Surveillance Patterns Following Lung Cancer Resection

Objective

The goal was to describe the current population-based trends in surveillance practices and the use of these modalities in patients with non-small cell lung cancer (NSCLC) following curative resection.

Methods

Data Source and Study design
This retrospective longitudinal cohort study used data from the Surveillance, Epidemiology, and End Results (SEER)-Medicare and included lung cancer patients. We included patients if they met following inclusion criteria: (i) Patients with American Joint Committee Cancer (AJCC) Stages I, II, and IIA NSCLC, (ii) age 66 and older, (iii) patients with continuous Medicare Part A and B coverage without HMO in the 1 year before and 4 months after the diagnosis date, (iv) claims for curative surgery within 4 months after diagnosis and (iii) patients who survived at least 15 months.

Variables Definitions
- A composite measure of guideline adherence was defined as 1) history and physical exam >2 times per year for the first two years and then annually; AND either 2) chest radiograph (CXR) >2 times per year for the first two years and then annually OR 3) CT 2 times per year for the first two years and then annually. Guideline adherence was assumed if patients received either CXR or CT at least twice annually in the initial two years of surveillance or either test annually in years 3-5.
- Independent variables included patient demographics and clinical characteristics.

Statistical Analysis
We calculated the proportion of patients who adhered to the composite guidelines as well as the proportion of patients receiving CXR or CT. We also evaluated the use of guideline-non-adherent testing (PET) for each surveillance period. We used a Cox proportional hazards model adjusting for relevant characteristics to determine characteristics associated with non-adherence. Because each patient could have up to five surveillance periods and multiple observations per patient, we used a GEE model to determine the characteristics of asymptomatic patients undergoing a PET scan.

Results

Descriptive Statistics
The study cohort included 7,223 patients. Table 1 presents the baseline characteristics for this cohort. Most patients were white (88.1%) and few were designated as having a low socioeconomic status (9.6%). Most (87.5%) had AJCC Stage I lung cancer and 58.5% had adenocarcinoma. Smoking-related pulmonary comorbidities were not present in 78.2% of patients.

Table 1. Baseline characteristics of patients undergoing curative surgery for non-small cell lung cancer, 1992-2005. Only patients surviving for 15 months postoperatively were included.

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>N</th>
<th>%</th>
<th>Tumor characteristics</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>7223</td>
<td>100%</td>
<td>Year of diagnosis</td>
<td>2913</td>
<td>40.3%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66-69</td>
<td>1813</td>
<td>25.1%</td>
<td>1992-1996</td>
<td>2551</td>
<td>35.3%</td>
</tr>
<tr>
<td>70-74</td>
<td>2484</td>
<td>34.4%</td>
<td>1997-2001</td>
<td>1759</td>
<td>24.4%</td>
</tr>
<tr>
<td>75-79</td>
<td>1960</td>
<td>27.1%</td>
<td>2002-2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 80</td>
<td>966</td>
<td>13.4%</td>
<td>Stage</td>
<td>6323</td>
<td>87.5%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Male 3482 48.2% II 602 8.3%
Female 3741 51.8% IIIA 298 4.1%
Race Tumor grade
White 6367 88.1% Well differentiated 880 12.2%
Black 334 4.6% Moderately differentiated 2572 35.6%
Other 522 7.2% Poorly/Un- differentiated 2827 39.1%
Low socioeconomic status Unknown 944 13.1%
No 6529 90.4% Histologic type
Yes 694 9.6% Adenocarcinoma 4226 58.5%
Smoking related pulmonary comorbiditya Squamous 2179 30.2%
0 5646 78.2% Large Cell 374 5.2%
1 1201 16.6% Other 444 6.1%
≥2 376 5.2% Hospital characteristics
SEER region Surgery hospital type
San Francisco 450 6.2% Nonprofit 5769 79.9%
Connecticut 1170 16.2% For-profit 642 8.9%
Detroit 1266 17.5% Public 812 11.2%
Hawaii 184 2.5% Surgery hospital size
Iowa 967 13.4% ≤ 200 beds 845 11.7%
New Mexico 204 2.8% 201-350 beds 2377 32.9%
Seattle 813 11.3% 351-500 beds 1377 19.1%
Utah 168 2.3% > 500 beds 2624 36.3%
San Jose 337 4.7% Medical school affiliation
Los Angeles 1183 16.4% Major 2670 37.0%
Atlanta and rural Georgia 481 6.7% Limited 1245 17.2%
No Affiliation 2684 37.2%

aSmoking-related pulmonary comorbidity: bronchitis, emphysema, asthma, bronchiectasis, extrinsic allergic alveolitis, or chronic obstructive pulmonary disease (COPD).

Guideline Adherence
Guideline adherence was 63.7% for the first surveillance year and decreased with each successive surveillance period. For the 2,898 patients eligible for surveillance by the fifth surveillance year, overall guideline adherence was only 28.5%. More patients received CXR as a surveillance modality than CT scanning in the first surveillance year (54.9% vs. 6.2%), and the use of each of these tests also decreased with each subsequent surveillance period (Table 3). In a Cox proportional hazards model (Table 4), patient characteristics associated with failure of guideline adherence included older age, female sex, black race, and Medicaid eligibility. There were few tumor or hospital characteristics associated with failure to achieve guideline adherence.

<table>
<thead>
<tr>
<th>Surveillance periods</th>
<th>4-15 months (N=7,223)</th>
<th>4-27 months (N=5,804)</th>
<th>4-39 months (N=4,651)</th>
<th>4-51 months (N=3,677)</th>
<th>4-63 months (N=2,898)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adherent, N (%)</td>
<td>4604 (63.7)</td>
<td>2334 (40.2)</td>
<td>1719 (37.0)</td>
<td>1199 (32.6)</td>
<td>825 (28.5)</td>
</tr>
<tr>
<td>CXR, N (%)</td>
<td>3965 (54.9)</td>
<td>1855 (32.0)</td>
<td>1378 (29.6)</td>
<td>976 (26.5)</td>
<td>681 (23.5)</td>
</tr>
<tr>
<td>CT, N (%)</td>
<td>445 (6.2)</td>
<td>111 (1.9)</td>
<td>71 (1.5)</td>
<td>37 (1.0)</td>
<td>21 (0.7)</td>
</tr>
</tbody>
</table>

Table 2. Adherence to Post-treatment Surveillance Guidelines and Use of PET Scan in Asymptomatic Patients Undergoing Curative Lung Resection For Each Surveillance Period
Trends in Guideline Adherence and Imaging Use

Imaging patterns for CXR and CT in the post-treatment period demonstrated small peaks at 6-month intervals and larger peaks at 12-month intervals (Figure 2). Guideline adherence was relatively stable over the study period, from 63.9% of patients diagnosed in 1996-1997 compared to 60.5% of patients in 2004-2005 (Figure 3, \( p=0.0002 \)). The use of surveillance CXRs decreased dramatically from 61.7% of patients in 1996-1997 to 35.8% of patients in 2004-2005, \( p<0.0001 \). In contrast, surveillance CT use increased from 2.1% of patients in 1996-1997 to 18.0% of patients in 2004-2005, \( p<0.0001 \).

**Figure 1. Monthly Imaging Rates**

**Figure 2. Trends in Guideline Adherence**

Conclusions

Surveillance practices for SEER-Medicare beneficiaries reflect the evolving recommendations over the past two decades. CT appears to be replacing CXR as the preferred surveillance imaging modality. While practitioners are obtaining imaging tests at regular intervals as currently recommended, overall guideline adherence was suboptimal and decreased with each successive year of surveillance. Prospective studies are needed to determine the benefit of screening beyond two years in this patient population with multiple competing risks.