Empyema of the Thorax in Adults:
Review of 105 Cases*

Gordon L. Snider, M.D., F.C.C.P.,** and Suhayl S. Saleh, M.D.†

Thoracic empyema has become an uncommon disease in adults, tending to occur in chronically ill debilitated individuals. In this series, pulmonary infection was the underlying cause in more than half the cases, with bronchogenic carcinoma or other serious lung disease present in one fifth of the pulmonary infections. Thoracic surgery preceded almost one quarter of all cases. Staphylococcus aureus and gram-negative bacilli were the most commonly found organisms. Successful therapy is founded on correct choice and adequate dose of antibiotics, prompt institution of adequate drainage, and recognition and treatment of underlying factors. Decortication, with or without pulmonary resection, and thoracoplasty continue to have a place in treating chronic empyema. Emphyema contributed to death in less than five percent of this series. However, overall mortality was just under 50 percent reflecting the occurrence of pleural sepsis in patients with a variety of serious neoplastic and degenerative diseases.

INTRODUCTION

Empyema of the thorax has become a relatively uncommon disease since the advent of antibiotics. Perhaps because of this decreased incidence, many physicians have lost sight of the important diagnostic and therapeutic challenges still presented by the disease. The present report, based on a review of the cases of empyema observed at Wood Veterans Center during the past 15.5 years, is divided into two parts. Part 1 deals with the pathology underlying the development of empyema and the bacterial etiology of the infection. In Part 2, the principles of therapy are discussed and the outcome in this series is presented.

PATIENT MATERIAL

The records of 105 patients with empyema of the thorax studied between Jan 1, 1952, and June 30, 1967, were reviewed. These 105 cases represent an incidence of 0.89 cases of empyema per 1,000 admissions to the hospital. The number of cases has fluctuated between one and 11 per year with no pattern evident (Fig 1). The patients were all men, and their age distribution was as follows: 19 percent of the patients were less than 45 years of age; 51 percent were age 45-65; and 30 percent were older than 65 years. The comparable percentages for all hospital admissions during the six years from 1960 to 1966 inclusive were 26, 30 and 44.

1. PATHOGENESIS AND BACTERIOLOGY OF EMPYEMA

Mechanism of Infection of the Pleural Space

The usual mechanisms of infection of the pleural space are summarized and illustrated in Figure 2. The pathogenesis of the empyema in the present series is shown in Table 1. Extension from pulmonary infection accounted for 38 cases or somewhat more than half of the patients. There was complicating pulmonary disease underlying the infection in ten of these cases: bronchogenic carcinoma in seven, septic infarction in two and tuberculosis in one case. Postsurgical empyema accounted for 23 cases, evenly distributed over the duration of the study (Fig 1). Empyema complicated 0.9 percent of the thoracotomies performed during the period of the study.

Trauma, esophageal fistulas, spontaneous pneumothorax and post-thoracentesis infection each accounted for four cases. The esophageal fistulas resulted from carcinoma of the esophagus in two instances and instrumentation in one instance; in the fourth instance the etiology of the perforation was not established. The four patients with spontaneous pneumothorax and empyema all had evidence of bronchopleural fistulas. The four patients

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who developed empyema following thoracentesis had clear sterile fluid removed on initial tap prior to the development of empyema. Two patients developed empyema as a complication of subdiaphragmatic pathology. In one patient a pancreatic pseudocyst extended from beneath the diaphragm into the pleural space. The other patient developed a subphrenic abscess complicating generalized peritonitis subsequent to an appendectomy for acute appendicitis with an appendiceal abscess.

The etiology could not be determined with certainty in six cases but was likely postpneumonic. Extension of infection from the mediastinum secondary to tracheal fistula, or to lymph node or bone infection was not observed in this series.

**Bacterial Etiology of Empyema**

A single organism was cultured in 52 cases; two or more organisms were cultured in 25 cases; the culture was sterile in 15 cases; and a culture was not done in 13 cases. The frequency of recovery of microorganisms from the 92 patients whose fluids were cultured is shown in Figure 3. *Staphylococcus aureus* was the most frequently recovered organism with gram-negative bacilli a close second. The following organisms comprised the gram-negative bacilli: Pseudomonas, 13 percent; Klebsiella pneumoniae, 6.5 percent; *Escherichia coli*, 6.5 percent; *Aerobacter aerogenes*, 1.1 percent; Proteus, 9.8 percent; Bacteroides, 3.3 percent, and Salmonella, 1.1 percent. Streptococci were recovered from 15.3 percent of the cultured specimens; 65 percent of these were *Streptococcus faecalis* and 5.5 percent were beta-hemolytic streptococci. The unusual microorganisms cultured included one instance each of *B subtilis*, Clostridium perfringens, *Staphylococcus albus* and Achromobacter.

**Table 1—Pathogenesis of 105 Cases of Empyema**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No. Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary infection**</td>
<td>58 (55.2)</td>
</tr>
<tr>
<td>Postsurgical</td>
<td>23 (21.9)</td>
</tr>
<tr>
<td>Posttraumatic</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Esophageal fistula</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Spontaneous pneumothorax</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Postthoracentesis</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Subdiaphragmatic path.</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>Etiology undetermined</td>
<td>6 (5.7)</td>
</tr>
</tbody>
</table>

*Figures in parenthesis are percent of total.

**There was underlying bronchogenic carcinoma, septic infarction or tuberculosis in ten of these patients or 9.5 percent of the total population.

Table 2 lists the pathogenetic mechanisms in the 25 patients with empyema from whom two or more organisms were recovered. There was a communication between the pleura and the exterior via either the bronchus or the gastrointestinal tract in 17 of these 25 cases.

**COMMENT**

The case material analyzed here is drawn from the selected adult population of a veterans hospital. Patients requiring emergency admission are probably underrepresented and there were no women in the series, hardly a surprising fact, since less than 10 percent of all hospital admissions are women. However, in representative populations empyema still occurs about three times more frequently in men than in women.1,2 The disease is most frequent in the fifth to seventh decades in adults1,2 and in our series occurred more frequently in this age group than expected from the age distribution of all admissions.

Bronchopulmonary infection and thoracotomy were the most frequent underlying factors but approximately half of the patients had associated neoplastic or neurological disease, renal or cardiac failure. Delay in institution of antibiotic therapy, the administration of an inadequate dose of antibiotic or too short duration of treatment were frequently antecedents of postpneumonic empyema. We were surprised to find that four patients developed empyema subsequent to a thoracotomy and which originally yielded sterile pleural fluid. This

**Table 2—Pathogenesis of 25 Cases of Empyema with Multiple Organisms**

<table>
<thead>
<tr>
<th>Pleural-Exterior Communication</th>
<th>No. Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postsurgical</td>
<td>10</td>
</tr>
<tr>
<td>Pneumonia with BP fistula*</td>
<td>3</td>
</tr>
<tr>
<td>Subdiaphragmatic lesion</td>
<td>2</td>
</tr>
<tr>
<td>Pleural biopsy</td>
<td>1</td>
</tr>
<tr>
<td>Trauma</td>
<td>1</td>
</tr>
<tr>
<td>Subtotal</td>
<td>17</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
</tr>
</tbody>
</table>

*BP indicates bronchopleural.
PORTAL OF ENTRY OF INFECTION

I. PULMONARY

PNEUMONIA
DIRECT EXTENSION

PNEUMONIA
LYMPHATIC EXTENSION

PNEUMONIA
OBSTRUCTED BRONCHUS
CA. FOREIGN BODY

PNEUMONIA
HEMATOGENOUS INFECTION

PNEUMONIA
NECROTIZING
Ruptured ABCESS

II. MEDIASTINAL

TRACHEAL FISTULA

ESOPHAGEAL FISTULA

ABCESS DUE TO
LYMPH NODE OR
OSTEOMYELITIS

III. SUBDIAPHRAGMATIC

VISCERAL PERITONEAL

IV. DIRECT INOCULATION

TRAUMA IATROGENIC

POST-OPERATIVE
INFECTED HEMOTHRAX
LEAKING BRONCHIAL
CLOSURE

Figure 2. Schema of mechanisms of infection of the pleural space.
The occurrence of more than one organism in the pleural space should immediately raise the suspicion of a communication with the exterior via the skin, tracheobronchial tree or gastrointestinal tract.

2. The Principles of Treatment of Empyema

Acute and Chronic Empyema

It is convenient in discussing the therapy of empyema to classify the disease into acute and chronic forms. Acute empyema may be defined as that stage of the disease in which obliteration of the pleural space is possible by means of adequate antibiotic therapy with closed drainage. Chronic empyema is that stage of the disease in which effective obliteration of the empyema space is impossible without the application of surgical measures such as prolonged open drainage, decortication or thoracoplasty. The pathologic changes which result in the development of chronic empyema are either loculation of the empyema space or the development of a thick epipleral fibrous membrane which traps the underlying lung. Destructive pathologic changes in the underlying lung may also act to prevent pulmonary reexpansion.

Early Diagnosis

Postpneumonic empyema is prevented by prompt treatment of pneumonia with an adequate dose of the appropriate antibiotic given for sufficient duration. Empyema, the presence of pus in the pleural space, is most effectively treated if diagnosed early. Therefore, the possibility of a purulent effusion must be considered whenever there is evidence of fluid in the pleural space and diagnostic thoracentesis should be performed promptly. In this series there were 15 patients in whom the diagnosis of empyema was made for the first time at autopsy, and in two of these the infection was believed to have contributed significantly to the patients’ death (Table 3). Gram-stained smears of the pus should be examined to provide preliminary information on bacterial etiology. Anaerobic as well as aerobic cultures should always be done and cultures for myco-

Table 3—Method and Results of Treatment in 105 Cases of Empyema

<table>
<thead>
<tr>
<th>Method</th>
<th>Total No.</th>
<th>Deaths from Empyema</th>
<th>Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracentesis</td>
<td>23</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Closed drainage</td>
<td>9</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Open drainage</td>
<td>34</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Decortication</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thoracoplasty</td>
<td>11</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Autopsy diagnosis</td>
<td>15</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Treatment refused</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>105</strong></td>
<td><strong>5</strong></td>
<td><strong>49</strong></td>
</tr>
</tbody>
</table>

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bacteria and fungi should be ordered unless the etiology of the empyema becomes quickly apparent.

**Antibiotic Therapy**

Appropriate antibiotic therapy must be administered in adequate dosage as soon as the diagnosis of empyema has been established. Initial antibiotic therapy is based on the findings of the gram-stained smear of the pus and on the organism most probable in the special circumstances of the case. Necessary changes can be made once the cultures and antibiotic sensitivity tests are available. For example, following thoracic surgery, if the smears do not reveal organisms, *Staphylococcus aureus* and gram-negative bacilli should be considered likely causes of empyema and initial antibiotic therapy should provide effective coverage for both groups of organisms. First and alternate choices of antibiotics used in the treatment of empyema at this institution are given in Table 4. The alternate drugs are recommended where there is reason to suspect hypersensitivity to the first choice drug. Some of the choices presented are of course arbitrary, since opinions vary as to the relative risk of toxicity from kanamycin as compared with the combination of chloramphenicol and streptomycin for the treatment of gram-negative organisms. Chloramphenicol should not be continued unless bacteriologic studies confirm the indication for its use. A decrease in dose and careful hematologic monitoring are necessary if it is to be used beyond a few days. The available literature, which has recently been reviewed by Weinstein, indicates that antibiotic levels are generally lower in the pleural space than in plasma. The indicated antibiotic should, therefore, be given in large doses and should be administered parenterally to assure adequate penetration into the pleura. Intrapleural instillation of antibiotics, although not routinely practiced, may be helpful in difficult gram-negative infections.

**Adequate Drainage and the Obliteration of the Pleural Space**

Adequate drainage of the pleural space is an essential complement of antibiotic administration. A number of the sterile empyemas in the present series probably resulted from the administration of antibiotic therapy without drainage. Complete evacuation of pus from the pleural space should be carried out promptly after the initial diagnostic aspiration; this may be done with a needle or by immediate institution of closed drainage. If fluid reaccumulates after needle drainage, one additional aspiration may be done but further fluid accumulation should be treated by instituting closed water-seal drainage. The more rapidly the chest wall and the underlying lung can be apposed, the more rapidly will obliteration of the pleural space and healing of the empyema occur. When there is a bronchopleural communication, the application of negative pressure to the water-seal drainage bottles hastens pulmonary expansion and obliteration of the empyema pocket.

Open pleural drainage is used only in patients with chronic empyema, either in preparation for surgical therapy or as definitive therapy, when the patient's general condition does not permit a surgical procedure. Thoracentesis was the only form of treatment used in 20 percent of our patients (Table 3). Closed drainage was used in nine subjects in this series; open drainage was resorted to in about one third of patients and most of these had serious associated disease (Table 3).

**Evaluation of Pathogenesis**

The pathogenesis of the empyema must be evaluated and the indicated therapeutic measures must be instituted. For example, special treatment measures may be necessary for drainage of a subdiaphragmatic abscess or the removal of a foreign body from the pleural space after trauma.

**Failure to Respond to Therapy**

When response to treatment is poor, the empyema fluid should be promptly recultured. This is especially necessary in the presence of a bronchopleural fistula since a new organism, such as a gram-negative rod, may have appeared which will require a change in antibiotic therapy. Unusual microorganisms such as *Actinomyces* or mycobacteria should also be sought.

**Promotion of Drainage**

Intrapleural fibrinolytic enzymes such as streptococcal fibrinolysin and deoxyribonuclease (streptokinase-streptodornase), have been disappointing in

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**Table 4—Antibiotics of Choice in Empyema**

<table>
<thead>
<tr>
<th>Organism</th>
<th>1st Choice</th>
<th>2nd Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staph. aureus</em></td>
<td>Methicillin</td>
<td>Cephalothin</td>
</tr>
<tr>
<td><em>Strep. pyogenes</em></td>
<td>Penicillin G</td>
<td>Lincomycin</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>Polymyxin B</td>
<td>Colistin</td>
</tr>
<tr>
<td><em>Gram negative</em></td>
<td>Chloramphenicol</td>
<td>Kanamycin</td>
</tr>
<tr>
<td><em>Bacilli</em></td>
<td>Streptomycin</td>
<td>Streptomycin</td>
</tr>
<tr>
<td><em>K pneumonia</em></td>
<td>Cephalothin</td>
<td>Chloramphenicol</td>
</tr>
</tbody>
</table>

*Initial dosage per 24 hours: penicillin, 10 to 20 million units intravenously (I.V.); methicillin, 8 to 12 gm, I.V.; lincomycin, 2 to 6 gm, I.V.; chloramphenicol, 6 to 12 gm, I.V.; ampicillin, 4 to 6 gm, I.V.; streptomycin, 4 gm, I.V. or intramuscularly 12 gm; streptomycin, 2 gm, I.M.; kanamycin 1 to 3.5 gm, I.M.; polymyxin B, 150 to 200 mg, I.M.; colistin, 150 to 300 mg, I.M.*

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promoting drainage in loculating empyema. These drugs should be used only in the presence of ade-
quate closed drainage so that products of enzymatic action may be removed from the thoracic space after one to two hours and marked febrile reactions prevented.

Irrigation with saline or with antibiotic solutions is effective in removing fibropurulent debris but should be used only as part of some overall plan. For example, in the Clagett-Geraci method of treating postpneumonectomy empyema, open dependent drainage is carried out followed by irrigation with neomycin solution until the exudate recovered from the empyema space has become minimal. The thoracic cavity is then filled with neomycin solution and is surgically closed.\(^5,6\)

\textit{Decortication}

Thoracotomy and decortication may become necessary for removal of an empyema pocket which has become loculated so that effective open or closed drainage is not possible.\(^7\) The operation is also used to remove a layer of thick organized fibrinous exudate on the visceral pleura which is preventing expansion of the underlying trapped lung. Decortication is often combined with resection of lung tissue which is seriously damaged or the site of a bronchopleural fistula. Decortication was used 12 times in this series (Table 3).

\textit{Thoracoplasty}

When an empyema persists, perhaps with a bronchopleural fistula, and the patient is not a suitable candidate for decortication, the infected pleural space can often be obliterated by a thoracoplasty.\(^6\) In this operation, segments of ribs are resected subperiosteally allowing the chest wall to fall in by its own weight and the below atmospheric pressure in the pleural space. The operation can be performed in stages and carries less risk than resection. Thoracoplasty was performed in twelve of our patients, (Table 3), chiefly in postoperative empyemas.

\textit{Results of Therapy}

The methods and results of treatment are sum-
marized in Table 3. Although there were 49 deaths in this series, in only five patients was empyema considered to be an important contributing cause of death. The causes of death in the remaining 44 patients were as follows: carcinoma of the lung, 12; other malignancy, 11; cardiac disease, 7; severe fibrosing pulmonary disease, 4; central nervous system disease, 3; renal failure, 3; inanition, 2; pulmonary embolism and hepatic disease, 1 each.

\textbf{Comment}

The mortality secondary to empyema reported by Yeh and his colleagues\(^1\) was similar to the mortality in this series. There were five deaths from empyema in their 110 patients and nine patients in whom death was believed to have resulted from the underlying disease. The much higher mortality from causes other than empyema in the present series reflects the much higher proportion of patients above age 60, 50.4 per cent, as opposed to 18.6 per cent of adults in Yeh's series. Empyema tends to occur in patients who are elderly, debilitated and seriously ill with other disease.

\section*{References}


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