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Improved Patient Outcome after Surgical Treatment for Loculated Empyema

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BACKGROUND: Empyemas complicate the hospital course of many patients. Advanced stages of empyema often require surgical intervention.

METHODS: A retrospective review of 70 adult patients with empyema, hospitalized between the years of 1992 and 1997, was performed. Data on age, length of stay, comorbidities, diagnostic studies, and treatment was obtained. We compared patient outcome from patients with loculated empyemas who had surgical treatment and those who were managed nonsurgically.

RESULTS: Seventy patient records were reviewed, 37 of which were of patients with loculated empyemas. Parapneumonic empyemas comprised 60% of all cases. Chest radiographs, computed tomography scan, and thoracentesis were the most common studies performed in both groups. Thirty-three patients with the radiographic finding of a loculated empyema were treated with either surgical decortication or tube thoracostomy.

CONCLUSION: Empyemas at various stages of development require different forms of therapy; advanced empyemas treated early with decortication have a shorter duration of treatment, lower incidence of recurrence and fewer complications. *Am J Surg.* 2000;179:1–6. © 2000 by Excerpta Medica, Inc.

Empyema is the collection of purulent exudate within the normally sterile pleural space. Empyema occurs most commonly as a result of pneumonia, thoracic surgery, or trauma. Approximately 66% of all cases of empyema are the result of a parapneumonic effusion.[1] Furthermore, as high as 40% of patients with pneumonia will develop an empyema.[2] Although the use of antibiotics has reduced the overall incidence of empyema, it is still a common clinical problem resulting in significant morbidity and mortality. The mortality from empyema has been reported to be between 1% and 19% in various series and as great as 40% among immunocompromised patients.[3] Early diagnosis and treatment of this thoracic pathology is believed to decrease the complication rate associated with this disease.[4] In addition, advances in imaging modalities have moved investigation beyond the realm of chest auscultation and percussion into an era of chest roentgenography, computed tomography (CT), fluoroscopy, and ultrasound.

Advanced stages of empyema will often not respond to treatment via repeated thoracentesis and prolonged thoracostomy; instead these empyemas will eventually require surgical decortication. Many simple empyemas, however, will be effectively treated by nonoperative interventions. Despite diagnosing advanced empyemas, many physicians do not immediately offer surgical decortication to their patients, thus prolonging hospitalization, increasing hospital cost, and increasing risk of nosocomial infections. The purpose of this study was to compare the results of surgical therapy and medical therapy in the management of patients with advanced empyema.

METHODS

The medical records for all patients diagnosed with empyema between 1992 and 1997 at the University of California, Irvine Medical Center (UCIMC) were retrospectively reviewed. The patients were identified by using the InVision database (Shared Medical Systems, Valley Forge, Pennsylvania) and searching the system for the International classification of diseases (ICD-9) code for empyema. All patients who met the selection criteria for empyema were included in the study. The selection criteria included all adult patients who were diagnosed with empyema. Empyema was defined as pleural fluid that was grossly purulent or fluid with a positive culture or gram stain with a pleural fluid white blood cell (WBC) count of greater than 5×10^9.[5–7] The data obtained included the patient's age at the time of diagnosis, length of stay in the hospital (LOS), comorbidities, studies performed for diagnosis and staging, and treatment. Treatment included antimicrobial therapy, thoracentesis, tube thoracostomy, and surgical decortication. Next, a comparison was done of all patients with the diagnosis of advanced loculated empyema, with respect to treatment and patient outcome. The patients were divided into two treatment groups: group A, those who underwent surgical decortication; and group B, those receiving medical therapy (tube thoracostomy and antimicrobial therapy) for their pleural/pulmonary disease.

Radiographic Diagnosis

Radiographic studies used for the diagnosis of empyema or confirmation of the same were recorded and findings noted. These included chest radiographs, CT scans of the chest,

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thoracentesis, and thoracic ultrasounds. The imaging reports of all of the patients were reviewed for the following descriptions: size of empyema or loculation, number of loculations, character of the fluid collection, pleural thickening, and depth of fluid collection.

Premorbid Thoracic Manipulation

Premorbid thoracic manipulation was considered any invasive thoracic procedure or any disruption of the normal thoracic integrity. These were divided into history of tube thoracostomy for pathology aside from empyema, thoracotomy for elective or emergency surgery, penetrating thoracic trauma, blunt trauma (causing contusion, hemothorax, or pneumothorax), and premorbid pneumonia. Patients admitted with a prior diagnosis of empyema, after completion of therapy for that episode, were considered to be recurrences.

Treatment Groups

Patients diagnosed with loculated empyema by radiographic studies were followed after initial drainage procedure. Patients who had thoracic decortication for the treatment of their empyema were considered to be a part of the surgical group (A) whereas those who were managed with simple tube thoracostomy and antibiotics were considered to be in the medical therapy group (B). Almost all of the patients in the surgical group had a tube thoracostomy performed initially, at the time of diagnosis, and eventual surgical decortication. The rate of recurrence in both groups was compared. A recurrence was described as any diagnosis of empyema after initial resolution of a prior episode of empyema. In order to determine the LOS between the two groups, a parameter specific to the disease process, that would exclude prolonged hospitalizations for unrelated pathology, was selected. This parameter was considered the "duration of treatment" and was defined as the time of initial diagnosis of loculated empyema and placement of thoracostomy tube to the time that the last chest tube was removed and empyema considered to have resolved. All patients had a thoracostomy tube placed immediately after or at the time of diagnosis of the loculated empyema. A comparison of the duration of treatment in the surgical group and the medical therapy group was performed. In the operative group, operative mortality as well as postoperative mortality was evaluated and compared with the mortality of the medical therapy group. Within the surgical group the number of days from diagnosis of loculated empyema to surgical intervention was evaluated.

Statistical Analysis

Analysis of variance (ANOVA) was used to compare the two groups. All statistical analysis was done using SYSTAT 7.0.1 (SPSS Inc., Chicago, Illinois).

RESULTS

Seventy adult patients with the diagnosis of empyema (includes all stages of empyema) were treated at our medical center during the study period. All 70 patients were reviewed as part of the study. The average age of all patients with empyema was 44 years (SD 17.3) and the average hospital length of stay for all empyema patients was 23.4 days (SD 14.2) with a median of 21 days. The average chest tube duration for all patients was 14 days (SD 9.3). The majority of empyemas followed a diagnosed case of pneumonia. Tube thoracostomy was the next leading premorbid thoracic disruption in our group of patients developing empyema (**Table I**). Several patients had more than one thoracic disruption. The number of patients with loculated empyemas was 37. Twenty had surgical decortication and 13 had medical treatment. The surgical treatment group primarily had open thoracotomy and decortication (n = 15) with the remainder of the operations being performed by video-assisted thoracic surgery (VATS) (n = 3) or minithoracotomy (n = 2). Four patients had no treatment; these patients were not included in either group.

TABLE I
Premorbid Thoracic Disruption Resulting in Empyema

Premorbid Thoracic Disruption	Number of Patients	Percent of Patients
Pneumonia	42	60.0%
Tube thoracostomy	21	30.0%
Thoracic surgery	15	21.4%
Thoracic trauma	14	20.0%

TABLE II
Study Performed to Diagnose Empyema

Diagnostic Study	Number of Patients	Percent of Patients
Chest radiograph	70	100.0%
Chest computed tomography	42	60.0%
Thoracentesis	42	60.0%
Thoracic ultrasound	14	20.0%

Diagnostic Study Results

Chest roentgenography was used in all patients initially (**Table II**). Computed tomography scan and ultrasound were used to diagnose advanced stages of empyema in all complicated cases. Thoracentesis was combined with CT or ultrasound to obtain fluid for cytologic diagnosis. In all patients who underwent ultrasound evaluation (n = 14), a CT scan was also performed within 24 to 36 hours of the ultrasound study. Ultrasound described 10 patients as having a loculated empyema and 4 without loculations. Ultrasound reports emulated CT scan reports in all 14 cases. Overall, ultrasound was used less frequently than CT scan to make the diagnosis of empyema. Twenty-four of the 70 patients underwent surgery (advanced loculated, n = 20; advanced unloculated, n = 4) for advanced empyemas using CT scan or ultrasound as the indicator or inability of the empyema to respond to medical therapy. Among this group of surgical patients, there were 8 patients who had ultrasound performed with the results paralleling those of CT scan. The ultrasounds described loculated empyemas and pleural thickening with the same discriminating capabilities as CT scan. Ultrasound accurately accessed the number of loculations, size, and character of each empyema compared with CT scan.

TABLE III
Operative Versus Nonoperative Management

	Operative Group	Nonoperative Group	*P* Value
Mean age (year)	34.95 + 14.66	48.92 + 18.52	0.024
Median length of stay (days)	18.50 + 19.09	24.00 + 10.89	0.712
Median chest tube duration (days)	12.50 + 5.01	20.00 + 10.33	0.001

Surgical Treatment versus Medical Treatment

The average length of stay for the medical therapy group was 22.77 days with a median of 24 days, while that of the surgical group was 24.95 days with a median of 18.5 days. There was no statistical difference between the two groups with regards to total hospital stay. The average chest tube duration for the medical therapy group was 22.85 days with a median of 20 days, while that of the surgical group was 12.95 days (ANOVA, $P = 0.001$) with a median of 12.5 days (**Table III**). In the surgical therapy group the average length of time from diagnosis to surgery was 6.20 days. There were 3 recurrences in the medical therapy group, and no recurrences in the surgically treated group. The length of time to recurrence ranged from 1 to 6 months. There were 2 early readmissions in the medical therapy group for continued treatment of an unresolved empyema whereas there were no readmissions in the surgical group. All patients were followed up for at least 30 days after completion of treatment and for as long as 3 years. The average length of time of follow-up was 412 days with a median of 162 days. There was one death in the medically treated group at 207 days after treatment and no deaths in the surgical group during the follow-up period.

Microbiology

Overall, the most common organisms to be isolated from the empyema fluid were *Streptococcus* (surgical 30%, medical 46%) and *Staphylococcus* (surgical 35%, medical 38%). Seven of the 37 advanced empyema patients had no bacterial growth on cultures but had grossly purulent fluid. Most patients were treated with multiple drug antibiotic therapy, and a few were treated with single regimen broad-spectrum antibiotics.

Immunosuppression

Medical conditions and medical treatments that may cause decreased wound healing or ineffective defense against infections were evaluated. There was 1 patient in each of the treatment groups on steroids. In the surgically treated group there were 4 patients with the following comorbidities: chronic obstructive pulmonary disease (COPD), lung cancer, liver cirrhosis, and chronic renal failure. In the medically treated group there were 4 patients with the following comorbidities: lung cancer, 2 patients with liver cirrhosis, and COPD.

COMMENTS

Empyema was first described to the medical community in the fifth century BC by Hippocrates.[8] Since that time, recognition of this disease process has increased along with the advances in diagnostic technology. Approximately 1.2 million people per year are affected by pneumonia, and up to 40% of these patients can develop an associated empyema.[2,9,10] Trauma and postthoracotomy patients comprise 20% of all cases of empyema.[3] Most cases of empyema can be diagnosed with an anterior-posterior (AP) chest radiograph and a lateral decubitus film of the chest. Simple empyemas can often be treated by tube thoracostomy and antimicrobial therapy. CT scan or ultrasound is necessary in diagnosing loculated empyemas. There are several stages of empyema to consider.[5–7] Stage I, referred to as the exudative stage, involves pleural fluid that is sterile, watery, and unloculated with an elevated number of white blood cells. The pleural fluid pH and glucose levels are normal. In stage II, the fibropurulent stage, the pleural fluid is infected and shows an elevation of polymorphonuclear (PMN) leukocytes and decreased pH and glucose. There may be a deposition of fibrin on the pleural surface, which organizes into loculations making drainage difficult. Stage III, the organizing stage, involves pleural fluid that is thick and loculated. An infiltration of fibroblasts on the pleural surfaces forms a thick inelastic peel that traps and limits the expansion of the lungs.[3,5] Complications during this stage include drainage through the chest wall (empyema necessitatis) or into the lung (bronchopleural fistula).

Treatments for the early stages of empyema include antibiotic therapy, therapeutic and diagnostic thoracentesis, and thoracostomy tube placement. Once empyema reaches the organized stage with thickened pleura, open thoracotomy with decortication is often required.[3] With decortication, purulent material and fibrous tissue in the pleural space is removed. Decortication is a major thoracic operation with a mortality rate of 1.3% to 8%.[4,11–13] CT and ultrasound are valuable techniques that can be used to diagnosis and assess the stages of empyemas. An empyema can advance through all the stages of maturation to organize a fibrin peel and loculations in as quickly as 1 week's time; however, not all patients will progress through these stages. Prompt diagnosis and treatment is crucial in keeping complication rates low and in providing optimal patient management.

The best treatment depends on the stage of the empyema. In this study we specifically reviewed patients with advanced loculated empyemas. Of the 37 patients with loculated empyemas approximately one third of them received medical therapy. Often the question arises as to when patients should undergo decortication for empyema. It appears from the data, that as soon as the diagnosis of a loculated empyema is made, decortication should be performed. In this series the majority of our operations were done by open thoracotomy. In more recent years we have increased our experience with VATS for decortication procedures. We evaluated duration of treatment, recurrence, early readmissions and mortality as outcome indicators. There was no mortality in either group that was

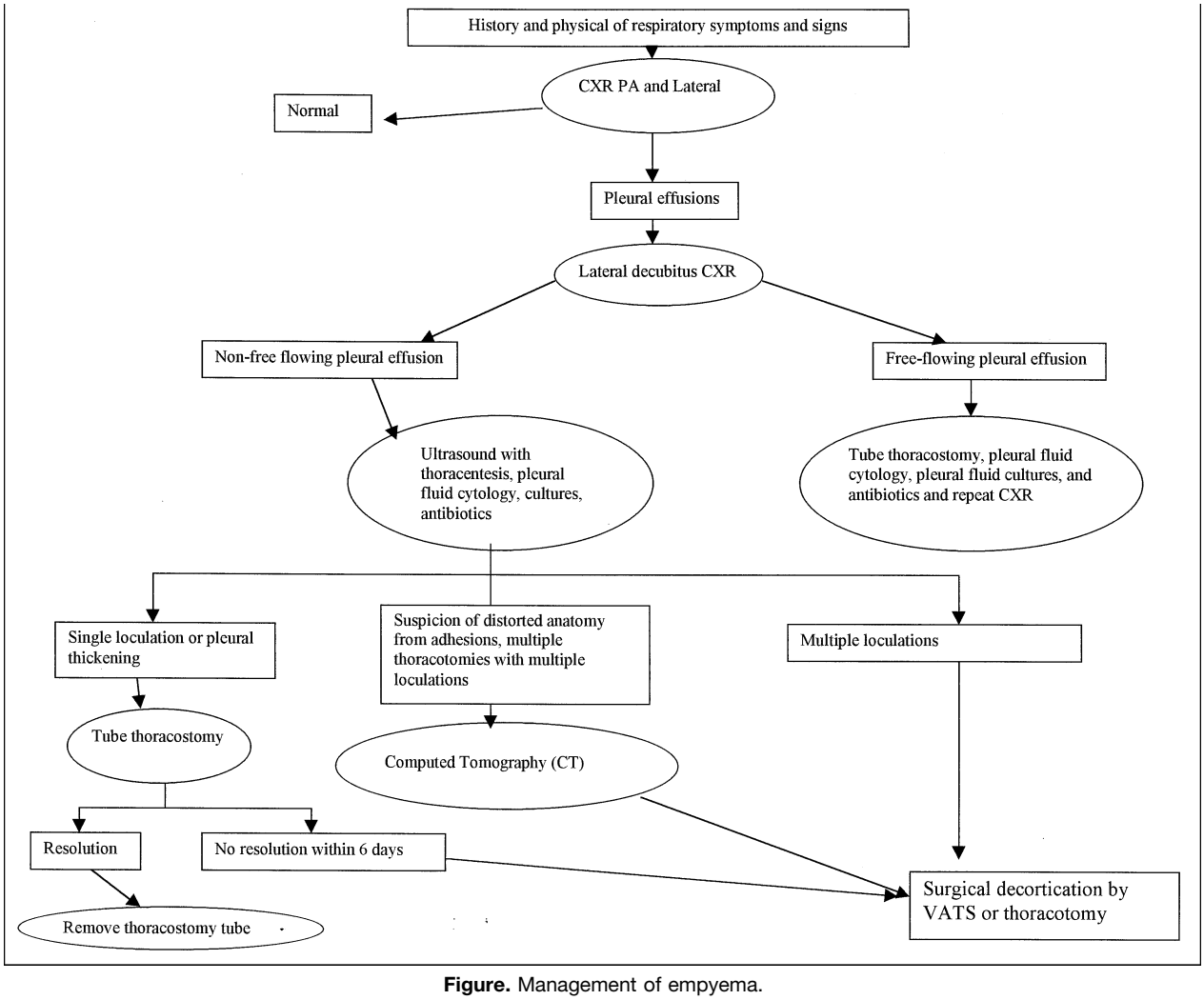

Figure. Management of empyema.

secondary to the empyema disease process. All patients were followed up for 30 days to 3 years. The number of readmissions and recurrences in the medically treated group outnumbered the surgically treated group (readmission 2 versus 0, recurrence 3 versus 0). The most impressive difference lies in the duration of treatment. We examined the duration of treatment for loculated empyema in an effort to focus on response to intervention for this disease process. When comparing the overall duration of treatment (the number of chest tube days after the diagnosis of a loculated empyema), we observed that the duration of treatment was significantly less in the surgical group relative to that observed in the medically treated group. A difference of almost 10 days was noted between the two groups. This would suggest that surgical intervention is beneficial with regard to earlier resolution of the disease.

Early surgical intervention on the duration of treatment needs further discussion. Our data revealed an average time between diagnosis of a loculated empyema and surgical intervention of more than 6 days. This would suggest that patients undergoing surgical therapy may have failed an initial trial of medical therapy for loculated empyema. This is further support for early surgical intervention in this group of patients (**Figure**).

In the medically treated group, the patients were diagnosed with advanced loculated empyemas but were not referred for surgery. The reasons for medical treatment alone were multiple. Patient refusal of surgical intervention was one; some patients were given the option of surgical decortication versus tube thoracostomy and chose to have tube thoracostomy alone. One patient with lung cancer chose conservative limited therapy because of the primary illness instead of undergoing surgery; this patient died approximately 7 months after completion of medical management from metastatic lung cancer. Many patients were not offered surgical consultation because medical management with multiple chest tubes was thought to be adequate.

All patients were started empirically on broad-spectrum antibiotics at the time of diagnosis of empyema. Patients with positive cultures had antibiotics altered to cover identified microorganism. Most patients had multiple organisms on culture and were placed on a multidrug antibiotic regimen. If no organisms were cultured the patient was continued on broad-spectrum antibiotics and worked up for tuberculosis. The antibiotic regimen in the medically treated group paralleled that of preoperative management in the surgical group. All tube thoracotomies were placed

for drainage of the empyema and were assessed each day for adequate drainage and patency.

The difference in outcome may bring into question differences in the susceptibility of patients to this infectious disease process. We looked carefully at medical conditions that would result in compromised immune systems or medical treatment that would result in immunosuppression (ie, chemotherapy, radiation therapy, steroids). The demographic differences between the two groups were not appreciable. The age of the two treatment groups was statistically similar. The comorbid factors between the two groups were similar. The two most common organisms in both groups were *Staphylococcus* and *Streptococcus*, and the antibiotic drug regimens were similar between the two groups, with multidrug antibiotic therapy being the most common approach to treatment.

This review, being retrospective, has the potential for treatment bias. It is possible that if a patient's condition was worse, then surgical measures would have been instituted more readily. While subtle differences in the disease process of each of these patients cannot be excluded, there did not appear to be a significant difference when comparing the comorbidities of the patients during the time of hospital stay. All patients were diagnosed with loculated empyema by thoracentesis and radiographic evaluation. The susceptibility of these patients to loculated empyemas is difficult to quantitatively evaluate; however, if we did operate on the sicker patients, this gives greater credence to the results of this review. Such selection bias would imply that patients with worse disease had a better response after surgical intervention than patients with better prognoses who did not undergo surgery.

In conclusion, surgical intervention for loculated empyema appears to reduce the rate of recurrence, readmission, and duration of treatment. Prompt diagnosis and treatment may translate to better management of advanced loculated empyema. As our experience with VATS increase we will be able to compare patient outcome after open thoracotomy and video-assisted thoracic surgery. The applicability of early surgical decortication needs to be further assessed by prospective studies.

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DISCUSSION

Reginald J. Franciose, MD (Denver, Colorado): I was particularly pleased to see that Dr. Powell supports our bias that empyema is a surgical disease. However, it seems to me that in 1999, the treatment of empyema is not a two-variable disease, medical versus surgical, but more a four-variable disease with multiple subvariables. There is medical treatment. There is fibrinolytic therapy, which can be directed by interventional radiologists or by the surgeon through chest tubes. That's been in widespread use since 1989. There is small-catheter directed interventional radiology where they can then place devices inside the empyema cavity, break up the loculations, and theoretically, more specifically, drain the loculations. That would be a third variable. And fourth, there is surgery, which has three variables: open thoracotomy with decortication, VATS technology, which has been available since 1992, and the so-called minithoracotomy, which is assisted by the camera with just a small incision allowing you to work with your open instruments.

My questions really are two. Given the fact that these other modalities were in widespread use at least during the latter half of your retrospective study, where did they fall into your categories or how were they used or were they not available?

Second, and more importantly for all of us trying to decide with all these variables how to treat this disease, what physiological, clinical, or radiologic information can you give us, to help us to cull out of future studies to allow us to best base our treatment with all these variables? Who will benefit from lytic therapy? How long should they get it before we consider it a failure? Are there any criteria for saying this patient cannot be done by VATS? Should we go to open thoracotomy?

This is a multifaceted disease that requires a very complex algorithm to be done efficiently for the patient's safety and for cost effectiveness. Unfortunately, it seems that the days of medical versus surgical therapy are over.

CLOSING

Ledford L. Powell, MD: You pointed out that this is not just two-tiered treatment process, that we should also be looking at medical therapy, which I described as tube thoracostomy and antimicrobial therapy, fibrinolytic therapy, intervention of radiology, and then the various forms of surgery.

Looking at the first three aspects of what you described,