Empyema Thoracis*
Factors Influencing Morbidity and Mortality
David G. Ashbaugh, MD, F.C.C.P.

The effects of delay in surgical treatment and the choice of operation on morbidity associated with empyema thoracis were evaluated in 122 consecutive patients. Patients (71 from a private practice and 51 from an inner-city trauma/indigent care facility) eligible for study were divided into treatment groups of chest tube only (CT = 39) and open drainage (OD = 19), or decortication (DC = 65). Delay in treatment was defined as >3 days from recognition of empyema to CT and >14 days to OD or DC when chest tubes were inadequate or were not used initially. Delay in OD significantly increased total illness (p = 0.023), days until removal of chest tubes (p = 0.037), and hospital stay (p = .048), but did not affect postoperative stay. Delay in DC increased total illness (p = 0.0001), but did not affect other variables. Delay in CT increased mortality from 3.4 percent to 16 percent. Delay did not increase mortality in OD and DC. DC was superior to OD in patients requiring major operation in total illness days (DC = 36.1 vs OD = 106.1) (p = 0.0005), days until removal of tubes (DC = 7.5 vs OD = 78.3) (p = 0.0001), and postoperative stay (DC = 11.6 vs OD = 17.3) (p = 0.018). Overall mortality was lowest in the DC group (6.1 percent). Delay in treatment increases morbidity and DC is more effective than OD in reducing morbidity and mortality when surgical intervention is necessary. (Chest 1991; 99:1162-65)

CT = chest tube (drainage); DC = decortication; HMC = Harborview Medical Center; OD = open drainage

The promise of antibiotics in the treatment of infection may lead to relaxation or ignorance of principles of treatment that were learned by hard-won experience in the preantibiotic era. The treatment of empyema thoracis is a case in point. Empyema remains a common illness with significant morbidity and mortality that approaches and sometimes exceeds reports from earlier times. Although the clinical stages of empyema, the frequent need for surgical intervention, and the appropriate operations are well documented, reliance on antibiotics may delay appropriate surgical intervention and prolong morbidity. This study was specifically undertaken to look at the effect of (1) delay in surgical intervention and (2) the choice of operation on morbidity and mortality.

METHODS

Patients
Seventy-one consecutive patients from the practice of a group of cardiothoracic surgeons in Boise, Idaho (1972 to 1988) and 51 consecutive patients from Harborview Medical Center (HMC), Seattle, Wash. (1984 to 1988) who were referred for surgical consultation were studied. All patients were determined to have empyema on the basis of clinical diagnosis, chest roentgenograms, and in most, but not all, laboratory confirmation based on thoracentesis findings. Patients excluded were those with long-standing, draining empyemas, empyemas whose definitive treatment was performed in another institution, and empyemas complicating resectional surgery. The practice in Idaho served an urban and rural area of roughly 300,000 population. HMC is an acute-care hospital in the University of Washington system that serves as the level 1 trauma center for Seattle and large areas of the Pacific Northwest and is also the primary hospital delivering care to indigent and underserved patients residing in King County, Washington. In all patients, an attempt was made to discern the illness responsible for the empyema, the bacterial organisms involved, the timing of various types of surgical intervention, and their effect on hospital stay, postoperative stay, total illness days, chest tube days, and mortality as they related to choice and timing of operative intervention.

Surgical procedures are defined as follows: (1) chest tube (CT) drainage, limited to percutaneous insertion of chest tubes; open drainage (OD), involving operations to break up loculations and drain the pleural space but not decortication; and (3) decortication (DC), visceral and parietal pleurectomy with reexpansion of the lung. Most patients undergoing OD or DC had failed chest tube drainage, although some had OD or DC as a primary procedure.

Statistical differences among groups were determined using the nonparametric Wilcoxon signed rank test (Mann-Whitney U) as there was significant skewing of data among individual patients.

RESULTS

Demographics of the study groups are shown in Table 1. Male subjects predominated by a margin of 2.3 to 1 and the age ranged from 1 to 83 years with an average age of 40 years. Cause of the empyema and

<table>
<thead>
<tr>
<th>Table 1 — Patient Data*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>Patients</td>
</tr>
<tr>
<td>Average age, yr</td>
</tr>
<tr>
<td>Male/female</td>
</tr>
</tbody>
</table>

*CT = chest tube only; OD = open drainage, with or without prior chest tube drainage; and DC = decortication, with or without prior chest tube drainage.

*From the Department of Surgery, University of Washington, Seattle.

Manuscript received August 3; revision accepted October 30.
Reprint requests: Dr. Ashbaugh, Department of Surgery, RF-25, University of Washington, Seattle 98195

Downloaded From: http://journal.publications.chestnet.org/pdfffaccess.ashx?url=/data/journals/chest/21628/ on 06/05/2017
Table 2—*The Etiology of Empyema*

<table>
<thead>
<tr>
<th>Etiologic Factor</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>83</td>
</tr>
<tr>
<td>Trauma</td>
<td>30</td>
</tr>
<tr>
<td>Aspiration</td>
<td>14</td>
</tr>
<tr>
<td>Neurologic</td>
<td>13</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>13</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>10</td>
</tr>
<tr>
<td>Lung abscess</td>
<td>4</td>
</tr>
<tr>
<td>Bronchopleural fistula</td>
<td>4</td>
</tr>
</tbody>
</table>

*Many patients, particularly trauma patients, had more than one etiologic factor.

Contributing causes are shown in Table 2. While pneumonia was the major cause for both groups of patients, trauma as a contributing cause was present in only 4 of 71 patients in the practice group as compared with 26 of 51 in the HMC group. Neurologic injury or illness was a contributing cause in 13 patients and in 7 of these the empyema was secondary to an aspiration pneumonia. Secondary infection of a traumatic hemorhorax occurred in ten patients.

Table 3 documents culture data. Of particular interest are the 15 patients who did not have cultures done prior to referral for surgery and the 30 patients whose cultures were sterile at the time of thoracentesis. In the latter group, all had received antibiotics prior to thoracentesis. When patients with traumatic hemorhorax developed empyema, 8 of 10 grew Staphylococcus aureus, coagulase-positive organisms. When aspiration was the cause, mixed organisms were grown in 10 of 14 patients.

Delay in Treatment

An arbitrary time period of three days from the identification of empyema was assigned to CT and 14 days to OD or DC. By 3 days, laboratory data confirming empyema should be in hand and 14 days is a reasonable time to see if antibiotics and CT will be effective. Furthermore, beyond two weeks, technical aspects of DC become progressively more difficult. Delay beyond three days in placing the chest tube had no statistically significant effect on total illness, hospital stay, or chest tube days. Delay in OD produced a statistically significant increase in total illness days (p = .023) and chest tube days (p = 0.037) but did not cause a change in postoperative days (Table 4). Hospital stay was increased from 15 to 31 days (p = .48). Delay in DC dramatically increased total illness (p = 0.001), but did not affect hospital stay, postoperative stay, or chest tube days (Table 5).

Choice of Operation

OD was compared with DC and DC patients had less total illness days (p = 0.0005), chest tube days (p = 0.0001), and postoperative days (p = 0.01) while hospital stay was not significantly reduced (Table 6). Comparisons of chest tube treatment to OD and DC were not done since the chest tube patients did not undergo a major surgical procedure.

Mortality

Deaths are shown in Table 7. Although mortality was highest in the OD group, the death rates among groups were not statistically significant.

Discussion

By combining the two groups in the analysis, biases such as population base, patient mix, and physician preference and experience that might be inherent in one group of patients would be balanced by the other group. In fact, there were few differences noted among the groups except for the higher numbers of trauma patients at HMC. Factors such as delay in treatment, preoperative and postoperative stay, total illness, and choice of operation were not statistically different among groups.

The major factors impinging on morbidity are the delay that frequently occurs before surgical consultation and the choice and timing of the operative procedure. The stages of empyema are (1) exudative, (2) fibrinopurulent, and (3) organizing. Stage 1 represents the fluid stage of empyema that responds nicely to CT or, in some patients, thoracentesis alone. This stage is present early and progression into stage 2 often occurs with 24 to 48 hours. Stage 2, the fibrinopurulent stage, may still be amenable to CT but again the window of opportunity is often short lived with rapid progression into stage 3 where only OD or DC is effective. In the patients who were reported by Van Way and associates, 12 half never advanced to stage 3 indicating more aggressive early treatment and also reflective of their very low mortality. In this series, 70 percent of patients were in stage 3, including several in the chest tube only group who refused surgery or were deemed unsuitable for operative intervention. Other authors have also commented on the need for early and aggressive ther-

Table 3—*Bacteriologic Data on Empyema Patients*

<table>
<thead>
<tr>
<th>Bacteriologic Data</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not done</td>
<td>15</td>
</tr>
<tr>
<td>Sterile</td>
<td>30</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>20</td>
</tr>
<tr>
<td>Coagulase positive</td>
<td>2</td>
</tr>
<tr>
<td>Coagulase negative</td>
<td></td>
</tr>
<tr>
<td>Mixed organisms</td>
<td>18</td>
</tr>
<tr>
<td>Streptococcus pneumonia</td>
<td>16</td>
</tr>
<tr>
<td>β-Hemolytic streptococcus</td>
<td>5</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>3</td>
</tr>
<tr>
<td>Hemophilus</td>
<td>2</td>
</tr>
<tr>
<td>Legionella</td>
<td>1</td>
</tr>
</tbody>
</table>

*Anaerobes, aerobes: gram negative and gram positive.
apy,\textsuperscript{3,13} and even the long-held belief that children should be treated conservatively\textsuperscript{14} is now being challenged\textsuperscript{15-18} by surgeons advocating an early aggressive approach, including DC. The current data document the effect of delay of operation in stage 3 empyma as prolonging morbidity.

The major controversy among surgeons is the choice of OD vs DC when tube drainage fails. Proponents of open drainage\textsuperscript{*} claim that this is the treatment of choice, but their mortality remains high and rate of cure of empyma low with only 43 of 70 patients cured, whereas in this series, all surviving patients were cured of their empyma (111/122). Van Way et al\textsuperscript{19} are more effective advocates of OD; however, the procedure described\textsuperscript{19} is actually a thoracotomy and debridement of the pleural space, which if done early before a peel develops and is adherent to the lung, avoids the need for DC. The effectiveness of DC as the procedure of choice is strongly supported in the literature and by my data. Perhaps the most striking article is that of Burford et al\textsuperscript{19} who demonstrated the effectiveness of early DC with low morbidity and mortality. More recent authors advocating early DC also cite the benefits in lowered morbidity. A novel approach has been advocated by Hutter et al\textsuperscript{4} using thoracoscopy to break up loculations followed by tube drainage. Tubes were removed at a mean of 20 days later which is, however, almost triple the time following DC in this series.

While mortality remains high overall, there is no evidence that DC carries a higher mortality than other forms of treatment and indeed, it may be the least lethal form of treatment of stage 3 empyma. The fact remains, however, that some patients are too ill to tolerate a major thoracotomy and for these patients,

\begin{table}[h]
\centering
\caption{Effect of Delay on Open Drainage*}
\begin{tabular}{lcccc}
\hline
\multicolumn{2}{c}{Category} & \multicolumn{2}{c}{Median} & \multicolumn{2}{c}{Mean} \\
\multicolumn{2}{c}{} & \textless14 days & \textgreater14 days & \textless14 days & \textgreater14 days \\
\hline
Total illness & 18 & 106 & 26.1 & 125.4 & 0.023 \\
Hospital days & 15 & 27 & 15.7 & 30.6 & 0.048 \\
Postoperative days & 11 & 17 & 12.8 & 21.7 & NS \\
Chest tube days & 13 & 46 & 20.2 & 92.1 & 0.037 \\
\hline
\end{tabular}
\end{table}

*Median, mean, and p values for \textless14 days and \textgreater14 days.

\begin{table}[h]
\centering
\caption{Effect of Delay in Decortication*}
\begin{tabular}{lcccc}
\hline
\multicolumn{2}{c}{Category} & \multicolumn{2}{c}{Median} & \multicolumn{2}{c}{Mean} \\
\multicolumn{2}{c}{} & \textless14 days & \textgreater14 days & \textless14 days & \textgreater14 days \\
\hline
Total illness & 21 & 37 & 24.7 & 49.8 & 0.0001 \\
Hospital days & 17 & 18 & 20.9 & 25.1 & NS \\
Postoperative days & 9 & 9 & 12 & 11 & NS \\
Chest tube days & 6 & 5 & 8 & 6.6 & NS \\
\hline
\end{tabular}
\end{table}

*Median, mean, and p values for \textless14 days and \textgreater14 days.

\begin{table}[h]
\centering
\caption{Morbidity as influenced by open drainage (OD) or decortication (DC)*}
\begin{tabular}{lcccc}
\hline
\multicolumn{2}{c}{Category} & OD & DC & OD & DC \\
\hline
Total illness & 53 & 25 & 106.1 & 36.1 & 0.0005 \\
Hospital days & 21 & 18 & 23.8 & 23.2 & NS \\
Postoperative days & 13 & 9 & 18.6 & 11.5 & 0.018 \\
Chest tube days & 29 & 5 & 78.3 & 7.4 & 0.0001 \\
\hline
\end{tabular}
\end{table}

*Median, mean, and p values.

\begin{table}[h]
\centering
\caption{Mortality for the Entire Series by Cause and by Treatment Category*}
\begin{tabular}{lccc}
\hline
Category & No. \\
\hline
ARDS & 5 \\
Neurologic & 2 \\
Massive hemoptysis & 1 \\
End-Stage COPD & 1 \\
Sepsis (abdominal) & 1 \\
Cardiorespiratory arrest & 1 \\
Deaths & \\
CT & 3/39 \\
OD & 4/19 \\
DC & 4/64 \\
7.6% & 21% & 6.2% \\
\hline
\end{tabular}
\end{table}

*ARDS = adult respiratory distress syndrome; COPD = chronic obstructive pulmonary disease; CD = chest tube (drainage); OD = open drainage; and DC = decortication.
Algorithm for Empyema

Pleural effusion
Thoracentesis

Gram stain-neg
Gram stain-pos

Observe
Increasing fluid

Resolution
Non-resolution

Open drainage
Decortication

Figure 1. An algorithm for the treatment of empyema. Antibiotics appropriate to treat the underlying condition are begun after thoracentesis when the patient presents with an effusion and suspected empyema.

OD with its higher morbidity and mortality may be the only available choice. Improved mortality is likely to come with an early diagnostic and therapeutic approach. To implement this, an algorithm is proposed for the treatment of empyema (Fig 1). At the earliest sign of fluid, a thoracentesis should be performed and an attempt should be made to remove all fluid. If the Gram stain is positive or pus is encountered, a chest tube should be inserted immediately. If no organisms are found, close observation with daily chest roentgenograms is begun and if fluid recurs, a chest tube is inserted. When a chest tube fails to fully expand the lung, early DC is performed under adequate antibiotic coverage with OD reserved for patients who cannot tolerate a major anesthetic or operation. When DC is performed before two weeks, the visceral peel usually separates easily and without blood loss; parietal DC is seldom needed and patients are often home with no tubes within seven to ten days. Using this approach, the following goals of treatment, as outlined by Mayo et al (7) may reasonably be achieved: (1) to save life, (2) to eliminate the empyema, (3) to reexpand the trapped lung, (4) to restore mobility of the chest wall and diaphragm, (5) to return respiratory function to normal, (6) to eliminate complications or chronicity, and (7) to reduce the duration of hospital stay.

ACKNOWLEDGMENT: The author would like to thank his former partners in Boise, Idaho, who generously allowed him to include their patients in this report. At HMC, patients were treated by various staff and residents who also deserve thanks for their endeavors. The author, however, takes complete responsibility for the analysis of the data and for the conclusions drawn from this study.

REFERENCES