Pleural Space Infections: Microbiologic And Fluid Characteristics In 84 Patients

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Citation

J Porcel, P Vázquez, M Vives, A Nogués, M Falguera, A Manonelles. *Pleural Space Infections: Microbiologic And Fluid Characteristics In 84 Patients*. The Internet Journal of Pulmonary Medicine. 2002 Volume 3 Number 1.

Abstract

Background. The reported spectra of microorganisms responsible for empyema is varied, reflecting patient selection, host factors and microbiological methods for diagnosis.
Patients and Methods. The medical and microbiological records of patients with positive cultures of pleural fluid, excluding Mycobacterium tuberculosis, were retrospectively analyzed in a teaching hospital over a 10-year period.
Results. A total of 93 microorganisms were identified from the pleural fluid of 84 patients. The majority of bacterial isolates were Gram-positive organisms (67%), specifically viridans streptococci (19 isolates), Streptococcus pneumoniae (17), and Staphylococcus aureus (12), whereas Escherichia coli (7) was the most commonly encountered Gram-negative aerobic pathogen. Anaerobic isolates were only found in about 6% of cases. Overall, 63% of effusions had high pleural fluid adenosine deaminase levels. Medical comorbidity was common (69%), and 12% of patients with positive pleural fluid cultures responded to antibiotic therapy alone.
Conclusions. Gram-positive aerobic microorganisms are still the most common isolated pathogens from pleural fluid in empyema. Adenosin deaminase activity is high in numerous parapneumonic effusions. Occasionally, a culture positive pleural effusion resolve without tube thoracostomy.

INTRODUCTION

Parapneumonic effusions and empyema are a common clinical problem without a good variety of treatment options, occasionally having poor outcomes. Empyema is usually a complication of pneumonia but may arise from infections at other sites. The microbial etiology of pleural space infections has changed since the introduction of antibiotics, and is modified by either specific patient factors such as surgical procedures, trauma or underlying conditions, or by methodological factors, namely the proper specimen collection, transport and culture. For these reasons, several studies have found discordant results in the spectrum of pathogens causing pleural infections[1]. We reviewed our experience with the microbial causes of pleural empyema over a 10-year period at a University hospital. In addition, we sought to ascertain the biochemical characteristics of these fluids and whether all culture positive effusions need drainage.

PATIENTS AND METHODS

The medical records of all patients who had a positive culture of pleural fluid at University Hospital Arnau de Vilanova, a 470-bed teaching hospital in Lleida, during the period of January 1992 through December 2001, were reviewed. We excluded cases of tuberculous pleuritis.

A parapneumonic effusion was diagnosed in patients with an effusion associated with a pulmonary infiltrate, and clinical signs of infection (fever, leukocytosis). Typical or non-complicated parapneumonic effusions received appropriate antibiotics alone. Complicated parapneumonic effusion referred to those nonpurulent-appearing effusions that did not resolve without tube thoracostomy, whereas empyema described pus within the pleural space, the end stage of a complicated effusion.

All patients underwent diagnostic thoracentesis under aseptic conditions, and the pleural fluid was processed for measurement of pH, glucose, protein, lactate dehydrogenase, adenosine deaminase (ADA), cell count and differential, cytology, and both aerobic and anaerobic bacterial cultures. Media routinely used were: McConkey and Columbia agar, Chocolate PVX, Schaedler sheep blood, thioglycolate-enriched media (bio-Mérieux, France), and blood culture media ESP 80A and ESP 80N (Trek Diagnostic Systems,

USA). Fungal cultures were done at the discretion of the attending physician. The microbiology of pleural effusions was classified as follows: aerobic Gram-positive bacteria, aerobic Gram-negative bacteria, anaerobic bacteria and other organisms.

The following data were collected for each patient: age, gender, predisposing factors, size and location of effusion, requirement of chest tube drainage, and biochemical and microbiological characteristics of pleural fluid. The size of the effusion was assessed on the posteroanterior radiograph by visually estimating the area of the hemithorax occupied by pleural fluid. Large effusions were defined as those that occupied 50% of the hemithorax.

Continuous data are reported as medians (25^{th}-75^{th} percentile). The χ_2 and Kruskal-Wallis tests were used to compare groups for qualitative and quantitative variables, respectively. A two-tailed P value 0.05 was considered significant. Statistical analysis was performed with SPSS 10.0 software.

RESULTS

From a total of 205 patients diagnosed of infectious pleural effusion, about 10%, 30% and 75% of typical, complicated parapneumonics and empyema respectively showed culture positive fluids. Specifically, the study population was comprised of 84 patients (41%) with positive cultures of pleural fluid. The median age was 61 (40-74) years, 33 (39%) patients were > 65 years of age, and male/female patient ratio was about 3:1. Excluded from analysis were 27 additional patients whose pleural fluid cultures showed growth of contaminant bacteria, including 9 cases of Staphylococcus epidermidis, and for whom there was an alternative diagnosis of the cause of pleural fluid accumulation. Almost all pleural space infections were parapneumonic in origin (73 patients, 87%). In addition, there were 5 empyemas following a surgical procedure, 3 following trauma, 2 spontaneous bacterial pleuritis complicating hepatic hydrothorax, and 1 secondary to esophageal perforation.

Ninety-three microorganisms, including 62 (67%) aerobic Gram-positive bacteria, 22 (24%) aerobic Gram-negative bacteria, and 6 (6%) anaerobic bacteria were recovered from the 84 patients (Table 1). In the aerobic Gram-positive group, viridans streptococci (19 isolates), Streptococcus pneumoniae (17 isolates), and Staphylococcus aureus (12) were the predominant pathogens. Among the aerobic Gram-negative group, Escherichia coli (7) was the leading organism. In 76 (82%) instances a single organism was recovered in pure culture. Viridans streptococci were the organisms more often present in mixed cultures, whereas pneumococci, S. aureus and E. coli were generally pure isolates.

Figure 1

Table 1: Microbial isolates in 84 cases of pleural space infectionsa

Organisms	No. of isolates
Aerobic Gram-positive bacteria	**62 (52)**
Viridans streptococci	19(13)
Streptococcus pneumoniae	17(17)
Staphylococcus aureus	12(11)
Enterococcus faecalis	7(6)
Streptococcus pyogenes	4(2)
Staphylococcus hominis	1(1)
Micrococcus spp	1(1)
Corynebacterium spp	1(1)
Aerobic Gram-negative bacteria	**22(19)**
Escherichia coli	7(6)
Pseudomonas aeruginosa	4(3)
Proteus mirabilis	3(3)
Salmonella enteritidis	2(2)
Eikenella corrodens	2(1)
Enterobacter cloacae	1(1)
Acinetobacter baumannii	1(1)
Haemophilus influenzae	1(1)
Unidentified Gram-negative bacillus	1(1)
Anaerobic bacteria	**6(2)**
Clostridium spp	2(2)
Peptostreptococcus spp	1(0)
Bacteroides spp	1(0)
Unidentified anaerobic bacteria	2(0)
Miscellaneous organisms	**3(3)**
Nocardia spp	1(1)
Candida spp	1(1)
Rhodotorula spp	1(1)
Total	**93(76)**

[a]Numbers in parentheses indicate the number of isolates that were recovered in pure culture TPE, typical parapneumonic effusion; CPE, complicated parapneumonic effusion; RBC, red blood cell count; WBC, white blood cell count; LDH, lactate dehydrogenase; ADA, adenosine deaminase

An underlying disease or associated medical conditions were present in 58 (69%) patients, of which the most common were malignancy (16 patients, 19%), human immunodeficiency virus disease (10 patients, 12%), and chronic obstructive pulmonary disease (8 patients, 10%), followed by alcoholism (7 patients, 8%), diabetes (4 patients, 5%), and cirrhosis (2 patients, 2%). With regard to specific organisms, 41%, 53%, 83% and 86% of patients with S. pneumoniae, viridans streptococci, S. aureus and Gram-negative aerobic bacteria in pleural fluid, respectively had significant comorbid medical problems. Human

immunodeficiency virus-infected individuals yielded mainly Gram-positive aerobic empyemas (8 out of 10 patients).

No chest tube drainage was inserted in 10 (12%) patients, from whom the following bacteria were isolated: S. pneumoniae (3 cases), E. coli (2), S. aureus (2), Pseudomonas aeruginosa (1), Staphylococcus hominis (1) and unidentified Gram-negative bacillus (1). Of note, 7 of 8 patients for whom chest radiographs were available for assessment had pleural effusions that occupied a third or less of the hemithorax. Moreover, 2 patients cured only with antibiotics (1 E. coli, 1 S. aureus) had cirrhosis and spontaneous bacterial pleuritis, a condition where tube thoracostomy is not indicated.

The fluid in culture-positive effusions was invariably an exudate. In more than 90% of cases, the pleural fluid differential white blood cell count revealed predominantly polymorphonuclear leucocytes. Overall, 63% (35/56) of culture positive fluids of parapneumonic origin, and in particular 74% (28/49) of post-pneumonic empyemas had an ADA level that exceeded the diagnostic cutoff for tuberculosis (40 U/L). When we moved from the initial pathophysiologic stage of a parapneumonic effusion (typical or non-complicated) to later stages (complicated and empyema), pleural fluid yielded higher white-cell counts, percentage of neutrophils, lactate dehydrogenase, and ADA, but lower pH and glucose content (Table 2). Likewise, positive bacterial cultures entailed more frequently an empyema (68%) than a complicated or uncomplicated parapneumonic effusion (20,5% and 11% respectively, $p<0.001$). In addition, when compared to the patients with typical parapneumonic effusions, a substantial percentage of patients with complicated parapneumonic effusions or empyema had large effusions (12% vs 65%, respectively, $p<0.001$).

Figure 2

Table 2: Pleural fluid characteristics of parapneumonic culture-positive effusionsa

Parameter	TPE (n=9)	CPE (n=15)	Empyema (n=49)	*P* value
RBC (No/mm^3)	3,080 (710-14,600)	6,980 (625-17,640)	3,640 (1,150-11,000)	0.801
WBC (No/mm^3)	2,540 (640-2,960)	1,800 (590-8,100)	37,600 (8,720-123,600)	<0.001
Neutrophils (%)	85 (10-90)	88 (72-93)	94 (90-97)	0.013
LDH (U/L)	1,491 (503-3,069)	1,797 (853-4,599)	10,000 (4,053-20,000)	0.002
Protein (g/L)	45 (41-49)	44 (30-53)	37 (27-50)	0.569
ADA (U/L)	48 (16-73)	23 (19-44)	88 (36-166)	0.009
Glucose (mg/dL)	83 (11-101)	80 (21-125)	2 (1-8)	0.002
PH	7.33 (7.02-7.44)	7.16 (6.91-7.44)	6.76 (6.29-7.00)	<0.001

[a]Data are given as median (25^{th}-75^{th} percentile)

DISCUSSION

This study highlights the continuing importance of streptococci in parapneumonic effusions and empyema. Thus, viridans streptococci and S. pneumoniae represented 21% and 19% of all bacterial isolates respectively. The latter was the most common organism recovered in pure culture. This finding may be due to the fact that the primary cause of pleural cavity infection in this series was pneumonia. Another study has also described a predominance of S. pneumoniae [2]. This is in contrast to findings of previously published studies in which some Gram-negative bacilli such as Klebsiella pneumoniae [3] or anaerobic bacteria[4] were the predominant pathogens. The paucity of anaerobic organisms in our series is notable and probably depends on the inadequate method to collect and transfer the pleural specimens to laboratory. In fact, the incidence of anaerobic isolates is dependent both on the care with which they are searched and on the type of population studied (e.g. aspiration-prone patients). Thus, in a recent study anaerobic bacteria were isolated in two thirds of 75 patients with thoracic empyema[5].

In eight separate comprehensive reports[2,3,4,6,7,8,9], including this one, which represent 772 patients and 1201 microorganisms, aerobic Gram-positive, aerobic Gram-negative and anaerobic bacteria were isolated in 42%, 23% and 35% of cases, respectively. Of these, S. aureus, S. pneumoniae, viridans streptococci, K. pneumoniae, E. coli, P. aeruginosa, Peptostreptococcus spp, Bacteroides spp and Fusobacterium spp caused most pleural infections. Moreover, data from the sum of five series[2,3,4,6,7] to the present one, totaling 1025 organisms, show that half of Gram-positive and Gram-negative aerobics are recovered in pure culture, in contrast to less than 20% of anaerobics.

Several comorbid conditions that alter systemic or local pulmonary host defenses such as malignancy, human immunodeficiency virus infection, and chronic obstructive pulmonary disease increase the risk of empyema. In our study, Gram-negative bacterial infection of the pleural space was associated with the higher incidence of underlying disease (86%). Conversely, in otherwise healthy adults, the bacteria most commonly causing pleural infection was S. pneumoniae.

High levels of ADA, a diagnostic test for tuberculous pleuritis, were found in the pleural fluid of a significant proportion of patients with parapneumonic effusion and especially empyema. However, tuberculosis is most

commonly suspected only in lymphocytic effusions, which easily exclude most of the parapaneumonic and empyema fluids[10]. The main problem in dealing with parapneumonic effusions is the selection of patients for pleural drainage[11]. Generally, when bacteria invade pleural space (fibronopurulent stage of a parapneumonic effusion) the ability to resolve the infection with antibiotics alone is lost. Thus, although not evaluated in prospective studies, expert consensus recommends that a positive pleural fluid culture warrants drainage of the pleural space[12,13]. We should stress that occasional patients with culture-positive pleural fluid can be successfully treated without chest tube drainage, specially if pleural effusion is small (a third or less of the hemithorax). Thus, a positive bacterial culture is a strong, but not an absolute indication for drainage[14], although we clearly favor its use[11].

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References

1. Everts RJ, Reller B. Pleural space infections: microbiology and antimicrobial therapy. Semin Respir Infect 1999;14:18-30.
2. Brook I, Frazier EH. Aerobic and anaerobic microbiology of empyema. A retrospective review in two military hospitals. Chest 1993;103:1502-7.
3. Chen KY, Hsueh PR, Liaw YS, Yang PC, Luh KT. A 10-year experience with bacteriology of acute thoracic empyema. Emphasis on Klebsiella pneumoniae in patients with diabetes mellitus. Chest 2000;117:1685-9.
4. Bartlett JG, Gorbach SL, Thadepalli H, Finegold SM. Bacteriology of empyema. Lancet 1974;1:338-40.
5. Boyanova L, Petrov D, Osmanliev D, et al. Anaerobic bacteriology in 75 cases of thoracic empyema in Sofia, Bulgaria. Anaerobe 2000;6:81-5.
6. Varkey B, Rose HD, Kutty K, Politis J. Empyema thoracis during a ten-year period. Analysis of 72 cases and comparison to a previous study (1952 to 1967). Arch Intern Med 1981;141:1771-6.
7. Alfageme I, Muñoz F, Peña N, Umbría S. Empyema of the thorax in adults. Etiology, microbiologic findings, and management. Chest 1993;103:839-43.
8. Kelly JW, Morris MJ. Empyema thoracis: medical aspects of evaluation and treatment. South Med J 1994;87:1103-10.
9. Smith JA, Mullerworth MH, Westlake GW, Tatoulis J. Empyema thoracis: 14-year experience in a teaching center. Ann Thorac Surg 1991;51:39-42.
10. Porcel JM, Vives M. Adenosine deaminase levels in nontuberculous lymphocytic pleural effusions. Chest 2002;121:1379-80.
11. Porcel JM, Rodríguez-Panadero F. ¿Cuándo y cómo drenar un derrame pleural?. Med Clin (Barc) 2002;118:265-7.
12. Light RW, Porcel JM. Derrame pleural paraneumónico y empiema. Med Clin (Barc) 2000;115:384-91.
13. Colice GL, Curtis A, Deslauriers J et al. Medical and surgical treatment of parapneumonic effusions. An evidence-based guideline. Chest 2000;118:1158-71.
14. Berger HA, Morganroth ML. Immediate drainage is not required for all patients with complicated parapneumonic effusions. Chest 1990;97:731-35.

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