with 1 being not useful and 5 being very useful); to indicate how the test altered the management of each patient; and to indicate how helpful PET scanning was in managing the specific patient (on a 0- to 5-point scale). In addition, a retrospective review of all available computerized records was performed to appraise coexisting pulmonary diagnoses and type of thoracic malignancy in these patients.

**Group II: General Survey Data**

A second survey regarding general impressions of PET scanning in patient management was developed and faxed to 488 physicians across the United States. These chest clinicians were chosen randomly from the ATS 1998 membership roster. Respondents were asked to identify their specialty, number of years in practice, and type of practice (university-based vs community-based). If PET scans were available to them, they were asked about the relative ease of obtaining studies (on a 0- to 5-point scale, with 0 being never and 5 being always easy); their primary reasons for obtaining them (excluding, diagnosing, or staging lung cancer); how helpful they found this information (on a 0- to 5-point scale, with 0 being never and 5 being very useful); to indicate how the test altered the management of each patient; and to indicate how helpful PET scanning was in managing the specific patient (on a 0- to 5-point scale). In addition, a retrospective review of all available computerized records was performed to appraise coexisting pulmonary diagnoses and type of thoracic malignancy in these patients.

**Statistical Analysis**

One-way analysis of variance was used to compare proportions among groups of respondents. χ² test was used to compare percentages of respondents. A p value < 0.05 was considered to be statistically significant.

**Results**

**Group I: Patient-Focused Survey Data**

We identified 126 patients with suspected or known thoracic malignancies who underwent PET scans at WFUBMC during this 11-month period. Surveys regarding these patients were mailed to 37 ordering physicians and 98 surveys (78%) were returned. Of these 98 PET scans, 46 scans (47%) were ordered by pulmonologists and 34 scans (35%) by cardiothoracic surgeons. Eighteen PET scans were obtained by other subspecialists, including 8 scans (8%) by oncologists, 5 scans (5%) by radiation oncologists, 3 scans (3%) by cardiologists, 1 scan (1%) by a nephrologist, and 1 scan (1%) by a neurosurgeon. Eight physicians (six pulmonologists and two cardiothoracic surgeons) ordered 72% of the 98 PET scans. According to the referring physician, indications for PET scans included 50 for diagnosis of potential lung cancers (56%), 39 for staging known malignancies (45%), and 5 ordered for both of these indications. The remaining four scans were obtained to appraise possible recurrence of disease or follow-up of treatment. Documented coexisting pulmonary disease in 51 patients included 40 cases of COPD, 5 cases of previous lung cancer, 5 cases of asthma, 2 cases of previous pulmonary emboli, 1 case of bronchiectasis, 1 case of previous tuberculosis, and 1 case of allergic bronchopulmonary aspergillosis. Positive pathology report findings were available on 53 patients, which included 45 cases of non-small cell lung cancer, 2 cases of small cell lung cancer, 1 case of carcinoid, 1 case of renal cell, 1 case of metastatic colon cancer, 1 case of neuroendocrine tumor, and 2 unspecified cases of lung cancer. When grading the ease of interpretation of the dictated PET scan results on a 5-point scale (mean ± SD), pulmonologists (4.15 ± 0.97) and cardiothoracic surgeons (4.29 ± 0.75) found it easier (p = 0.05) to interpret these PET reports than other specialists (3.65 ± 1.11).

PET scanning was believed to be very helpful (4.28 ± 0.74) in management of these patients, with pulmonary and cardiothoracic subspecialists finding PET most helpful (Fig 1, 2). Overall, PET scans influenced treatment in 64 patients (65%) and offered new information in 83 patients (85%). The specific influences of PET scan results cited by ordering physicians are summarized in Figure 3. PET scan results influenced decisions regarding biopsy of abnormalities seen at other imaging procedures in several ways. In four patients, positive scans heightened suspicions of lung cancer and prompted clinicians to perform needle biopsies of lung lesions. In six patients, unilateral positive PET findings in patients with bilateral chest radiographic abnormal-
ities or extrathoracic FDG uptake guided selection of the biopsy site. In 11 patients, negative PET scans led clinicians to closely follow some abnormalities when suspicions of malignancy were otherwise low. In 16 patients with strongly positive PET findings, high clinical suspicions of malignancy and what were regarded as prohibitively high risks of biopsy in the setting of severe lung disease, treatment was selected on the basis of PET results, including seven patients where surgery was not recommended, four patients referred for radiation therapy, three patients treated for recurrence, and two patients referred for chemotherapy based on PET findings.

Group II: General Survey Data

Of 488 surveys faxed to ATS members, 139 responses (28%) were returned, including 73 from university-based physicians (53%) and 60 from community-based physicians (43%). Fifty-one respondents (39%) reported that they had access to PET. PET scanning was more frequently available to
university-based physicians (49%) than their community-based counterparts (27%, p = 0.016). Of the 44 WFUBMC surveys, 29 responses (66%) were returned, with two physicians not completing the questionnaire since they do not routinely order PET scans.

Responses to the general survey about PET are summarized in Tables 1, 2. Of the 43 ATS physicians who included their reasons for ordering PET scans, 65% ordered PET for excluding cancer, 60% for staging cancer, and 47% for diagnosing cancer (Table 1). When grading the helpfulness of PET scans on a 5-point scale, those ATS physicians with access to PET overall gave PET a rating of 2.77 ± 1.22 and found it less helpful than physicians at our institution (3.83 ± 0.51, p = 0.001). Of the 44 respondents who listed how PET tended to affect their patient management, the majority used the procedure to influence decisions to proceed with surgery and/or biopsy (Table 2). Of those 71 responding physicians who did not have access to PET, the majority (69%) indicated that they would like to have PET available, including 72% of university-based physicians and 67% of community-based physicians. Practice experience was not a significant factor in whether ATS physicians believed PET was helpful (2.75 ± 1.3 if ≤ 15 years time spent in practice vs 2.79 ± 1.12 if > 15 years) or in how often physicians without access to PET estimated they would use it (1.54 ± 1.17 vs 1.98 ± 1.2).

Of those 27 WFUBMC physicians who order PET scans (4 cardiothoracic surgeons, 6 hematologists/oncologists, 10 pulmonologists, and 7 radiation oncologists), 48% order them for diagnosing and excluding cancer, while 96% order them for staging cancer (p = 0.001 compared with ATS physicians; Table 1). PET influenced the decision to proceed with surgery the most often according to responding WFUBMC physicians, followed by assisting in decision to perform a biopsy and looking for residual disease (Table 2). Overall, WFUBMC physicians rated the general usefulness of PET as 3.83 ± 0.51, with pulmonologists as the subspecialists giving the lowest ranking of 3.3 ± 0.48 vs 3.8 ± 0.47 for other specialists (p = 0.014).

**DISCUSSION**

With the increasing utilization of PET, we assessed effects of this imaging procedure on patient management together with the attitudes and practice behaviors of physicians at our institution and of a national sample of chest clinicians. Despite limitations inherent to such surveys and other selection biases, these data provide important information regarding this technology. Review of specific PET scan findings in individual patients from the patient-based survey showed that not only was new information frequently obtained in patients with suspected lung cancer, but also that this information often had major effects on patient care. These observations were consistent with clinicians’ attitudes regarding

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**Table 1—Primary Indications for the Ordering of PET: General Survey**

<table>
<thead>
<tr>
<th>Reason for Ordering PET</th>
<th>ATS Physicians (n = 43)</th>
<th>WFUBMC Physicians (n = 27)</th>
</tr>
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<tbody>
<tr>
<td>Exclude cancer</td>
<td>28 (65)</td>
<td>13 (48)</td>
</tr>
<tr>
<td>Diagnose cancer</td>
<td>20 (47)</td>
<td>13 (48)</td>
</tr>
<tr>
<td>Stage cancer</td>
<td>26 (60)†</td>
<td>26 (96)†</td>
</tr>
<tr>
<td>Recurrence</td>
<td>1 (2)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Diagnose nodule</td>
<td>2 (5)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

*Data are presented as No. (%).
†p = 0.002.

**Table 2—Impact on Patient Management for Physicians Ordering PET: General Survey**

<table>
<thead>
<tr>
<th>Area of Influence</th>
<th>ATS Physicians (n = 44)</th>
<th>WFUBMC Physicians (n = 26)</th>
</tr>
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<tbody>
<tr>
<td>Proceed with biopsy</td>
<td>28 (64)</td>
<td>15 (58)</td>
</tr>
<tr>
<td>Proceed with surgery</td>
<td>33 (75)</td>
<td>22 (85)</td>
</tr>
<tr>
<td>Choose biopsy site</td>
<td>20 (45)</td>
<td>13 (50)</td>
</tr>
<tr>
<td>Palliative treatment</td>
<td>12 (27)</td>
<td>8 (31)</td>
</tr>
<tr>
<td>Evaluate treatment response</td>
<td>11 (25)</td>
<td>5 (19)</td>
</tr>
<tr>
<td>Follow up residual disease</td>
<td>16 (36)</td>
<td>12 (46)</td>
</tr>
</tbody>
</table>

*Data are presented as No. (%).
PET, not only within our institution but also in a national sample of clinicians from the general survey.

The primary indication for obtaining PET scans in both surveys was for the diagnosis, exclusion, and/or staging of lung cancer. The appeal of using this noninvasive imaging modality for these clinical indications resides in its function as a metabolic as well as anatomic test. Increased uptake in primary lesions increases the likelihood of malignancy and may portend a poorer prognosis. Small, nonpathologically enlarged mediastinal lymph nodes (<1 cm by CT criteria) may have increased FDG uptake indicating micrometastases. Likewise, larger lymph nodes meeting CT size criteria for cancer involvement but not pathologically involved may not demonstrate increased uptake. Combining these two modalities (CT and PET) may more accurately stage lung cancer.

Not surprisingly, in the patient-based survey, most PET scans (82%) at our Comprehensive Cancer Center were ordered by pulmonologists and cardiothoracic surgeons, who found PET scanning to be more useful and PET results easier to interpret than did other clinicians. This is not unexpected, in that those specialists who frequently order and review PET scans are more likely to be familiar with the technology (and its limitations) and thus more comfortable with interpreting the results. Since many physicians refer patients to chest physicians for evaluation of possible thoracic malignancies, and these specialists are the ones who identify surgical candidates and select biopsy sites, it is not surprising that they tended to find PET scanning to be more valuable in patient care. In many instances, chest clinicians may have reviewed PET scan images with CT scans as well as reports, but this process was not evaluated.

Inquiries about specific influences on patient management in the general survey showed that PET scanning was used frequently by both physicians at WFUBMC and ATS chest clinicians to guide decisions on whether to proceed with biopsy or surgery, select biopsy sites, or proceed with palliative treatment and/or conservative follow-up. By taking advantage of the additional metabolic information provided by FDG uptake, physicians can incorporate PET scan results into their clinical determinations about the pretest probability of malignancy and subsequently to determine the need to proceed with biopsy or conservatively follow a lesion. At our institution, PET scanning is used in conjunction with CT scanning to assess for mediastinal disease or metastases toward which transbronchial needle aspiration can be focused during bronchoscopic procedures or other more invasive open techniques. Furthermore, physicians can attempt to maximize their yield from biopsies by concentrating on areas of hypermetabolic activity on PET. We did not appraise our clinicians’ separate views about chest CT in these patients, and it is possible that their very positive impressions about PET reflected its complementary effects on CT findings, and their use of the combination of these data.

PET was not readily available to the majority of national physicians whom we surveyed, particularly those who are community based. Whereas about half of responding university-based chest physicians could obtain PET scans, only 27% of their community-based counterparts had the same opportunity. This difference is probably accounted for by multiple factors. These would include the expense related to initial setup, containment, and availability of the FDG as well as lack of widespread acceptance of the clinical usefulness of PET scanning in thoracic malignancies. It is interesting that despite these uncertainties, most chest clinicians would like to have access to PET scanning, as evidenced by the responses of 70% of those to whom it was unavailable. Whether the future performance of PET in community-based settings justifies this enthusiasm remains to be seen.

One important finding from our study was the significant discrepancy between views at our institution and those of ATS members regarding the helpfulness of PET in patient management. At our center, PET was perceived to be extremely helpful in evaluating and guiding therapeutic decisions in specific patients with possible non-small cell lung cancer by both the patient-based and general surveys. Because PET was not obtained routinely in all patients at risk for lung cancer, it is likely that the very high value assigned to PET results is accounted for, at least in part, by selection of patients in whom particular management uncertainties or risks had warranted further information. This may best be reflected by the lower value assigned to PET on the general survey of its helpfulness (3.83) in patient management, compared to the more specific patient-based survey (4.28), where it was believed to be very helpful in patient care and often influenced clinical decision making (p = 0.004). Better delineation of the subsets of patients with non-small cell lung cancer in whom PET has the most to offer is needed. National chest clinician respondents to our general survey were considerably less enthusiastic in their appraisal, and they do not consider PET to be as valuable a tool. We believe that this tempered response toward the overall usefulness of PET reflects not only a relative unfamiliarity with PET, but even more importantly, the lack of well-controlled prospective studies showing significant changes in both patient care and validated outcomes. In addi-
tion, this variation probably reflects the overall positive anecdotal experiences with PET at our center, previous local research investigations establishing the test performance characteristics of PET, the relative ease of obtaining PET scans at our center as compared to other institutions, and the overall rapid time frame with which this information can be incorporated in patient evaluation.

Robin\textsuperscript{21} has described “iatroepidemics,” related to the premature application of unvalidated technology. Based on local experience, PET scans are ordered frequently and considered useful at our Comprehensive Cancer Center in the management of patients with thoracic malignancies, although most ATS chest clinicians do not currently obtain them routinely. Since there are few data defining the influence of PET on patient care, randomized, controlled investigations are needed to assess the optimum roles of this imaging modality, its cost-effectiveness, and whether PET scanning can impact mortality and improve patient outcomes.

REFERENCES

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