Empyema Thoracis*
Therapeutic Management and Outcome

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Study objective: We evaluated treatment and outcome of patients with thoracic empyema at a teaching institution.

Design and setting: Retrospective chart review over a 44-month period at a university hospital.

Patients and measurements: Charts of patients with a hospital discharge diagnosis of thoracic empyema were reviewed. Age, symptoms, alcohol use, empyema etiology, culture results, number of loculations, date and success of each procedure, length of hospital stay, and hospital discharge status were recorded for each patient. Success of procedure, recovery time, time between procedures, and total hospitalization time were compared between procedures and between subgroups.

Results: Charts from 43 patients were reviewed. Twenty-four of 43 (56%) cases were parapneumonic empyemas. Forty of 43 (93%) patients had symptoms attributable to their empyema, with fever being the most common (65%). Seventy-nine procedures were needed to treat the 43 patients (1.84 procedures per patient). Success rates ranged from 11% (3/27) for tube thoracostomy to 95% (21/22) for decortication (p=0.0001). Delay between procedures averaged 6.2 ± 1.1 (mean ± SEM) days between the first and second procedure (n=27), and 10.4 ± 5.1 days between the second and third procedure (n=8). Mean recovery after successful intervention ranged from 9 to 19.3 days depending on the procedure (p=NS). Comparisons between multiloculated and uniloculated empyemas, parapneumonic and nonparapneumonic empyemas, and culture proven and biochemically proven empyemas showed no significant difference in procedure success rates or length of hospital stay.

Conclusion: Multiple therapeutic options exist for the treatment of thoracic empyema. Optimal therapy requires selection of the most appropriate first procedure for each patient with early postprocedure imaging to avoid inordinate delays between interventions.

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MUSC=Medical University of South Carolina

Key words: chest tube; decortication; empyema; fibrinolysis; pleura; pneumonia

Despite improved antimicrobial therapy and multiple options for drainage of the infected pleural space, empyema thoracis continues to cause significant morbidity and mortality. Tube thoracostomy, image directed catheters, intrapleural thrombolitics, thorascopic drainage, decortication, and chronic open drainage have all been used with success rates ranging from 10 to 90%. The variable success rates of the procedures can be attributed, in part, to the stage of the empyema at presentation. In the initial exudative stage, pleural fluid is free flowing and usually amenable to closed drainage by tube thoracostomy. The exudative stage, however, may be brief, sometimes lasting less than 48 h. Progression to the fibrinopurulent stage results in the formation of fibrin strands throughout the pleural fluid creating a multiloculated pleural space. At this point, closed drainage with a single chest tube is unlikely to be successful. Progression to the organizational stage virtually guarantees the need for more aggressive drainage because of the extensive pleural peel that restricts lung expansion even if the fluid can be successfully drained. Because many of the infections that cause empyema are indolent, patients are often seen by a physician after their parapneumonic empyema has already reached the fibrinopurulent or organizational stage. These patients often are subjected to multiple procedures and long hospitalizations before the empyema is successfully treated.

We reviewed our experience with thoracic empyema over a 44-month period at the Medical University of South Carolina (MUSC) with special attention to procedures used, success rates of each procedure, interval between procedures, length of hospitalization, and outcome.

Methods

Seventy-seven patients had a medical record discharge diagnosis of thoracic empyema at the MUSC Hospital between January 1, 1989 and August 31, 1993. Seventy of the 77 charts were available for review.

Forty-five of the 70 patients had thoracic empyema confirmed by one of three criteria: (1) pleural fluid culture or Gram's stain...
Table 1—Demographic Data for 43 Patients With Thoracic Empyema

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No. (n=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult patients</td>
<td>n=39</td>
</tr>
<tr>
<td>Age range, yr</td>
<td>22-81</td>
</tr>
<tr>
<td>Age, mean ± SEM, yr</td>
<td>48.2±2.6</td>
</tr>
<tr>
<td>Pediatric patients</td>
<td>n=4</td>
</tr>
<tr>
<td>Age range</td>
<td>4 mo-4 yr</td>
</tr>
<tr>
<td>Gender, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>34 (79)</td>
</tr>
<tr>
<td>Female</td>
<td>9 (21)</td>
</tr>
</tbody>
</table>

showing organisms; (2) documentation of grossly purulent fluid at thoracentesis or thoracotomy; or (3) biochemical evidence of empyema defined as pH <7.10 and either lactate dehydrogenase level >1,000 IU/L or glucose level <40 mg/dL. The remaining 25 patients were excluded from analysis because the diagnosis of thoracic empyema could not be confirmed.

Charts were reviewed for patient age, symptoms, and whether alcohol abuse was known or suspected. Empyemas were classified by etiology, culture results, and number of localizations as defined on decubitus chest radiograph, ultrasound, or chest computed tomography (CT) scan. Empyemas were defined as multiloculated if two or more collections of pleural fluid were observed. The date and success of each procedure was recorded. Successful procedures were defined by empyema resolution such that no further intervention was needed. Recovery time was defined as the time from successful procedure until hospital discharge. Recovery time was not assessed in patients with empyema tubes, because most of their treatment time was as an outpatient.

Procedure success was compared using χ² analysis (StatView SE + Graphics, Abacus Concepts, Berkeley, Calif). Recovery time, time between procedures, and total hospitalization time were compared between procedures and groups by analysis of variance. Comparisons between uniloculated and multiloculated empyemas, parapneumonic and nonparapneumonic empyemas, alcohol abusers and nonalcohol abusers, and between biochemically diagnosed empyemas and culture or Gram’s stain proven empyemas were performed with analysis of variance or χ² depending on the variable studied. P values ≤0.05 were considered significant. Data are recorded as mean ± SEM.

RESULTS

Forty-five patients with thoracic empyema were discharged from the MUSC Hospital between January 1, 1989 and August 31, 1993. Two of the patients were transferred to MUSC for placement of an image-directed catheter and then transferred back to their referring hospital. These two patients were not included in the analysis because no other outcome measure was available. Demographic data for the remaining 43 patients are in Table 1.

Twenty-four of the 43 cases of thoracic empyema occurred during or after a bronchopulmonary infection (parapneumonic empyema). Of the remaining 19 cases, 4 occurred after gunshot wounds to the upper abdomen (three with transdiaphragmatic injuries), 4 occurred after seeding from an extrapulmonary source (2 after esophageal rupture, 1 after extension from a skin infection at a previous thoracotomy scar, and 1 from bacteremia), and 11 were from iatrogenic causes (9 postthoracotomy, 1 postthoracentesis, and 1 after percutaneous drainage of a liver abscess).

Most of the patients had symptoms attributable to their empyema (Table 2), with fever being the most common symptom (28/43, 65%). The lack of symptoms in three patients could not be explained by corticosteroid use or neurologic disease.

Seventy-nine procedures were performed on 43 patients (1.84 procedures per patient), and 41 had resolution of their empyema. One patient died without adequate drainage of his Aspergillus fumigatus empyema despite tube thoracostomy and intrapleural streptokinase, and one patient with advanced AIDS was discharged from the hospital with long-term antibiotic therapy for a persistent uniloculated empyema after two unsuccessful attempts at catheter drainage. Both patients desired no further intervention. Two additional patients died despite successful empyema treatment, one of bowel infarction and the other with multiorgan failure after Pseudomonas sepsis.

Seventeen patients required a single procedure, 16 patients required two procedures, 6 patients required three procedures, and 2 patients required four procedures for successful empyema treatment. Patients requiring multiple procedures (n=27) waited 6.2±1 days between the first and second procedure, and an additional 10.4±5.1 days between their second and third procedure (n=8). The two patients who required a fourth procedure waited an addi-

Table 2—Presenting Symptoms in Patients With Thoracic Empyema (n=43)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>No. (%)</th>
</tr>
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<tbody>
<tr>
<td>Fever</td>
<td>28 (65)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>16 (37)</td>
</tr>
<tr>
<td>Cough</td>
<td>9 (21)</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>8 (19)</td>
</tr>
<tr>
<td>Weight loss</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Lethargy</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>3 (7)</td>
</tr>
</tbody>
</table>

Table 3—Time to Hospital Discharge After Successful Procedure (p=NS)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Successful Procedures</th>
<th>Recovery Time, days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube thoracostomy</td>
<td>2*</td>
<td>9±2*</td>
</tr>
<tr>
<td>Image-directed catheter</td>
<td>7*</td>
<td>10.4±2.4</td>
</tr>
<tr>
<td>Intrapleural thrombolytics</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Decortication</td>
<td>21</td>
<td>19.3±6.2</td>
</tr>
<tr>
<td>Eloesser flap</td>
<td>2</td>
<td>9±1</td>
</tr>
</tbody>
</table>

*One patient in each group died after successful therapy and was not included.

¹Mean ± SEM.
tional 1 and 14 days between their third and fourth procedure.

The 39 patients discharged from the hospital after successful treatment of their empyema averaged 19.8 ± 3.8 hospital days after beginning treatment for their empyema. Recovery time ranged from a mean of 9 to 19.3 days depending on the procedure (Table 3).

Long-term follow-up was available on three of the five patients discharged home from the hospital with empyema tubes. Those three patients had frequent follow-up visits for an average of 105 ± 11 days before the empyema tube was completely removed.

Utilization and success rate for each procedure are listed in Table 4. Thrombolytics (streptokinase [7], urokinase [1]) were used through both large-bore chest tubes (n=6) and smaller pigtail catheters (n=2), with one success occurring with each type of catheter. The overall success rate for “nonsurgical” interventions was 27% (13/49), while surgical interventions were successful 93% of the time (28/30).

Twenty-four patients had parapneumonic and 19 had nonparapneumonic empyemas. There was no significant difference in age, initial procedure, number of procedures, success rates of each procedure, length of time between each procedure, or length of hospitalization after successful therapy between the two groups.

Multiloculated empyemas were documented in 21 of 43 (49%) patients. Tube thoracostomy, the most common first procedure in both the uniloculated and the multiloculated groups, was successful in one patient in the uniloculated group and two patients in the multiloculated group. Intrapleural thrombolytics were used in six patients with multiloculated empyemas and two patients with uniloculated empyemas, with the only successes in the multiloculated group (2/6, 33%). There was no significant difference between uniloculated and multiloculated empyemas with respect to timing of procedures, success rates of different procedures, or length of hospitalization.

Seventeen of 43 patients had a history of alcohol abuse with 12 of the 17 having parapneumonic empyemas. There was no significant difference in age, number of procedures, success of procedures, time between procedures, or in the type of initial procedure between patients with or without a history of heavy alcohol use.

Pleural fluid cultures were positive in 27 of 43 (60%) patients and multiple organisms were obtained in 7 patients (Table 5). One additional patient had Gram-positive cocci in pairs on stain but a negative culture. Most nonparapneumonic empyemas had positive cultures (16/19, 84%), while only 11 of 24 (46%) parapneumonic empyemas had a positive culture or Gram’s stain. A comparison between the patients with culture or Gram’s stain proven empyema and those diagnosed by biochemical criteria revealed no significant difference in number of procedures needed per patient, type of procedures used, success rates of each procedure, time between procedures, time from onset of therapy to hospital discharge, or the time from successful intervention to hospital discharge between the two groups.

**DISCUSSION**

Therapy for thoracic empyema requires appropriate antibiotics, prompt drainage of the infected pleural space, and lung reexpansion. However, there is no clear consensus on the best way to obtain these objectives.3

Because of the indolent nature of many infections that lead to empyema and the potential for rapid pleural fluid loculation, patients frequently come to medical attention when the pleural fluid is not free
flowing and closed drainage is unlikely to be successful. This was true in our population, where all 43 patients had loculated pleural fluid at presentation. Despite the expected low success rate for tube thoracostomy in the treatment of late empyema, it remains a first-line therapy, if for no other reason than to attempt to decrease the severity of pleural sepsis until further therapy can be instituted.

With the low success rate of tube thoracostomy for loculated empyema, attention has focused on other approaches to drainage of the pleural space. One option is the use of image-directed catheters, small-bore “pigtail” catheters placed with ultrasound or CT guidance. Early reports of drainage by image-directed catheters have reported success rates ranging from 70 to 90%.2,4 Our success rate with image-directed catheters of 57% is similar to that reported previously, with failures related to inadequate drainage or poor lung reexpansion. While this option appears favorable, the added cost of multiple CT scans and the need for multiple catheters in some patients is a potential drawback.

Intrapleural thrombolitics have been used in the treatment of thoracic empyema since the 1950s.5 Initial interest, however, waned because of unacceptable adverse effects due to impurities in the streptokinase preparation.6 With the introduction of purer forms of streptokinase in the 1980s, there has been renewed interest in the use of intrapleural thrombolitics. Several reports have documented successful drainage of multiloculated empyemas through a single chest tube with thrombolitics,6-8 with few adverse effects.9,10 Further study is needed to identify the best agent, dose and dosing interval. Proper staging of the empyema is important when using fibrinolytics, since these agents will not effectively resolve loculations once organization has begun. The number of loculations may also impact on success rates of intrapleural thrombolitics. Fibrinolysis is likely to be more successful in patients with multiloculated empyemas, where treatment is ineffective because of inadequate drainage. Fibrinolytic therapy is less likely to resolve thick-walled uniloculated empyemas, where the problem is more often incomplete reexpansion of the lung. Both successes with fibrinolytic therapy in our study occurred in multiloculated empyemas (2/6), while the two patients who received fibrinolytic therapy for uniloculated empyema required further intervention.

Thoracotomy with decortication has gained favor as primary therapy for empyema because of the realization that surgery can be safely performed at any stage of an empyema with low morbidity and mortality.11 Decortication in our review also had an excellent success rate (95%) with no associated mortality and minimal morbidity.

Thoracoscopy was not used in any of our patients. Several investigators have reported successful lysis of
adhesions and debridement of empyema cavities via thoracoscopy. Success rates of only 60% and the inability to adequately perform a decortication by thoracoscopy limit the usefulness of this technology to treatment of early empyema. However, it appears reasonable to begin with thoracoscopy and if the procedure is not successful, a decortication can be done through a formal thoracotomy.

Chronic open drainage via empyema tube with or without rib resection remains an alternative in those patients too debilitated to undergo a more invasive procedure. The associated morbidity and extended length of treatment, however, makes this option unattractive.

Criticism of retrospective empyema series commonly focuses on whether interventions are independently selected for a given patient. Variables such as number of loculations, stage of empyema, cause of empyema, and other underlying diseases are likely to impact on the success rate for a given procedure. Comparisons between multiloculated and uniloculated empyemas and between parapneumonic and nonparapneumonic empyemas in our patients showed no statistically significant difference in type of initial procedure, hospitalization time, or success rates of individual procedures.

Alcohol abuse is a risk factor for thoracic empyema, primarily because of the increased incidence of aspiration pneumonia. Alfageme and colleagues reported a 29% incidence of alcohol abuse in their review of thoracic empyema and also noted an increased incidence of anaerobic infection in the group with a history of alcohol abuse. Our incidence of alcohol abuse (40%) was even higher than that reported by Alfageme et al. Although the incidence of anaerobic infection is higher, and presumably this population of patients presents to their physician at a later time in the evolution of their empyema, we found no difference in the success rates of each procedure or in the number of procedures needed to successfully treat the empyema between patients with and without alcohol abuse.

Culture results from patients with thoracic empyema have shown a trend toward increasing numbers of Staphylococcus aureus infections. The number of anaerobic organisms cultured has varied, depending on the methods used for recovery. Our culture results were similar to other reports, with S. aureus being the most common pathogen isolated. Streptococcus pneumoniae grew from only one culture.

Most reports concerning thoracic empyema have included only cases with positive pleural fluid cultures, positive Gram’s stains, or grossly purulent pleural fluid. It is unclear whether an empyema diagnosed by biochemical criteria alone will respond differently than a culture-proved empyema. It is possible that an empyema diagnosed only by biochemical criteria may represent an early empyema, one that may be amenable to a nonsurgical (closed) drainage as suggested by several authors. In our review, there was no difference in outcome between those empyemas diagnosed by biochemical criteria and those diagnosed by culture or Gram’s stain. Both types of empyema required multiple procedures and long hospitalizations to effect cure.

Length of hospital stay for empyema is long because of multiple procedures and coexistent diseases. In the era of cost containment, any change in care that could potentially decrease the number of hospital days would be beneficial. All successful procedures in our study resulted in postprocedure hospitalizations of 9 to 10 days except for decortication, which had a mean postoperative hospital stay of 19 days (p=NS). Two patients in the decortication group, however, were hospitalized for 133 and 57 days after decortication, one for further treatment of esophageal rupture, and one with postoperative adult respiratory distress syndrome. The median postoperative stay for the decortication group was 12 days, a stay similar to previous reports.

To minimize the morbidity and mortality associated with thoracic empyema, physicians need to determine the most appropriate first procedure and minimize the time interval between procedures. Most patients in this study required multiple procedures and waited an unacceptable length of time between procedures. There is not one best approach to the treatment of thoracic empyema. Each patient must be evaluated individually with consideration of stage and characteristics of the empyema and the condition of the patient. With this in mind, we have devised an algorithm for the treatment of thoracic empyema (Fig 1). This approach focuses on early imaging of the chest once an empyema has been documented by thoracentesis, with initial therapy guided by the number of loculations. We believe the first procedure should be different for a uniloculated empyema than a multiloculated empyema, recognizing that drainage of uniloculated empyemas is usually easily accomplished, and the problem is frequently one of insufficient reexpansion of the lung. Multiloculated empyemas are more difficult to drain successfully and usually warrant a more aggressive approach. We think decortication should be considered early in any patients who are good surgical candidates, because it has a high success rate and low morbidity and mortality. Once the patient has begun treatment for thoracic empyema, it is crucial that early imaging be done to confirm adequate drainage and lung reexpansion, allowing further intervention to proceed in a timely fashion.
Randomized prospective trials comparing the multiple therapeutic options in the treatment of thoracic empyma are still needed to clarify the best approach to treating thoracic empyma.

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