Clinical Features and Prognostic Factors of Lung Abscess

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Background and purpose: Despite the advances in the care of patients with lung abscess during the past few years, lung abscess continues to cause significant morbidity and death. In order to increase understanding of this condition, this study was designed to assess the clinical features and prognostic factors of lung abscess

Methods: We retrospectively reviewed the medical records and chest radiographs of adult inpatients with lung abscess, who were treated at the National Cheng Kung University Hospital from January 1997 through December 2003.

Results: A total of 50 patients with lung abscesses were evaluated during the study period; the median age was 61 years old (range, 22 to 88 years). The mean hospital stay was 23.6 ± 13.9 days (range, 8-80 days). Eight patients died, yielding a mortality rate of 16%. The risk factors for lung abscess included smoking (48%) and diabetes mellitus (34%), followed by lung cancer (16%). *Klebsiella pneumoniae* was the major pathogen found in this study (5/15, 33%). Patients who died had significantly lower hemoglobin levels than those who survived (10.8 ± 1.6 g/dl vs. 12.3 ± 2.0 g/dl, $p < 0.05$). As we chose a hemoglobin level of 12 g/dL as the cut-off point, the patients with anemia on admission had a higher mortality rate than those without (8 of 27 vs. 0 of 23, $p = 0.005$). The patients who died had a longer duration of fever after treatment began than those who survived (13.9 ± 7.5 days vs. 5.6 ± 4.4 days, $p = 0.001$). Patients with fever lasting more than 7 days after the beginning of antibiotic treatment had a poor prognosis and were associated with a higher mortality rate than those with fever lasting less than 7 days (35% vs. 3%, $p < 0.05$).

Conclusions: A high rate of morbidity and mortality is associated with lung abscess despite the advances in antibiotic treatment. Anemia and prolonged fever after the beginning of antibiotic treatment were 2 risk factors that affected the mortality rate in patients with lung abscess. ***(Thorac Med 2004; 19: 445-452)***

Key words: lung abscess, clinical feature, prognostic factor

Introduction

During the pre-antibiotic era, prior to 1945, lung abscess carried a high mortality rate, from 35% to 70%, with less than half of the survivors being "cured" [1]. Despite the advances in anti-

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biotic treatment in recent years, the mortality rate has remained high (from 10 to 38%) [2-6]. A number of studies have demonstrated that the presence of several underlying conditions in patients with lung abscess is associated with a poor outcome [3,7-8]. The host factors associated with a poor prognosis include advanced age, debilitation, malnutrition, human immunodeficiency virus infection or other forms of immunosuppression, pulmonary or extrapulmonary malignancies, and a persistence of symptoms for more than 8 weeks. The poor outcomes associated with the above conditions may be due, in part, to the predominance of aerobic organisms such as *Pseudomonas* spp, *Streptococcus pneumoniae, Klebsiella* spp, and *Staphylococcus aureus* as the causative agents of lung abscesses [9]. Hirshberg *et al.* reported that the patients with anemia on admission (hemoglobin level < 10 g/dl) had a higher mortality rate than those with a higher hemoglobin level (58.3 vs. 12.9%, $p < 0.001$) [7]. A large abscess size and a right-lower-lobe location have also been associated with a poor prognosis. To evaluate the clinical features and prognostic factors of lung abscess, we retrospectively analyzed all cases of lung abscesses that were treated at the National Cheng Kung University Hospital during a 6-year period.

Patients and Methods

Patient Characteristics

We retrospectively reviewed the medical records of all patients with lung abscesses that were treated at the National Cheng Kung University Hospital, a tertiary referred-care medical center in southern Taiwan. The charts of all patients with lung abscess as the discharge diagnosis, from January 1, 1997 through December 31, 2003, were reviewed. Lung abscess was defined as a history of a recent onset of malaise, fever, and cough productive of sputum, compatible clinical examinations, and a chest radiograph that showed an intrapulmonary cavity with an air-fluid level. The cavity size of the lung abscess was more than 3 cm in diameter. Patients with pulmonary tuberculosis, pleural cavitary lesions, bronchiectasis, cavitary carcinoma, Wegener's granulomatosis, septic embolism, or fungal infection were excluded from this study.

Data Collection

The demographic characteristics, clinical manifestations, and laboratory data, including, age, gender, clinical symptoms (fever, purulent sputum, duration of symptoms before admission), underlying diseases, size and location of abscess, blood tests (white blood cell count, hemoglobin, platelet count, and biochemistry), length of hospital stay, type of procedure during hospitalization, and bacteriological reports, were collected and analyzed. We also recorded the patients' responses to antibiotic treatment. Fever was defined as an ear temperature above 37.5°C. Duration of fever since the beginning of antibiotic treatment was defined as a period from the first day of antibiotic treatment to the occurrence of 2 occasions 8 hours apart without fever. The size of abscess was evaluated by recording its largest diameter or calculating its volume according to an ellipse formula, 4/3*ABC/2, where A and B represent the diameter measured from chest posterior-anterior films, and C the diameter measured from the lateral chest film [7].

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Science computer program (SPSS, Inc., Chicago, Ill, version 10.0.7C). All data were presented as mean ±

standard deviation (SD). Differences in the subject characteristics and laboratory values between the deceased patients and the survivors were determined using the Student's *t* test. When the data were skewed rather than normally distributed, differences between the 2 groups were determined using the Mann-Whitney *U* test. The chi-square test was used to compare the category variables between 2 groups of patients. A two-sided 95% confidence interval (95% Cis) was used. Statistical significance was defined as $p < 0.05$.

Results

A total of 50 patients were enrolled in this study, including 40 men and 10 women. The mortality rate was 16% (8/50). The mean age and the mean hospital stay are listed in Table 1. The mean duration from the onset of symptoms to diagnosis was 9.0 ± 10.3 days (range, 1 to 60 days). The most common symptom, fever, was seen in 90% of the patients (Table 1). Smoking was the most common associated risk factor in our study, which was present in 24 patients (48%). The second most common risk factor was diabetes mellitus (34%) (Table 1). Fifteen pathogens were isolated from our patients, 3 from bronchioalveolar lavage within 48 hrs of antibiotic treatment, 4 from the specimens obtained via percutanous aspiration, 3 from the specimens obtained by operation, and 5 from blood cultures. The organisms isolated from the sputum and not included as colonization, could not be ruled out in these samples. In our study, *Klebsiella pneumoniae* was the most predominant pathogen (5/15, 33%). The radiographic characteristics of lung abscess are summarized in Table 2. The most common site of involvement was the right lower lobe.

Twelve patients received a bronchoscopic examination to exclude an obstructive lesion predisposing to lung abscess or to obtain a microbiological diagnosis of lung abscess. Tumors were found in 5 of these patients, and all of the cell types were squamous cell carcinoma. The ratio of lung cancer in our patients was about 10% (5/50). Bronchoscopic lavage was performed in 12 patients, but only 3 pathogens grew from these specimens. Surgery was performed on 17 patients (17/50, 34%), and the mortality rate in this group was 17.6% (3/17). There were 3 postoperative deaths because of the poor underlying conditions in these patients.

In the analysis of the prognostic factors for lung abscess (Table 3), the patients who died had significantly lower hemoglobin than those who survived (10.8 ± 1.6 g/dl vs. 12.3 ± 2.0 g/dl, $p < 0.05$). As we chose a hemoglobin level of 12 g/dl as the cut-off point, the patients with anemia on admission had a higher mortality rate than those without anemia (8 of 27 vs. 0 of 23, $p = 0.005$). The mean (± SD) albumin levels were 2.78 ± 0.51g/dl, and hypoalbuminemia was common in these patients. Thirty-five patients (70%) had an albumin level < 3 g/dl, but hypoalbuminemia was not associated with a higher mortality rate ($p = 0.407$). The location of the lung abscess was not associated with a higher mortality rate. The patients who died had a larger abscess volume than those who survived (137.4 ± 181.4 vs. 81.7 ± 106 ml), but this did not reach statistical significance ($p = 0.161$). The patients who died had a longer duration of fever under antibiotics treatment than those who survived (13.9 ± 7.5 days vs. 5.6 ± 4.4 days, $p = 0.001$). As we chose 7 days as the cut-off point, we found that fever lasting more than 7 days under appropriate antibiotic treatment was a poor prognostic factor, and was associated with a higher mortality

Table 1. Clinical features of patients with lung abscess.

Age (year, mean ± SD)	60.7 ± 14.3
Gender	
Male (%)	40 (80%)
Female (%)	10 (20%)
Duration of symptoms before diagnosis (days, median)	7
Body temperature (°C)	37.7 ± 1.1
Respiratory rate (/min)	23.4 ± 4.1
Heart rate (/min)	101 ± 19.4
Mean blood pressure (mmHg)	89.5 ± 15.4
Mean duration of hospital stay (days, mean ± SD)	23.6 ± 13.9
Clinical symptoms	
Fever	45 (90%)
Cough	44 (88%)
Dyspnea	21 (42%)
Hemoptysis	17 (34%)
Chest pain	15 (30%)
Body weight loss	8 (16%)
Risk factors for lung abscess	
Smoking	24 (48%)
DM	17 (34%)
Lung cancer	8 (16%)
Malignancy*	6 (12%)
Excessive alcohol ingestion	6 (12%)
Conscious disturbance	6 (12%)
Aspiration	6 (12%)
Chronic obstructive pulmonary disease	6 (12%)
Pulmonary tuberculosis	6 (12%)
Bed ridden	5 (10%)
Others¶	10 (20%)
Laboratory data	
White blood count (10^3/cmm)	17.3 ± 7.9
Hemoglobin (mg/dl)	12.1 ± 1.9
Platelet count (10^3/cmm)	304.1 ± 158.6
Albumin (g/dl)	2.78 ± 0.5
CRP (mg/l)	182 ± 135.8
Pathogens	
Klebsiella pneumoniae	5 (33.3%)
Viridans streptococci	2 (13.3%)
Hemophilus influenzae	2 (13.3%)
Pseudomonas aeruginosa	2 (13.3%)
Moraxella cataralis	1 (6.7%)
Neisseria species	1 (6.7%)
Aspergillus fumigatus	1 (6.7%)
GPB#	1 (6.7%)

* Malignancy other than lung cancer; ¶ Others including congestive heart failure, cerebrovascular accident, liver cirrhosis, renal failure; # GPB: Gram-positive bacilli

Table 2. Location, mean diameter, and mean volume of the lung abscess, and the mortality rate of the patients.

Site	No of patient (%)	Mean Diameter, cm	Mean Volume, mL	Mortality, No. of patients (%)
RUL*	11 (22)	5.3 ± 2.3	74.9 ± 84.3	0 (0)
RML*	8 (16)	5.6 ± 3.0	129.5 ± 187.6	2 (25)
RLL*	19 (38)	5.2 ± 2.1	75.2 ± 89.7	3 (15.8)
LUL*	5 (10)	2.7 ± 0.8	15 ± 14.9	1 (20)
LLL*	7 (14)	7.8 ± 3.7	167 ± 163.2	2 (29)

Data are presented as mean ± SD.

* RUL: right upper lobe, RML: right middle lobe, RLL: right lower lobe, LUL: left upper lobe, LLL: left lower lobe

Table 3. The prognostic factors of lung abscess patients in the mortality and survival groups.

Patient Characteristics	Survival	Mortality	*p* value
Age, yr	60.9 ± 15.3	59.9 ± 8.7	0.50
Gender F/M	9 / 33	1 / 7	1.0
Duration of symptoms before admission (days)	9.8 ± 10.9	5.5 ± 5.5	0.28
Smoking	20 / 42	4 / 8	1.0
Body temperature (°C)	37.7 ± 1.0	37.7 ± 1.2	0.831
Blood pressure (mmHg)	89.5 ± 15.1	89.9 ± 17.8	0.068
Laboratory data			
Blood WBC count (10^3/cmm)	17.3 ± 8.1	17.4 ± 7.7	0.95
Hemoglobin (g/dl)	12.3 ± 2.0	10.8 ± 1.6	0.046*
Anemia (hemoglobin < 12 g/dl)	19 / 42	8 / 8	0.005*
Platelet count (10^3 /cmm)	305 ± 157	296 ± 177	0.88
BUN level (mg/dl)	17 ± 9.8	28 ± 34.7	0.406
Creatinine (mg/dl)	1.20 ± 1.3	1.0 ± 0.5	0.574
Albumin level (g/dl)	2.80 ± 0.5	2.6 ± 0.2	0.28
Hypoalbuminemia (Alb < 3g/dl)	28 / 42	7 / 8	0.407
Location of abscess on the chest radiograph			
RUL	11 / 42	0 / 8	0.174
RML	7 / 42	2 / 8	0.623
RLL	13 / 42	4 / 8	0.419
LUL	5 / 42	0 / 8	0.557
LLL	5 / 42	2 / 8	0.310
Diameter of the lung abscess (cm)	6.4 ± 2.5	5.2 ± 2.7	0.162
Volume of the lung abscess (ml)	81.7 ± 106	137.4 ± 181.4	0.161
Duration of fever since antibiotic treatment (days)	5.6 ± 4.4	13.9 ± 7.5	0.001*
Prolonged fever ≥ 7 days under antibiotic treatment	13 / 42	7 / 8	0.005*
Hospital stay (days)	23.4 ± 14.0	24.3 ± 14.3	0.88

* $p < 0.05$

rate than fever of less than 7 days (35% vs. 3%, p = 0. 005).

Discussion

Although there has been a significant reduction in the incidence of lung abscess, the high mortality rate of this disease still presents a serious challenge. The overall mortality rate was 16% in our study, which was similar to that of previous reports. Hagan and Hardy reported that the mortality rate was 22% in the 1960s, 25% in the 1970s, and 28% in 1980-1982 [10]. In the series by Estrera *et al*, published in 1980, the overall mortality rate was 10.2% (11/107) [4].

The main predisposing factor in the development of lung abscess in our patients was smoking (48%) followed by DM (34%), which is different from that reported in previous studies. Altered consciousness was the most important factor in previous studies [10]. In the bacteriological analysis, according to previous reports, anaerobic bacteria are the most important pathogens in patients with lung abscess. In the study by Jerng *et al*, *Viridans streptococci* had a strong clinical significance in the pathogenesis of lung abscess and empyema [11]. In our study, few anaerobic bacteria were isolated due to the low isolation rate of pathogens using percutaneous or transtracheal aspiration [12]. *K. pneumoniae* (5/15, 33.3%) was the most common pathogen isolated in our patients. The high ratio of DM patients in our study may explain why *K. pneumoniae* was more frequently isolated than in previous studies [10]. *Viridans streptococci* (2/15, 13.3%) were isolated from 2 patients. Different sampling procedures, different laboratory techniques and partial antibiotic treatment might explain the varying results.

In our study, the patients with anemia (Hb < 12 g/dl) on admission had a higher mortality rate than those with a higher hemoglobin level. According to the study by Hirshberg et al, anemia was an independent predictor of a poor prognosis [7]. A large cavity size was a poor prognostic sign in previous studies [8,12]. In our study, the difference did not reach statistical significance. Similar to previous studies, most of the lung abscesses were localized at the right lower lobe [7,10,13]. The patients in this study who died had a longer duration of fever under antibiotic treatment than those who survived. A fever lasting longer than 7 days under appropriate antibiotic treatment was associated with a higher mortality rate than a fever of less than 7 days under similar treatment. The poor prognostic factor of a prolonged fever under antibiotic treatment has not been explored in previous studies.

Five patients were found to have concurrent lung cancer in our study. From the results of previous studies, lung cancer, particularly squamous cell carcinoma, may necrose and form central cavitations. The cavity may then become infected and produce an abscess. This process is referred to as *in situ* infection of a lung tumor, or a carcinomatous abscess. Sosenko *et al* reported that patients presenting with a symptomatic abscess had associated malignancies in 7 to 18% of cases, but more recent reports have indicated that the incidence may be as high as 36% [14]. In our study, the incidence was 10% (5/50). Routine bronchoscopic examination for studying lung cancer was not recommended for all patients with lung abscess due to the relatively low incidence.

In conclusion, the mortality rate of patients with lung abscess is still high despite advances in antibiotic treatment. *K. pneumoniae* was an important pathogen for lung abscess in our patients. If a poor response to initial empirical

therapy occurs, selected antibiotics that cover *K. pneumoniae* are recommended for these patients. Anemia on admission and prolonged fever lasting more than 7 days under appropriate antibiotic treatment were 2 significant risk factors affecting mortality in this study.

References

1. Glover RP, Clagett OT. Pulmonary resection for abscess of the lung. Surg Gynecol Obstet 1948; 86: 384-95.
2. Weiss W, Cherniack NS. Acute nonspecific lung abscess: a controlled study comparing orally and parentally administered penicillin G. Chest 1974; 66: 348-51.
3. Chidi CC, Mendelsohn HJ. Lung abscess: a study of the results of treatment based on 90 consecutive cases. J Thorac Cardiovasc Surg 1974; 68: 186-72.
4. Estrera AS, Platt MR, Mills LF, *et al.* Primary lung abscess. J Thorac Cardiovasc Surg 1980; 78: 275-82.
5. Delarue NC, Person FG, Nelems JM, *et al.* Lung abscess: surgical implications. Can J Surg 1980; 23: 297-302.
6. Pohlson EC, McNamara JJ, Char C, *et al.* Lung abscess: a changing pattern of the disease. Am J Surg 1985; 150: 97-101.
7. Hirshberg BH, Sklair-Levi, Ran Nir-Paz. Factors predicting mortality of patients with lung abscess. Chest 1999; 115: 746-50.
8. Harber P, Terry PB. Fatal lung abscesses: review of 11 years' experience. South Med J 1981; 74: 281-3.
9. Henry C, Mwandumba, Nicholas J. Pyogenic lung infections: factors for predicting clinical outcome of lung abscess and thoracic empyema. Curr Option in Pul Med 2000; 6: 234-9.
10. Hagan JL, Hardy JD. Lung abscess revisited: a survey of 184 cases. Ann Surg 1983; 197: 755-62.
11. Jerng J-S, Hsueh P-R, Teng L-J, *et al.* Empyema thoracis and lung abscess caused by viridans streptococci, Am J Respir Crit Care Med 1997; 1508-14.
12. Bartlett JG, Gorbach SL: Treatment of aspiration pneumonia and primary lung abscess, penicillin G vs clindamycin. JAMA 1975; 234: 935-7.
13. Chidi CC, Mendelsohn HJ. Lung abscess: a study of the results of treatment based on 90 consecutive cases. J Thorac Cardiovasc Surg 1974; 68: 168-72.
14. Sosenko A, Glasroth J. Fibroptic bronchoscopy in the evaluation of lung abscess. Chest 1985; 87: 489-94.

肺膿瘍臨床表現暨預後因子之探討

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背景：雖然在過去的幾年對於病人之醫療照顧有明顯的進步，肺膿瘍仍然持續有相當高的死亡率。本研究旨在探討肺膿瘍臨床表現暨預後因子。

方法：我們回溯性之研究分析從 1997 年一月至 2003 年十二月總計六年期間，在成功大學附設醫院診斷為肺膿瘍並接受治療之病人的病歷記錄與放射學檔案。

結果：在這段研究的時間總計有五十位罹患肺膿瘍之病人。平均年齡是 61 歲(範圍由 22 到 88 歲)。平均住院天數為 23.6 ± 13.9 天。8 位病人死亡，死亡率為 16%。肺膿瘍患者常合併之危險因子依序是吸煙(48%)與糖尿病(34%)。引起肺膿瘍細菌方面的分析 *Klebsiella pneumoniae* 是最主要的病菌(5/15, 33%)。至於預後因子之分析，到院時貧血(血色素< 12 gm/dl)的患者有較高的死亡率分別為 29.7% vs 0% ($p = 0.005$)。死亡患者比起存活患者經治療後有較長的發燒期間分別是 13.9 ± 7.5 vs. 5.6 ± 4.4 天 ($p = 0.001$)。經抗生素治療，仍然發燒超過七天是一個不好的預後因子，其死亡率分別是 35% vs. 3% ($p < 0.05$)。

結論：即使是抗生素治療的進步，肺膿瘍死亡率依舊相當的高。到院時貧血與在廣效抗生素治療下持續性高燒大於七天是影響肺膿瘍患者死亡之兩個重要的危險因子。***(胸腔醫學 2004; 19: 445-452)***

關鍵詞：肺膿瘍、臨床特徵、預後因子

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