

Pyogenic lung abscess in an infectious disease unit: a 20-year retrospective study

Thomas Maitre , Vichita Ok, Ruxandra Calin, Ludovic Lassel, Ana Canestri, Michel Denis, Mohammed Hamidi, Sebastian Tavolaro, Charlotte Verdet, Antoine Parrot, Jacques Cadranel and Gilles Pialoux

Ther Adv Respir Dis

2021, Vol. 15: 1–9

DOI: 10.1177/
17534666211003012

© The Author(s), 2021.

Article reuse guidelines:
sagepub.com/journals-
permissions

Abstract

Background: Pyogenic lung abscesses are rare and poorly described infections. This study aimed to describe their prognostic factors.

Methods: We retrospectively included all patients hospitalized between 1 January 1998 and 1 June 2018, with an International Classification of Diseases, version 10 (ICD-10) diagnosis of pyogenic lung abscess, from the Diamm based medical records (Micro6, Nancy, France). Parasitic, fungal, or mycobacterial lung abscesses were excluded.

Results: A total of 64 patients were included. Abscesses were associated with immunosuppression in 28 patients, including HIV infection and immunosuppressive therapy for eight and 12 patients, respectively. Bacterial identification was obtained for 36 patients. Nine patients (14%) developed lung abscesses after hematogenous dissemination. They differed from bronchogenic abscesses by their younger age ($p=0.03$), the absence of smoking or emphysema ($p=0.05$), *Staphylococcus aureus* ($p=0.001$) or *Streptococcus* spp. ($p=0.05$) isolation, and the smaller size of their abscess ($p=0.02$). Overall, evolution was marked by radiological sequelae (46.9%), relapse (12.5%), and death (4.8%). Radiological sequelae occurred more frequently during the course of bronchogenic abscesses ($p=0.02$), particularly when they spontaneously discharged ($p=0.04$). Relapses were more frequent in patients with emphysema ($p=0.04$) and when *Haemophilus influenzae* was isolated ($p=0.04$). In multivariate analysis, poor outcomes, including death, sequelae, and relapse occurred more frequently in patients who had bronchogenic abscess ($p=0.02$), and in those who received antibiotics during less than 6 weeks ($p=0.05$).

Conclusion: A duration of antibiotic treatment of less than 6 weeks and bronchogenic presentation were globally associated with poor outcome of pyogenic lung abscesses. These data should be considered when proposing guidelines for the care of pyogenic lung abscesses.

The reviews of this paper are available via the supplemental material section.

Keywords: abscess, bronchogenic, hematogenous, lung, pyogenic

Received: 18 February 2021; revised manuscript accepted: 22 February 2021.

Introduction

Lung abscesses are defined as necrotic cavitory lesions containing pus in the pulmonary parenchyma, leading, after formation of bronchopulmonary fistula, to an air-fluid level inside the cavity.^{1–3} They are usually caused by pyogenic bacteria, particularly anaerobic bacteria, *Staphylococcus aureus*, and aerobic Gram-negative bacteria.^{4–7} In the pre-antibiotic era, mortality from lung abscesses was approximately 75% without treatment.⁸ Lung

abscess mortality decreased to 20–35% with percutaneous drainage⁹ and less to 10% with antibiotic therapy.^{9–12} Antibiotic treatment, with or without drainage, is currently the standard of care, but up to now no specific guidelines define the duration of antibiotic treatment. Some studies have shown that it may require 3–20 weeks to cure a lung abscess by antibiotic treatment.^{13,14} Globally, the mortality rate of lung abscesses varies from 1% to 20% depending on study periods

Correspondence to:

Thomas Maitre
Department of Infectious
Diseases, AP-HP Hôpital
Tenon, Sorbonne
Université, Paris, France
thomas.maitre5@gmail.com

Vichita Ok
Department of
Parasitology and Mycology,
AP-HP Hôpital Avicenne,
Sorbonne Paris Nord,
Bobigny, France

Ruxandra Calin
Ludovic Lassel
Ana Canestri
Michel Denis
Mohammed Hamidi
Gilles Pialoux
Department of Infectious
Diseases, AP-HP Hôpital
Tenon, Sorbonne
Université, Paris, France

Sebastian Tavolaro
Department of Radiology,
AP-HP Hôpital Tenon,
Sorbonne Université,
Paris, France

Charlotte Verdet
Department of
Bacteriology, AP-HP
Hôpitaux Universitaires
de l'Est Parisien, Paris,
France

Antoine Parrot
Jacques Cadranel
Department of
Pneumology, AP-HP
Hôpital Tenon, Sorbonne
Université, Paris, France

and patients' history,^{4,6,9-13,15-17} and thus deserves to be better defined. Finally, there is a lack of data regarding other outcome factors, such as radiographic sequelae or relapse in adult lung abscesses.

Our objective was to assess clinical and radiological presentation, bacterial identification and prognostic factors, over the 20-year period of the study, to suggest improvements in the care of patients with lung abscesses.

Methods

Study population

We retrospectively included all patients over 18 years of age hospitalized between 1 January 1998 and 1 June 2018 in the infectious disease unit of Tenon University Hospital (Paris, France) with a diagnosis of pyogenic lung abscess. Consecutive cases of lung abscess were identified by a retrospective search of medical discharge summaries for the 20-year period with the appropriate International Classification of Diseases, version 10 (ICD-10) code.

Data collection

A retrospective review of medical records of all identified cases was performed. All cases of lung pyogenic abscess with clinical and radiological evidence were included; parasitic, fungal, and mycobacterial lung abscesses were all excluded from the study. Lung abscess was defined as a necrotic lung cavitory lesion of more than 2 cm in diameter. Data were collected using a standardized form. General data collected were: patient age, gender, country of birth, HIV infection, other immunosuppressive conditions, tobacco use, alcoholism, diabetes mellitus, dental decay, aspiration risk, oro-tracheal intubation, tracheostomy, sinusitis, lung cancer, emphysema, bronchiectasis, broncho-oesophageal fistula, pulmonary embolism, and pulmonary contusion. The time between the first symptoms and the diagnosis of lung abscess was also recorded. Lung abscesses were considered as acute when the time between the first symptoms and diagnosis was less than 6 weeks and chronic when it was equal to or more than 6 weeks, as in another study.¹⁴ Abscesses secondary to bacteremia occurring from another entry site defined hematogenous lung abscesses. Other abscesses were considered to be bronchogenic. Radiological investigations defined the number of abscesses, pulmonary lobe location,

pleural disease, and the largest abscess diameter. Bacterial identification data were also recorded. Therapeutic data collected included the antibiotic molecules administered, treatment duration, percutaneous drainage, surgical management, and spontaneous discharge. Outcome data collected comprised mortality, relapse, and radiological sequelae. Relapse was defined as a new lung abscess occurring in the same location as the previous disease after the end of antibiotic treatment. Radiological sequelae were defined as cavitory lesions, bronchiectasis, or infiltrates persistent in the location of the lung abscess 2 months after treatment ended.

Statistics

The patients' characteristics were explored using classic descriptive parameters. Univariate analysis comparing the two patient groups (bronchogenic *versus* hematogenous abscess) was performed using the χ^2 test for qualitative variables (or the Fisher's test when conditions for the χ^2 test were not met). Quantitative variables were compared using the Student's *t*-test (or the Mann-Whitney test when the Student's test conditions were not met). These analyses were performed using Stata 14 software. Differences were considered statistically significant when the *p*-value was ≤ 0.05 .

For the outcome analysis, we considered the composite 'poor outcome' criterion defined as death, relapse and/or radiological sequelae. Univariate and multivariate analyses to identify factors associated with the outcome were performed using a logistic regression model. Variable selection for the multivariate logistic regression model was based on significance from univariate analysis as pre-screening ($p < 0.25$). The odds ratio (OR) along with 95% confidence interval (95% CI) were calculated. *p*-Values associated with the models' variables were reported with the threshold of statistical significance set at 5%. These analyses were performed using R software.¹⁸

Ethics

Data were recorded in a clinical database (DIAMM-G; Micro-6, Nancy, France). The National Commission on Informatics and Liberties (CNIL) approved the database used in this study. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki (revised in Edinburgh in 2000), as

reflected by *a priori* approval by the institution's human research committee.

Results

General description of the patients

We retrospectively included a total of 64 patients hospitalized between 1 January 1998 and 1 June 2018 with at least one pyogenic lung abscess. The general characteristics are summarized in Table 1. The patients were predominantly men ($n=47$; 73.4%). The median age at lung abscess diagnosis was 48 years (interquartile range (IQR) 43–58). Overall, 34 patients (53.1%) were born in France.

Lung abscess underlying conditions

The underlying conditions are detailed in Table 1. Immunosuppression was observed in 28 patients (43.7%), and included HIV infection ($n=8$, 12.5%), diabetes mellitus ($n=7$, 10.9%), and others (18.7%). Underlying conditions were smoking for 47 patients (73.4%), alcoholism for 25 (39.0%), and dental decay for 22 (34.4%); other conditions were less frequent: emphysema for 14 patients (21.9%), aspiration risks for nine (14.0%), sinusitis for five (7.9%), lung cancer for three (4.7%), and tracheostomy for three (4.7%). Bronchiectasis, pulmonary embolism, and lung contusion were each observed in one patient (1.6%).

Clinical and radiological presentations

The lung abscess symptom onsets were acute in 44 patients (68.7%). Seventeen patients (26.6%) had multiple lung abscesses. Radiographic analyses showed the right lower lobe (RLL) to be the more frequent location ($n=21$, 32.8%). Multi-lobe abscesses were more frequently observed in acute presentation [eight (18.2%) versus zero (0%); $p=0.04$]. Pleural effusion was more frequent in non-immunosuppressed patients [18 (50.0%) versus six (23.1%); $p=0.05$]. The mean of the largest abscess diameter was 55.7 mm (± 28.1). The abscess diameters appeared larger when the patient had underlying chronic sinusitis ($p=0.02$).

Nine patients (14.1%) developed lung abscesses after hematogenous dissemination, whereas the others developed lung abscesses after bronchogenic dissemination. The main differences between bronchogenic and hematogenous lung

abscesses are reported in Table 2. Patients with hematogenous abscesses were younger [45 years (29–50) versus 48 years (44–60); $p=0.03$]. Multi-lobe abscesses were more frequently observed in patients with hematogenous abscesses [five (55.5%) versus three (5.4%); $p=0.01$]. Smoking and emphysema conditions appeared more frequently in patients with bronchogenic abscesses ($p=0.05$). The abscess diameters were larger when they had bronchogenic origin (59.8 mm \pm 27.5 versus 30.4 \pm 16.4, $p=0.02$).

Microbial identification

The microbial agent responsible for the lung abscess was identified for 36 (56.2%) patients. Bacteria were more frequently documented in immunosuppressed patients [11 (92.7%) versus 25 (48.1%); $p=0.006$], those with underlying aspiration risks [eight (88.9%) versus 28 (50.9%); $p=0.03$], and when percutaneous drainage was performed [eight (88.9%) versus 28 (50.9%); $p=0.03$]. The microbial agents isolated in lung abscesses are detailed in Table 1. The four more frequently identified bacteria were *Staphylococcus aureus* ($n=11$), *Streptococcus* spp. ($n=7$), *Pseudomonas aeruginosa* ($n=6$), and *Haemophilus influenzae* ($n=3$). *Streptococcus* spp. were more frequently documented when pleural effusion complicated the lung abscesses [three (12.5%) versus zero (0.0%); $p=0.05$], in women [five (29.4%) versus two (4.2%); $p=0.01$], and in hematogenous lung abscesses [three (33.3%) versus four (7.3%); $p=0.05$]. *S. aureus* was more frequently identified when the abscesses were multiple [seven (41.2%) versus four (0.8%); $p=0.005$], multi-lobe [four (50.0%) versus seven (12.5%); $p=0.02$], or of hematogenous origin [six (66.7%) versus five (9.0%); $p=0.0001$]. *P. aeruginosa* was more frequently isolated in patients with tracheostomy [two (66.7%) versus four (6.6%); $p=0.02$] and those with aspiration risks [three (33.3%) versus three (5.4%); $p=0.03$]. *Staphylococcus* spp. and *Streptococcus* spp. were more frequently documented in hematogenous abscesses ($p=0.001$ and $p=0.05$, respectively), whereas microbial documentation appeared less frequent in bronchogenic abscesses ($p=0.003$) (Table 2).

Treatment and outcomes

The treatment and outcomes are detailed in Table 2. All patients received antibiotics. The mean duration of antibiotic treatment was 5.0 (\pm 2.5) weeks. In addition, 11 patients benefited from a

Table 1. General characteristics, radiological presentation, and microbiological identification of patients with pyogenic lung abscesses.

General characteristics	
Male, <i>n</i> (%)	47 (73.4)
Age in years, median (IQR)	48 (43–58)
Country of birth, <i>n</i> (%)	
France (%)	34 (53.1)
Africa (%)	20 (31.2)
Middle East (%)	1 (1.6)
Asia (%)	4 (6.2)
Americas (%)	1 (1.6)
Former USSR (%)	2 (3.1)
Immunocompromised conditions, <i>n</i> (%)	28 (43.7)
HIV (%)	8 (12.5)
Immunosuppressive therapy, <i>n</i> (%)	12 (18.7)
Diabetes mellitus, <i>n</i> (%)	7 (10.9)
Lung cancer, <i>n</i> (%)	3 (4.7)
Intravenous drug use	4 (6.2)
Smoking, <i>n</i> (%)	47 (73.4)
Alcoholism, <i>n</i> (%)	25 (39.1)
Dental decay, <i>n</i> (%)	22 (34.4)
Aspiration risks, <i>n</i> (%)	9 (14.1)
Orotracheal intubation, <i>n</i> (%)	1 (1.6)
Tracheostomy, <i>n</i> (%)	3 (4.7)
Sinusitis, <i>n</i> (%)	5 (7.9)
Emphysema, <i>n</i> (%)	14 (21.9)
Broncho-oesophageal fistula, <i>n</i> (%)	1 (1.6)
Pulmonary embolism, <i>n</i> (%)	1 (1.6)
Lung contusion, <i>n</i> (%)	1 (1.6)
Bronchiectasis <i>n</i> (%)	1 (1.6)

(Continued)

Table 1. (Continued)

General characteristics	
Clinical and radiological presentation	
Hematogenous dissemination, <i>n</i> (%)	9 (14.1)
Multiple abscesses, <i>n</i> (%)	17 (26.6)
RUL location, <i>n</i> (%)	15 (23.4)
LUL location, <i>n</i> (%)	15 (23.4)
LLL location, <i>n</i> (%)	16 (25.0)
RLL location, <i>n</i> (%)	21 (32.8)
ML location, <i>n</i> (%)	6 (9.4)
Multiple lobe involvement, <i>n</i> (%)	8 (12.5)
Pleural effusion, <i>n</i> (%)	24 (37.5)
Abscess diameter, mean in mm (±SD)	55.7 (±28.1)
Microbiological diagnosis	
Microbiological identification, <i>n</i> (%)	36 (56.2)
<i>Staphylococcus aureus</i> , <i>n</i> (%)	11 (17.2)
<i>Streptococcus pneumoniae</i> , <i>n</i> (%)	3 (4.7)
<i>Streptococcus anginosus</i> , <i>n</i> (%)	2 (3.1)
<i>Streptococcus sanguinis</i> , <i>n</i> (%)	1 (1.6)
<i>Streptococcus intermedius</i> , <i>n</i> (%)	1 (1.6)
<i>Haemophilus influenzae</i> , <i>n</i> (%)	3 (4.7)
<i>Pseudomonas aeruginosa</i> , <i>n</i> (%)	6 (9.4)
<i>Escherichia coli</i> , <i>n</i> (%)	1 (1.6)
<i>Klebsiella</i> spp, <i>n</i> (%)	2 (3.1)
<i>Enterobacter</i> spp, <i>n</i> (%)	2 (3.1)
<i>Legionella pneumoniae</i> , <i>n</i> (%)	1 (1.6)
<i>Prevotella baroniae</i> , <i>n</i> (%)	1 (1.6)
<i>Pasteurella multocida</i> , <i>n</i> (%)	1 (1.6)
<i>Hafnia alvei</i> , <i>n</i> (%)	1 (1.6)
<i>Gemella haemolysans</i> , <i>n</i> (%)	1 (1.6)
LLL, left lower lobe; LUL, left upper lobe; ML, middle lobe; RLL, right lower lobe; RUL, right upper lobe; USSR, Union of Soviet Socialist Republics.	

Table 2. Main differences between bronchogenic and hematogenous lung abscesses.

	Bronchogenic abscess	Hematogenous abscess	p-Value
Patients (%)	55 (85.9)	9 (14.1)	
General characteristics			
Age, median in years (IQR)	48 (44–60)	45 (29–50)	0.03
HIV infection (%)	7 (12.7)	1 (11.1)	n.s.
Other immunocompromised conditions (%)	9 (16.4)	3 (33.3)	n.s.
Intravenous drug use (%)	3 (5.4)	1 (11.1)	n.s.
Smoking (%)	43 (78.2)	4 (44.4)	0.05
Alcoholism (%)	24 (43.6)	1 (11.1)	n.s.
Diabetes mellitus (%)	7 (12.7)	0 (0.0)	n.s.
Dental decay (%)	17 (30.9)	5 (55.5)	n.s.
Aspiration risk (%)	8 (14.5)	1 (11.1)	n.s.
Sinusitis (%)	3 (5.4)	2 (22.2)	n.s.
Emphysema (%)	14 (25.4)	0 (0.0)	0.05
Radiological presentation			
RLL location (%)	15 (27.3)	6 (66.7)	0.03
Multiple lobe location (%)	3 (5.4)	5 (55.5)	0.01
Multiple abscess (%)	9 (16.4)	8 (88.9)	0.001
Main abscess diameter, mean in mm (\pm SD)	59.8 (\pm 27.5)	30.4 (\pm 16.4)	0.001
Microbiological diagnosis			
Microbiological identification (%)	27 (49.1)	9 (100.0)	0.003
<i>Staphylococcus aureus</i> (%)	5 (9.1)	6 (66.7)	0.001
<i>Streptococcus</i> spp. (%)	4 (7.3)	3 (33.3)	0.05
<i>Pseudomonas aeruginosa</i> (%)	6 (10.9)	0 (0.0)	n.s.
Treatment			
Duration of antibiotic treatment, mean in weeks (\pm SD)	5.08 \pm 2.61	5.89 \pm 2.62	n.s.
Percutaneous drainage (%)	8 (14.5)	1 (11.1)	n.s.
Surgical management (%)	2 (3.6)	0 (0)	n.s.
Spontaneous discharge (%)	6 (10.9)	0 (0)	n.s.
Outcomes			
Mortality (%)	3 (5.4)	0 (0.0)	n.s.
Radiological sequelae (%)	29 (52.7)	1 (11.1)	0.02
Relapse (%)	8 (14.5)	0 (0.0)	n.s.
Adverse outcomes (%)	32 (58.2)	1 (11.1)	0.01
RLL, right lower lobe; n.s., non-significant.			

drainage procedure. Percutaneous drainage was performed in nine patients and surgical management in two. Percutaneous drainage was more frequently performed when pleural effusion complicated the lung abscess [six (25.0%) versus three (7.5%); $p=0.05$] and in documented *Streptococcus* spp. lung abscesses [three (42.9%) versus six (10.5%); $p=0.05$]. Spontaneous discharge of the abscess occurred in four patients. Among the 64 patients treated with antibiotic treatment, 30 (46.9%) received antibiotics for less than 6 weeks and 34 (53.1%) for more than 6 weeks. The proportion of emphysema was higher in the group treated for less than 6 weeks [11 (37%) versus three (9%); $p<0.01$]. Bacteria were more frequently identified in the group treated for more than 6 weeks [23 (67%) versus 13 (43%); $p=0.05$].

Poor outcomes included mortality (4.8%), relapse (12.5%), and radiological sequelae (46.9%). Relapses were more frequent in patients with emphysema [four (28.6%) versus four (8%); $p=0.04$] and in documented *H. influenza* lung abscesses [two (66.7%) versus six (9.8%); $p=0.04$]. Radiographic sequelae occurred more frequently in patients with bronchogenic abscesses [29 (52.7%) versus one (11.1%); $p=0.02$] (Table 2), those with spontaneous discharge [four (100%) versus 26 (43.3%); $p=0.04$], and when the abscesses were limited to one lobe [29 (96.7%) versus 27 (79.4%); $p=0.04$]. Globally, in univariate analysis, poor outcomes were more frequently observed in patients with underlying emphysema ($p=0.03$). They were less frequently observed in hematogenous lung abscess ($p=0.03$) and when the antibiotic treatment duration was over 6 weeks ($p=0.02$). In multivariate analysis, the risk of poor outcomes was lower in patients who received more than 6 weeks of antibiotic treatment [OR=0.31 (0.09–0.96); $p=0.05$], and in patients suffering from hematogenous abscesses [OR=0.07 (0.00–0.48); $p=0.02$], but was not increased in patients with underlying emphysema [OR=1.64 (0.32–9.77)] (Table 3 and Figure 1).

Discussion

There are no specific guidelines for the care of patients with lung abscesses, few and short series of such patients are reported in the literature.^{6,12,13,17} Patients who develop lung abscesses make up a very heterogeneous population. In the present study, we distinguished pragmatically two

main groups of patients with a specific presentation, microbial identification, and prognosis. The first one consists of the youngest patients, who developed lung abscesses associated with hematological dissemination, that is, positive blood cultures from another entry site. Their radiological presentations consisted of multiple abscesses in multiple lobe locations of smaller size than bronchogenic abscesses. The main bacteria associated with these presentations were Gram-positive cocci, particularly *S. aureus* and *Streptococcus* spp. These bacteria had recently showed a particular affinity to invade the pleural space and induce pleural effusion complicating lung abscess by pleural infection.¹⁹ Thus, we recommend that empiric antibiotic treatment should consist of bactericidal molecules against *Streptococcus* and *Staphylococcus* spp. as soon as hematogenous presentation is suspected. Empiric treatment should cover methicillin-resistant *Staphylococcus aureus* (MRSA) when severe pulmonary infection requires admission in the intensive care unit, and should consider the potential risk of MRSA in specific situations such as nosocomial context or intravenous drug use. We suggest empiric treatment with amoxicillin and clavulanic acid,^{20,21} and vancomycin if MRSA had to be covered.²² The second group is composed of the oldest patients and corresponds to those developing lung abscesses with a bronchogenic presentation. Their abscesses were more frequently unique, limited to one lobe, and larger than those observed in the hematogenous presentation. Patients who developed bronchogenic lung abscesses appeared to have a history of smoking and previous emphysematous lung disease. Globally, patients with bronchogenic lung abscesses had a worse prognosis than those with hematogenous lung abscesses in our study. Among patients with a bronchogenic presentation, *P. aeruginosa* was more frequently isolated in patients with aspiration risks and, more particularly, tracheostomy. Therefore, we recommend including *Pseudomonas* spp. in the spectrum of empiric antibiotic treatment proposed for patients with aspiration risk and suggest empiric treatment with piperacillin and tazobactam to maintain anti-aerobic activity.²³

The median age of the patients (48 years) and large proportion of smoking history (73%), as well as the frequency of alcoholism (39%), dental decay (34%), HIV infection (12%), diabetes mellitus (11%), and aspiration risks (14%) of our studied population are similar to those reported in

previous work.^{6,12,13,17} Nevertheless, we observed a smaller proportion of lung cancer (5%), and bronchiectasis (2%) than in the other studies.^{6,12,13,17} Just under half of the patients were immunosuppressed. Immunocompetent patients developed lung abscesses, which were more frequently complicated by pleural effusion. These data support the previous results of Mansharamani *et al.*,⁶ who reported more pleuritic chest pain in immunocompetent patients hospitalized with a lung abscess. In our study, the RLL was the most frequently affected lung segment (in 33% of patients), contrary to what Mansharamani *et al.*⁶ observed. This difference can be explained by the exclusion of mycobacterial infections from our study, which clearly mainly affect apical segments of the lung.²⁴ Moreover, the large proportion of alcoholism (40%) and other aspiration risks (14%) in our study, led to the aspiration of oral secretion when unconscious, and concerned particularly the RLL because anatomically the right bronchus is straighter than the left.

Our microbiological data show that *S. aureus* and *P. aeruginosa* were the two main bacteria isolated in lung abscesses, as in the study by Mansharamani *et al.*⁶ *Streptococcus* spp. appeared as the principal bacteria identified in community-acquired lung abscesses¹³ and was the third most frequent in our study, which combines nosocomial and community-acquired lung abscesses. Early reports identified multiple species of anaerobic bacteria in lung abscesses on regular basis,^{7,25–28} whereas recent studies such as ours found anaerobes in a substantially lower proportion in favour of aerobes.^{14,29–31} The increasing wide-spectrum empiric antibiotic treatment before bacteriological study in daily practice, impacting particularly anaerobic bacteria, could explain this difference.³²

Table 3. Multivariate logistic regression model of factors impacting outcomes in 64 patients hospitalized with pyogenic lung abscess.

Factors	Multivariate analysis		
	OR	95% CI	p-Value
Duration of antibiotic treatment over 6 weeks	0.31	(0.09–0.96)	0.05
Emphysema	1.64	(0.32–9.77)	0.6
Hematogenous abscess	0.07	(0.00–0.48)	0.02
LUL location	3.67	(0.88–20.11)	0.09
ML location	0.16	(0.01–1.25)	0.13

CI, confidence interval; LUL, left upper lobe, ML, middle lobe; OR, odds ratio.

The mortality rate of lung abscess patients can vary widely, from 1% to 20%, depending on the study.^{4,6,9–13,15–17} We have shown that larger abscesses correlate with a poorer prognosis as described in previous studies.^{15,17} In our study, outcomes were assessed not only by mortality, but also relapse and radiological sequelae rates. The relapse rate was higher in patients with emphysema, which may be induced by the shorter antibiotic treatment duration we observed in these patients as worse outcome was not confirmed in our multivariate analysis. We observed radiological sequelae in 47% of patients. This high rate is close to that (49%) recently published in children.³³ Radiological sequelae were more frequently observed in patients with bronchogenic abscesses and when spontaneous discharge occurred. This finding may also be explained by the persistence of aspiration risk factors (e.g. tracheostomy) in these patients. In addition to antibiotic treatment, percutaneous drainage and/or

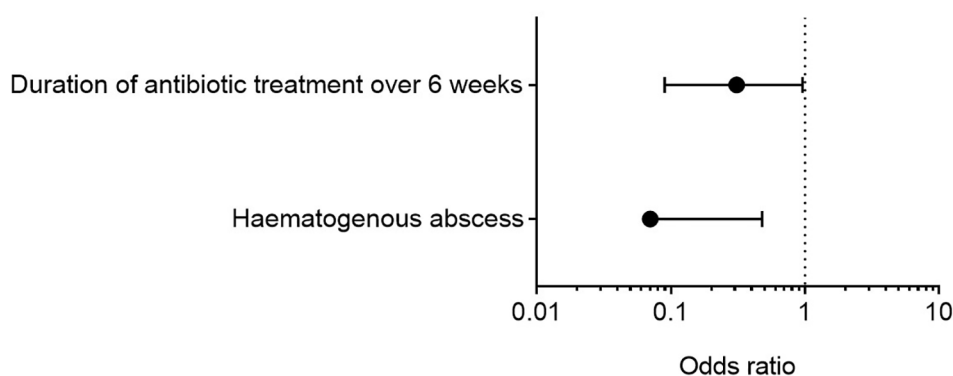


Figure 1. Main factors which impact significantly on pyogenic lung abscess outcomes.

surgery may be necessary to cure certain patients. The use of these techniques varies widely depending on the study, as percutaneous drainage and surgery were performed in 1–94% and 2–41% of patients, respectively.^{6,12,13} In our study, percutaneous drainage was performed in 14% of patients and surgery in 3%, without a significant impact on outcomes. Percutaneous drainage provided bacterial identification and was preferentially performed when pleural effusion complicated the lung abscess. There is no consensus on the duration of antibiotic treatment and it depends on the clinical and radiological response of the patient. Treatment should obviously be administered until at least fever, putrid sputum, and abscess fluid have resolved. According to expert opinions, the rate of therapeutic failure including relapse, is low if antibiotic therapy is pursued until radiography changes to a normal range.³⁴ This may require a total duration of 28–48 days, as suggested in a previous study.¹³ Expert opinions recommend a prolonged antibiotic therapy over 6 weeks to prevent therapeutic failure;³⁵ our study is the only to confirm poor outcomes in patients treated for less than 6 weeks.

The limitations of this study included its retrospective nature, its being a single-center study, and the small number of patients. Moreover, the 20-year period of the study may have complicated the interpretation of the results, given the considerable improvements in both diagnosis and treatment of lung abscesses from 1998 to 2018. Moreover, the poorer prognosis observed in patients with bronchogenic abscess may be due to their general and pulmonary comorbidities and only a fraction of them was considered in our multivariate analysis.

This study indicates that the clinical and radiological presentations of lung abscesses are the main parameters which determine bacterial identification, and outcomes. We suggest that this presentation should guide empirical antibiotic treatment. The prognosis of patients was globally unfavourable when the presentations were bronchogenic and the treatment duration less than 6 weeks. These data should be considered when proposing guidelines for the care of patients with lung abscesses.

Author contributions

Study conceptualization and design: TM, LL and GP; data collection: TM and MH; statistical

analysis: VO, MH and TM; interpretation of results: TM, JC and GP; manuscript preparation: TM, GP, JC and VO; approval for final version of the manuscript: all authors.

Conflict of interest statement

The authors declare that there is no conflict of interest.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Thomas Maitre  <https://orcid.org/0000-0002-5463-336X>

References

1. Bartlett JG and Finegold SM. Anaerobic pleuropulmonary infections. *Medicine (Baltimore)* 1972; 51: 413–450.
2. Takaro T, Scott SM, Bridgman AH, *et al.* Suppurative diseases of the lungs. Pleurae and pericardium. *Curr Probl Surg* 1977; 14: 1–62.
3. Seo H, Cha S-I, Shin K-M, *et al.* Focal necrotizing pneumonia is a distinct entity from lung abscess. *Respirol Carlton Vic* 2013; 18: 1095–1100.
4. Hagan JL and Hardy JD. Lung abscess revisited. A survey of 184 cases. *Ann Surg* 1983; 197: 755–762.
5. Mori T, Ebe T, Takahashi M, *et al.* Lung abscess: analysis of 66 cases from 1979 to 1991. *Intern Med Tokyo Jpn* 1993; 32: 278–284.
6. Mansharamani N, Balachandran D, Delaney D, *et al.* Lung abscess in adults: clinical comparison of immunocompromised to non-immunocompromised patients. *Respir Med* 2002; 96: 178–185.
7. Bartlett JG, Gorbach SL, Tally FP, *et al.* Bacteriology and treatment of primary lung abscess. *Am Rev Respir Dis* 1974; 109: 510–518.
8. Lord FT. Certain aspects of pulmonary abscess, from analysis of 227 cases. *Boston Med Surg J* 1925; 192: 785–788.
9. Weiss W and Cherniack NS. Acute nonspecific lung abscess: a controlled study comparing orally and parenterally administered penicillin G. *Chest* 1974; 66: 348–351.

10. Weiss W. Oral antibiotic therapy of acute primary lung abscess: comparison of penicillin G and tetracycline. *Curr Ther Res Clin Exp* 1970; 12: 154–160.
11. Weiss W. Delayed cavity closure in acute nonspecific primary lung abscess. *Am J Med Sci* 1968; 255: 313–319.
12. Moreira J da S, Camargo J de JP, Felicetti JC, et al. Lung abscess: analysis of 252 consecutive cases diagnosed between 1968 and 2004. *J Bras Pneumol* 2006; 32: 136–143.
13. Takayanagi N, Kagiya N, Ishiguro T, et al. Etiology and outcome of community-acquired lung abscess. *Respir Int Rev Thorac Dis* 2010; 80: 98–105.
14. Kuhajda I, Zarogoulidis K, Tsirgogianni K, et al. Lung abscess-etiology, diagnostic and treatment options. *Ann Transl Med* 2015; 3: 183.
15. Harber P and Terry PB. Fatal lung abscesses: review of 11 years' experience. *South Med J* 1981; 74: 281–283.
16. Pohlson EC, McNamara JJ, Char C, et al. Lung abscess: a changing pattern of the disease. *Am J Surg* 1985; 150: 97–101.
17. Hirshberg B, Sklair-Levi M, Nir-Paz R, et al. Factors predicting mortality of patients with lung abscess. *Chest* 1999; 115: 746–750.
18. R Core Team. *R: a language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing, 2018.
19. Hassan M, Cargill T, Harriss E, et al. The microbiology of pleural infection in adults: a systematic review. *Eur Respir J* 2019; 54: 1900542.
20. Fernández-Sabé N, Carratalà J, Dorca J, et al. Efficacy and safety of sequential amoxicillin-clavulanate in the treatment of anaerobic lung infections. *Eur J Clin Microbiol Infect Dis* 2003; 22: 185–187.
21. Germaud P, Poirier J, Jacqueme P, et al. [Monotherapy using amoxicillin/clavulanic acid as treatment of first choice in community-acquired lung abscess. Apropos of 57 cases]. *Rev Pneumol Clin* 1993; 49: 137–141.
22. Denu RA, Patel D, Becker BJ, et al. MRSA septicemia with septic arthritis and prostatic, intraretinal, periapical, and lung abscesses. *WMJ* 2020; 119: 62–65.
23. Gin A, Dilay L, Karlowsky JA, et al. Piperacillin-tazobactam: a beta-lactam/beta-lactamase inhibitor combination. *Expert Rev Anti Infect Ther* 2007; 5: 365–383.
24. Aktoğu S, Yorgancioglu A, Cirak K, et al. Clinical spectrum of pulmonary and pleural tuberculosis: a report of 5,480 cases. *Eur Respir J* 1996; 9: 2031–2035.
25. Bartlett JG. Anaerobic bacterial infections of the lung and pleural space. *Clin Infect Dis* 1993; 16 (Suppl. 4): S248–S255.
26. Glauser FL and Bartlett RH. Pneumoperitoneum in association with pneumothorax. *Chest* 1974; 66: 536–540.
27. Kapila R, Sen P, Salaki J, et al. Evaluation of clindamycin and other antibiotics in the treatment of anaerobic bacterial infections of the lung. *J Infect Dis* 1977; 135 (Suppl): S58–S64.
28. Gudiol F, Manresa F, Pallares R, et al. Clindamycin vs penicillin for anaerobic lung infections. High rate of penicillin failures associated with penicillin-resistant bacteroides melaninogenicus. *Arch Intern Med* 1990; 150: 2525–2529.
29. Wang J-L, Chen K-Y, Fang C-T, et al. Changing bacteriology of adult community-acquired lung abscess in Taiwan: *Klebsiella pneumoniae* versus anaerobes. *Clin Infect Dis* 2005; 40: 915–922.
30. Allewelt M, Schüler P, Bölskei PL, et al.; Study Group on Aspiration Pneumonia. Ampicillin + sulbactam vs clindamycin ± cephalosporin for the treatment of aspiration pneumonia and primary lung abscess. *Clin Microbiol Infect* 2004; 10: 163–170.
31. DiBardino DM and Wunderink RG. Aspiration pneumonia: a review of modern trends. *J Crit Care* 2015; 30: 40–48.
32. Bartlett JG. The role of anaerobic bacteria in lung abscess. *Clin Infect Dis* 2005; 40: 923–925.
33. Wojsyk-Banaszak I, Krenke K, Jończyk-Potoczna K, et al. Long-term sequelae after lung abscess in children – two tertiary centers' experience. *J Infect Chemother* 2018; 24: 376–382.
34. Allewelt M. Aspiration pneumonia and primary lung abscess: diagnosis and therapy of an aerobic or an anaerobic infection? *Expert Rev Respir Med* 2007; 1: 111–119.
35. Lorber B. *Bacterial lung abscess*, 7th ed. Philadelphia, PA: Churchill Livingstone Elsevier, 2010.