# Culture-positive thoracic empyema in adults

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## Summary

Twenty-nine adult patients with culture-positive thoracic empyema were seen at the University Hospital Kuala Lumpur from 1984 to 1988. Cough, fever, chest pain, dyspnoea and weight loss were the common presenting symptoms. The empyema in 16 patients was associated with primary bronchopulmonary infections, nine occurred following thoracentesis of culture-sterile pleural effusions, two occurred as post-thoracic surgery complications, one following a subdiaphragmatic abscess and one as a result of a stab wound. The most common culture isolates were *Streptococcus milleri, Pseudomonas aeruginosa* and *Klebsiella pneumoniae.* Closed tube thoracostomy, the most common form of drainage procedure employed, was able to effect a cure or control of the empyema in 11 out of 19 patients in whom it was used.

*Key words:* Adult, culture-positive, thoracic empyema.

## Introduction

Thoracic empyema, the accumulation of pus in the pleural cavity, continues to be a relatively common and troublesome clinical problem. Direct extension from a pulmonary focus, usually an area of pneumonia, is a common route of infection of the pleural space. The bacteriology of empyema has changed remarkedly during the years. Before antimicrobial agents became available, the most common cause of thoracic empyema was *Streptococcus pneumoniae.* The next most common causative organism was haemolytic *Streptococcus.* When penicillin became available, empyema caused by these two organisms substantially decreased. However, empyemas caused by *Staphylococcus aureus* increased in numbers. The availability of beta-lactamase resistant antistaphylococcal drugs decreased the incidence of staphylococcal empyema, only to give place to more serious infections by gram-negative and anaerobic bacteria.[1–3]

The principles of managing thoracic empyema include the prompt institution of appropriate antimicrobial therapy with provision for adequate drainage of pus and obliteration of the pleural space with full re-expansion of the lung. This study reviews the University Hospital experience with thoracic empyema in adults during the period from January 1984 to December 1988. We

present the clinical features, bacteriology, treatment and outcome of 29 adult patients with culture-positive thoracic empyema seen at the University Hospital during the period under review.

## Patients and methods

For this study, thoracic empyema was defined as the accumulation of pus in the pleural cavity. The diagnosis was made when diagnostic thoracentesis yielded pus. We conducted a retrospective review of the medical records of adult patients with culture-positive thoracic empyema seen at University Hospital, Kuala Lumpur from January 1984 to December 1988. The patients had been admitted either to the medical or surgical units.

Empyema was suspected on the basis of suggestive history and physical signs and chest radiograph appearances of pleural effusion with or without pneumonia. The diagnosis was confirmed when diagnostic thoracentesis yielded pus. Patients who developed empyema following chest-tube insertion for initially sterile pleural effusions had separate diagnostic thoracentesis performed to obtain specimens for culture. Pus from the empyema was cultured for aerobic and anaerobic bacteria before the commencement of antibiotic therapy. Isolates were identified by conventional methods and their susceptibilities to a range of antibiotics were determined by the disc method. For patients who were already on antibiotics, pus from the empyema was cultured for bacteria before antibitiotic therapy was changed. Culture for *Mycobacteria* was also performed when tuberculosis was suspected.

The duration of antibiotic therapy was guided by clinical response and seldom needed to be for more than three to four weeks. Antibiotic coverage was changed when necessary, based on culture and sensitivity results.

The effect of therapy was evaluated by looking at the duration of hospital stay, decrease in fever and total leucocyte count and improvement in the chest radiographic changes. Other parameters looked for included improved sense of well-being, weight gain, and negative repeat culture of pleural aspirate.

Excluded were those patients with culture-negative pleural aspirates and those with pleural aspirates which were not frank pus.

## Results

Twenty-one patients were males and eight were females. Five patients were Malays, 17 were Chinese and seven were Indians. The average age of the patients was 50 years with a range of 16 to 80 years. The common presenting symptoms are as shown in Table 1. Finger clubbing was present in only four patients. The empyema in 12 patients occurred in the right hemithorax while 17 patients had the empyema in the left hemithorax.

Table 2 shows the etiology of the thoracic empyemas. There is a high percentage (31%) of iatrogenic empyema i.e. empyema occuring as a result of contamination of an originally sterile pleural effusion.

Associated diseases present were as follows: primary neoplasm of the lung in six patients, metastatic carcinoma to the lung and pleura from carcinoma of the breast in two patients, diabetes mellitus in three patients, intravenous heroin abuse in one patient, and Wilson's disease in one patient. Four patients were considered to be immunocompromised when their empyemas

developed – the two patients with carcinoma of the breast were receiving cytotoxic chemotherapy, the patient with Wilson's disease was on penicillamine and supraphysiological doses of prednisolone and one patient with squamous cell carcinoma of the bronchus was receiving dexamethasone for superior vena cava obstruction.

The organisms isolated from the thoracic empyema are shown in Table 3. Tables 4 and 5 show the culture isolates and the number of different organisms isolated respectively in the various types of thoracic empyema. A pure growth of a single species was obtained in ten out of the 16 cases of empyema due to primary bronchopulmonary infections. Five out of nine cases of iatrogenic empyema were polymicrobial (i.e. two or three different bacterial species were grown).

Twenty-four patients received systemic antibiotics in conjunction with some form of drainage procedure. Four patients received antibiotics alone, all four had small para pneumonic empyema. One patient refused all forms of treatment.

**Table 1**
**Common Presenting Symptoms of Thoracic Empyema**

| Presenting symptoms | No. of patients | Percentage |
|---|---|---|
| Cough | 24 | 82.8 |
| Fever | 20 | 69.0 |
| Chest pain | 19 | 65.5 |
| Dyspnoea | 17 | 58.6 |
| Weight loss | 16 | 55.2 |

**Table 2**
**Etiology of Thoracic Empyema**

| Etiology of empyema | | No. of patients |
|---|---|---|
| Primary bronchopulmonary infection | | 16 (55%) |
| parapneumonic | 15 | |
| tuberculosis | 1 | |
| Iatrogenic* | | 9 (31%) |
| maglignant effusion | 4 | |
| tuberculous effusion | 3 | |
| heart failure | 1 | |
| nephrotic syndrome | 1 | |
| Postoperative complication | | 2 (7%) |
| pulmonary resection | 1 | |
| oesophagectomy | 1 | |
| Subdiaphragmatic abscess | | 1 (3.5%) |
| Stab wound | | 1 (3.5%) |
| Total | | 29 |

* Thoracentesis/chest tube insertion for initially sterile effusions.

**Table 3**
**Culture Isolates in Patients with Thoracic Empyema**

| Organism | No. of patients |
|---|---|
| *Streptococcus milleri* | 9 |
| *Pseudomonas aeruginosa* | 7 |
| *Klebsiella pneumoniae* | 6 |
| Nonhaemolytic *streptococcus* | 4 |
| *Staphylococcus aureus* | 2 |
| *Serratia marcescens* | 2 |
| Coliforms | 2 |
| *Diphtheroids* | 2 |
| Anaerobic *streptococcus* | 1 |
| *Streptococcus viridans* | 1 |
| *Streptococcus faecalis* | 1 |
| *Actinomycetes* | 1 |
| *Mycobacterium tuberculosis* | 1 |
| *Acinetobacter calcoatosus* | 1 |
| *Proteus* species | 1 |
| *Pasteurella multocida* | 1 |
| *Haemophilus influenzae* | 1 |
| *Enterobacter cloacae* | 1 |
| *Eikenella* species | 1 |
| *Escherichia coli* | 1 |
| Total | 46 |

**Table 4**
**Bacteriology of Thoracic Empyema in 29 Patients**

| Etiology of Empyema | Culture Isolates (No. of cases) | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Streptococcus milleri* | *Pseudomonas aeruginosa* | *Klebsiella pneumoniae* | Streptococcus species | *Staphylococcus aureus* | *Serratia marcescens* | Others |
| Primary bronchopulmonary infection | 7 | 2 | 2 | 3 | 1 | 1 | 7 |
| Iatrogenic | | 5 | 3 | 1 | 1 | | 5 |
| Postoperative complication | 1 | | 1 | 2 | | | 1 |
| Subdiaphragmatic abscess | 1 | | | | | | |
| Stab wound | | | | 1 | | 1 | |
| Total | 9 | 7 | 6 | 7 | 2 | 2 | 13 |
| Percentage of total isolates | 19.6 | 15.2 | 13.0 | 15.2 | 4.3 | 4.3 | 28.4 |

Table 5
Number of Different Organisms Isolated in Thoracic Empyema

| Etiology of empyema | No. of different organisms isolated | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| | (No. of patients) | | |
| Primary bronchopulmonary infection | 10 | 5 | 1 |
| Iatrogenic | 4 | 4 | 1 |
| Postoperative complication | | 1 | 1 |
| Subdiaphragmatic abscess | 1 | | |
| Stab wound | | 1 | |
| Total number of patients | 15 | 11 | 3 |

**Results of therapeutic needle aspiration as initial drainage procedure**: Between one and three aspirations were performed with a large bore needle (13 gauge needle) in conjunction with the use of antibiotics as the initial mode of treatment in five patients. This approach was successful in only two patients, both of whom had only small parapneumonic empyemas on chest x-ray. *Streptococcus milleri* and nonhaemolytic *Streptococcus* respectively were isolated from the empyema aspirates. After failure of repeated needle aspirations the other three patients underwent closed chest tube drainage which was successful treatment for one patient. One patient died from septicaemic shock and one patient required thoracotomy and decortication which cured the empyema.

**Results of closed chest tube drainage as initial drainage procedure**: 16 patients underwent closed chest tube drainage together with systemic antibiotic treatment as the initial mode of treatment, with cure being achieved by this method in nine patients. For the other seven patients in whom closed drainage failed, two patients underwent thoracotomy and decortication as the next surgical procedure and the empyema was cured in both patients. One patient died from septicaemia and one patient died from a cardiac arrest. Two patients underwent thoracotomy plus pneumonectomy as the second surgical procedure and were cured. The remaining patient had rib resection which did not effect adequate drainage of the empyema and eventually needed thoracotomy and decortication which finally cured the empyema.

**Results of thoracotomy as initial drainage procedure**: Three patients underwent thoracotomy as the initial treatment in addition to systemic antibiotics. In two patients decortication was performed. The third patient underwent rib resection. All three patients recovered from their empyema.

Table 6 shows the mode of therapy that eventually cured or controlled the empyema due to the various etiologies. The final outcome of the patients with thoracic empyema is shown in Table 7. Two patients died from empyema-related septicaemia. The first patient had a parapneumonic empyema with an underlying squamous cell carcinoma of the bronchus causing superior vena cava obstruction and was on dexamethasone. The empyema was treated with systemic antibiotics and chest tube drainage. The second patient had diabetes mellitus, myxoedema and nephrotic

syndrome. He developed empyema following diagnostic thoracentesis for a pleural effusion. The empyema was treated with systemic antibiotics and chest tube drainage. The third patient had a post-thoracentesis empyema which was treated with systemic antibiotics and chest tube drainage. He died from a myocardial infarction.

**Table 6**
**Mode of Therapy Which Cured or Controlled Empyema**

| Empyema cured/controlled by | Etiology of Empyema | | | | | |
|---|---|---|---|---|---|---|
| | Primary bronchopulmonary infection | Iatrogenic | Postoperative complication | Subdiaphragmatic abscess | Stab wound | Total |
| | (No. of patients) | | | | | |
| Antibiotics alone | 4 | | | | | 4 |
| Thoracentesis* | 2 | | | | | 2 |
| Closed tube* thoracostomy | 5 | 4 | 1 | 1 | | 11 |
| Decortication* | 2 | 2 | 1 | | 1 | 6 |
| Pneumoneetomy* | 1 | 1 | | | | 2 |
| Mortality | 1 | 2 | | | | 3 |

* In addition to systemic antibiotics

**Table 7**
**Final Outcome of Patients with Thoracic Empyema**

| Outcome | No. of patients |
|---|---|
| Cure/control of empyema | 25 |
| Treatment refused | 1 |
| Died | 3 |

## Discussion

In this review, 16 patients (55%) had thoracic empyema associated with primary bronchopulmonary infections. The reported incidence of empyema due to anaerobic organisms (anaerobes alone or in combination with aerobes) varied greatly in different series. In a series of 226 patients with thoracic empyema reviewed by Sullivan et al,[4] 19% were caused by anaerobes. In the study by Barlett et al,[2] anaerobes were the exclusive isolates in 35% of the cases and were present in combination with aerobes in 41% of the cases. In an analysis of 72 cases, Varkey et al[5] found the incidence of anaerobic empyema to be 38.8%. *Bacteroides* were the most preponderant anaerobe, constituting 37.8% of all anaerobic isolates in Varkey's series. *Bacteroides fragilis* alone accounted for 8.9% of the anaerobic isolates. The low isolation rate of anaerobic organisms in this study could be due to improper collection and handling of the culture specimens. In order not to

miss the isolation of anaerobes, specimens of pleural aspirates should be submitted to the laboratory with minimum delay. The use of a suitable anaerobic transport medium for the specimens will help to improve the isolation rate of anaerobes. Pleural aspirates should be routinely cultured aerobically as well as anaerobically.

*Streptococcus milleri* was the most common organism isolated in parapneumonic empyema in this review. It was also the overall commonest organism isolated. In a study on lung abscess and empyema by Neild et al[6] *Streptococcus milleri* was also the commonest culture isolate, constituting 13.7% of all the organisms isolated.

The other common culture isolates in this study were *Pseudomonas aeruginosa* and *Klebsiella pneumoniae.* It is not surprising that *Pseudomonas aeruginosa* was the most common organism isolated from empyema that occurred following diagnostic thoracentesis and chest tube placement for initially sterile effusions as it was a common hospital commensal. The culture specimens in patients with pre-existing chest-tubes should be obtained by performing separate diagnostic thoracenteses. This is important because chest-tubes become colonised very easily and specimens taken via the chest-tubes are often contaminated by the colonisers which may or may not be the true pathogens.

When antibiotic therapy needs to be commenced before the results of culture and sensitivity are available we recommend a combination of penicillin plus an aminoglycoside to provide coverage for *Streptococcus* and gram-negative organisms. Metronidazole should be added in situations where anaerobes are suspected to be responsible because *Bacteroides fragilis* is almost invariably penicillin resistant and so are *Bacteroides* found in the gut flora like *B. vulgatus* and *B. ruminicola.*

Not every patient with thoracic empyema requires surgical treatment. Antibiotics alone or antibiotics plus therapeutic thoracentesis were able to cure six out of 15 of our patients. However, this mode of treatment was effective only for parapneumonic empyema. Surgical treatment should be carried out if the pus is thick and difficult to aspirate even with a large-bore needle or when the empyema is massive (more than one litre). In a study by Mandal and Thadepalli[7] about 25% of their patients with spontaneous parapneumonic empyema required no more than simple needle aspiration and prompt initiation of appropriate antibiotic treatment. Of their patients, 39% required intercostal tube drainage and 36% required decortication.

Closed chest tube drainage is the preferred treatment in the surgical management of most acute empyemas. However, the failure rate has been reported as 26% to 36% when closed tube drainage was used as the initial surgical treatment.[5] Closed chest tube drainage was the most common form of surgical drainage procedure employed for our patients and it was able to effect a cure or control of the empyema in only 11 out of 19 patients (58%) in whom it was used.

Apart from closed chest tube drainage, other surgical methods of drainage include rib resection, open tube drainage, thoracotomy and decortication or empyemectomy. In a recent study, Lemmer and coworkers found chest tube drainage to be effective in curing 67% of parapneumonic empyema but only 12% of postoperative empyema. They recommend early rib resection particularly for postoperative empyemas and those occurring in immunocompromised patients.[8,9]

Decortication should be done when the pus is thick and gelatinous, multiloculated and located posteriorly like a reversed D-shaped density as seen on a lateral view of the chest x-ray. Decortication is also indicated for previously untreated and neglected empyema or empyema with incomplete drainage or incomplete re-expansion of the lung. Both decortication and

empyemectomy eliminate the foci of infection and the limiting fibroblastic membrane and thereby facilitate lung re-expansion. However, it has been reported that decortication provides only slight improvement in the pulmonary function in adults who had preoperative reduction in vital capacity of more than 40%[10] in contrast to a definite improvement in pulmonary function in children.[11]

The mortality rate in thoracic empyema depends on whether it is primary (ie. associated with a primary bronchopulmonary infection) or secondary (postoperative, etc.), the age of the patient, the bacteriology, the correct antibiotic used and the mode of surgical therapy instituted. Early diagnosis, gram stain, culture of pus for both aerobic and anaerobic bacteria, prompt commencement of antibiotics effective against these bacteria, close monitoring of the patient's clinical condition, and institution of appropriate surgical procedures as soon as needed will contribute to a favourable outcome in the management of thoracic empyema.

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