Factors Predicting Mortality of Patients With Lung Abscess*

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Background: The rates of morbidity and mortality associated with lung abscess are still significant despite the introduction of antibiotic treatments. The aim of this work was to identify the factors that predict a poor outcome for patients with lung abscess.

Methods: We retrospectively reviewed the records and the roentgenographic files of adult patients with lung abscess who were hospitalized from 1980 to 1996 at the Hadassah University Hospital, in Jerusalem, Israel.

Results: The study population comprised 75 patients, and the mean age was 52 years old (range, 12 to 89 years). The mean (± SD) hospitalization duration was 25.7 ± 21.5 days (range, 5 to 94 days). Fifteen patients (20%) succumbed to the infection. The patients who died had more predisposing factors (± SD), such as pneumonia, neoplasm, and altered consciousness, than those who survived, respectively: 2.73 ± 1.4 vs 1.9 ± 1.3 (p < 0.03). The patients with anemia on admission (hemoglobin levels of < 10 g/dL) had a higher mortality rate than those with higher hemoglobin levels, respectively: 58.3 vs 12.9% (p = 0.0008). A higher mortality rate was also associated with infection by Pseudomonas aeruginosa (83%), Staphylococcus aureus (50%), and Klebsiella pneumoniae (44%). The patients who died had larger abscess volumes (± SD) than those who survived (233 ± 99 vs 157 ± 33 mL), although it did not reach statistical significance.

Conclusion: High rates of morbidity and mortality are associated with lung abscess despite appropriate antibiotic therapy and better supportive care. In patients with several predisposing factors, such as a large abscess size and a right-lower-lobe location, the prognosis was worse. The patients infected with S aureus, K pneumoniae, and particularly P aeruginosa had an ominous prognosis. As the prognosis for lung abscess has not improved sufficiently since the introduction of antibiotics, other modalities should be considered for patients with poor prognostic signs.

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Key words: diameter; lung abscess; outcome; predisposing factors

Lung abscess is defined as a circumscribed collection of pus in the lung, which leads to cavity formation and a radiographic finding of an air fluid level in the cavity.1–3 The incidence of lung abscess has declined since the introduction of antibiotic treatment, and the prognosis has improved. The prognosis is relatively poor, however, for elderly, debilitated, malnourished, and immunocompromised patients. Moreover, large abscesses and aerobic bacteria were associated with a worse outcome.2

This study was designed to assess the factors predicting the outcome of lung abscess patients admitted to a tertiary referral center in Jerusalem, Israel.

Materials and Methods

We retrospectively reviewed the records of adult patients with lung abscess at the Hadassah University Hospital, in Jerusalem, Israel. Included were patients with lung abscesses that were diagnosed according to the clinical presentation and one of the following findings: a chest radiograph or CT showing an intrapulmonary cavity with an air fluid level within it, a pathology specimen, or an autopsy report.5,8,13 Between January 1980 and August 1996, 85 inpatient files were identified. Ten files were excluded because of inadequate information.

The medical records were reviewed for the following information: age, gender, medical history with an emphasis on known predisposing factors for lung abscess, clinical course, and outcome. Laboratory results and bacteriological reports were reviewed as well.
The patients were classified as having a secondary lung abscess if an obstructing lesion such as a bronchogenic carcinoma was identified, or if a systemic illness that compromised immunologic defenses was identified. The rest of the patients were classified as having a primary lung abscess.

We recorded the largest diameter, volume, wall thickness, and number of abscesses by re-evaluating the chest radiograph files of 42 patients. In 19 of these reviews, CT chest examinations were utilized as well. The re-evaluation was conducted in a blinded manner by two senior radiologists. We calculated the abscess volume according to an ellipse formula, \( \frac{4}{3} \pi \times ABC/2 \), where \( A \) and \( B \) represent the diameter measurements of the posterior and anterior chest films, and \( C \) is the diameter calculated from the lateral chest film. Old radiographic reports were used to locate the site of the abscess when current radiographic files were not available. The patients with pleural cavity lesions, cavitary carcinoma, or Wegener’s granulomatosis were excluded from the study.

### Results

Of the 75 patients in the study, 52 were men and 23 were women. The mean age (± SD) was 52 ± 19 years old (range, 12 to 89 years). Seventy-five percent of the patients were < 60 years old.

The most common presenting symptom, fever, was seen in 78% of the patients. Twenty-six patients (42%) had a fever between 37.5 and 38.0°C, and 36 patients (58%) had a fever of > 38.1°C. Forty-three patients (57%) had cough, 22 patients (29%) had chest pain, 16 patients (21.3%) had malaise, 11 patients (14.7%) had weight loss, 7 patients (9.3%) had hemoptysis, and 3 patients (4%) had dyspnea. The mean (± SD) time from the beginning of symptoms to diagnosis was 14.8 ± 17 days (range, 1 to 120 days). The mean (± SD) hospitalization stay was 25.7 ± 21.5 days (range, 5 to 94 days). Fifteen patients (20%) succumbed to the infection.

Nineteen patients (25.3%) had a secondary lung abscess. The mortality rate was greater in patients with a secondary lung abscess (26%) than in those with a primary lung abscess (18%), respectively: 5 of 19 vs 10 of 56 deaths.

In 66 patients, one or more underlying conditions were identified. The most common associated underlying condition, COPD, was present in 28 patients (37%). Other pulmonary risk factors included pneumonia in 13 patients and pulmonary neoplasm in 5 patients. The extrapulmonary-associated conditions are shown in Table 1. The most frequent associated conditions were altered consciousness, debilitation, immunocompromise, and periodontal disease. The number of predisposing factors (both lung-related and systemic) correlated with both hospital stay and mortality (Fig 1). The patients with one predisposing risk factor or without any predisposing risk factors had a shorter mean (± SD) hospital stay than those patients with three to five predisposing risk factors, respectively: 17 ± 11 vs 32 ± 25 days (p < 0.05). The patients who died had more predisposing risk factors (± SD) than those who survived, respectively: 2.73 ± 1.4 vs 1.9 ± 1.3 (p < 0.03).

The mean (± SD) WBC count was 13,800 ± 6,630 mL, the hemoglobin level was 12 ± 2.2 g/dL, and the platelet count was 301,000 ± 160,000/mL. The mean (± SD) albumin level was 30 ± 5.1 g/L, and the Westergren sedimentation rate (± SD) was 87.6 ± 42 mm/h (range, 8 to 155 mm/h). The patients with hemoglobin levels of < 10 g/dL on admission had a greater mortality rate (58.3%) than those with higher hemoglobin levels (12.9%), respectively: 7 of 12 vs 7 of 54 (p = 0.0008). There was no significant statistical difference in the hemoglobin and albumin levels in patients with primary or secondary lung abscess.

In 47 patients, a total of 65 infecting organisms were isolated (Table 2). The cultures were negative for all others. In 40 cases, the organisms were

### Table 1—Associated Conditions of Patients With Lung Abscess

<table>
<thead>
<tr>
<th>Pathology</th>
<th>No. of Patients (%)</th>
</tr>
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<tbody>
<tr>
<td>Prior lung illness</td>
<td>28 (37)</td>
</tr>
<tr>
<td>COPD</td>
<td>13 (17)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Other*</td>
<td>7 (9)</td>
</tr>
<tr>
<td>Extrapulmonary condition</td>
<td></td>
</tr>
<tr>
<td>Altered consciousness</td>
<td>19 (25)</td>
</tr>
<tr>
<td>Debilitated patient</td>
<td>13 (17)</td>
</tr>
<tr>
<td>Immunocompromised host</td>
<td>12 (16)</td>
</tr>
<tr>
<td>Periodontal disease</td>
<td>11 (15)</td>
</tr>
<tr>
<td>Other†</td>
<td>9 (12)</td>
</tr>
</tbody>
</table>

* Asthma, bronchiectasis, and lung transplantation.  † Inflammatory bowel disease; hematological malignancy; rheumatoid arthritis; and renal transplantation.
isolated from the sputum. In five cases, the organisms were isolated through bronchoscopy prior to antibiotic treatment, and in two cases by percutaneous aspiration. Infections with *Pseudomonas aeruginosa* and *Staphylococcus aureus* were associated with higher mortality rates, respectively: 83% and 50%. Anaerobic cultures were not available.

The abscess locations are presented in Table 3. The most common localization was seen in the right lower lobe. Abscesses found in the lower lobes were significantly larger than in those above them (p < 0.05). Abscesses in the right lower lobe correlated with increased mortality (p < 0.05). The patients who died had a larger abscess volume (± SD) than those who survived (233 ± 99 vs 157 ± 33 mL), but this did not reach statistical significance. A larger abscess diameter correlated well with the length of hospitalization and with lower albumin levels on admission, respectively: r = 0.5 and r = 0.46 (p < 0.001). The mean (± SD) abscess wall thickness was 5.5 ± 4 mm. There was no correlation between the abscess diameter and the clinical course of the patient.

Ten patients had multiple abscesses, with two to five abscesses for each of those patients. Patients with multiple lesions were hospitalized longer (± SD) than those with fewer abscesses, respectively: 38.3 ± 14.9 vs 23.8 ± 18 days (p < 0.03). Multiple lesions were not associated with increased mortality.

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of Patients (%)</th>
<th>Average Largest Diameter, cm</th>
<th>Average Volume, mL</th>
<th>Mortality, No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right lower lobe</td>
<td>28 (37.3)</td>
<td>7.3 ± 3.5*</td>
<td>249 ± 362*</td>
<td>8 (28.5)</td>
</tr>
<tr>
<td>Right upper lobe</td>
<td>17 (22.6)</td>
<td>5.4 ± 1.4</td>
<td>70 ± 18</td>
<td>3 (17.6)</td>
</tr>
<tr>
<td>Left upper lobe</td>
<td>12 (16)</td>
<td>4.6 ± 1.5</td>
<td>119 ± 103</td>
<td>2 (16)</td>
</tr>
<tr>
<td>Left lower lobe</td>
<td>10 (13.3)</td>
<td>7.7 ± 2.4</td>
<td>179 ± 104</td>
<td>0</td>
</tr>
<tr>
<td>Right middle lobe</td>
<td>6 (8)</td>
<td>5.5 ± 3.9</td>
<td>158 ± 230</td>
<td>0</td>
</tr>
<tr>
<td>Bilateral</td>
<td>2 (2.8)</td>
<td></td>
<td></td>
<td>2 (100)</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SD.*
poor underlying physical condition that is probably the cause of increased mortality in this group. However, there was no difference in the hemoglobin or albumin levels between the groups with a primary or secondary lung abscess. The lack of difference might be because the basic physical condition of the patients who are prone to aspiration, such as alcoholic or demented patients (classified as having a primary lung abscess), is poor.

Anaerobic bacteria are implicated as major pathogens in patients with lung abscesses. These bacteria have been isolated using percutaneous or transtracheal aspiration. Since these techniques were seldom used in our patients, we did not isolate anaerobic bacteria. We have found that patients with *P. aeruginosa* had a death rate of 83%. Other infections associated with a higher mortality rate were *S. aureus* (50%) and *Klebsiella pneumoniae* (44%). Hammond et al. stated that lung abscesses with different mechanisms of pathogenesis may have different infecting organisms. The patients infected with *P. aeruginosa* or *K. pneumoniae* may have acquired these organisms during hospitalization or as a result of their underlying illness.

A larger cavity size is a poor prognostic sign. We have reviewed the radiographic files of 42 patients. The patients who died had larger abscess volumes (± SD) than the patients who survived the event (233 ± 99 vs 157 ± 33 mL), although the difference did not reach statistical significance. The diameter of the abscess correlated with the hospitalization time (r = 0.5; p < 0.001). Most of the abscesses were confined to the right lower lobe. Similar results have been reported by Hagan and Hardy and Chidi and Mendelsohn. Abscesses located in the lower lobes were significantly larger than abscesses located in the upper lobes. A right lower lobe abscess correlated with increased mortality.

An invasive approach, such as surgery and percutaneous drainage, is reserved for the minority of patients (10 to 15%) who do not respond to a conservative treatment. In our cohort, percutaneous tube placement was technically successful in 8 of the 11 patients in whom it was attempted, but the overall results were disappointing, as 5 patients in this group died. Rice et al. described the successful tube drainage of 14 patients with a cavity of > 4 mL. Only one patient died as a complication of the abscess. Yellin et al. described the course of seven patients with primary lung abscesses who did not respond to conservative treatment and were candidates for operations. All were successfully treated by percutaneous tube drainage. There were no relapses after a follow-up period of 2 to 5 years. Weissberg described seven patients with lung abscess and severe sepsis that were in critical condition and were not candidates for pulmonary resection. They were treated by tube drainage. Prompt clinical recovery occurred in all of the cases, with a complete resolution of symptoms within 4 to 24 days. CT-guided drainage in unresponsive patients was successfully attempted by others. Thus, it was concluded by these authors that percutaneous drainage is a efficient and safe mode of treatment that avoids unnecessary loss of functioning lung parenchyma in cases of refractory lung abscess. The reason for the difference between our findings and the success rates reported in the literature is unclear to us. It should be emphasized that the efficacy of percutaneous tube drainage is still being debated and is probably not always successful, as shown in our cohort.

Intermittent transbronchial catheterization with an indwelling intracavitary catheter has been suggested as a method to facilitate drainage. In our series, it was successful in 8 of the 16 patients (50%) in whom it was attempted. The role of bronchoscopy as a mode of drainage is a controversial issue, and results from large series are lacking.

A lobectomy, which was the mainstay of treatment in the preantibiotic era, is rarely performed and is reserved for unresponsive patients. In our series, only three patients required surgery. Thus, our experience is limited.

The results presented here are limited because of the retrospective nature of the study and the lack of anaerobic cultures. However, the size of the cohort described, along with several others, is one of the largest in the literature.

We conclude that lung abscess still carries a high morbidity and mortality rate despite appropriate antibiotic therapy and better supportive care. Patients having several predisposing factors have a worse prognosis, probably reflecting a worse basic physical condition. Roentgenographic prognostic signs were the size of the abscess and a right lower lobe location. An ominous prognosis was associated with *S. aureus, K. pneumoniae, and particularly P. aeruginosa* infections. As the prognosis of lung abscess has not improved sufficiently since the introduction of antibiotics, other treatment modalities should be considered. An aggressive approach, including surgery and tube placement, may be considered for patients having poor prognostic factors.

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**References**