

# Parapneumonic Effusions and Empyema

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Parapneumonic effusions occur in 20 to 40% of patients who are hospitalized with pneumonia. The mortality rate in patients with a parapneumonic effusion is higher than that in patients with pneumonia without a parapneumonic effusion. Some of the excess mortality is due to mismanagement of the parapneumonic effusion. Characteristics of patients that indicate that an invasive procedure will be necessary for its resolution include the following: an effusion occupying more than 50% of the hemithorax or one that is loculated; a positive Gram stain or culture of the pleural fluid; and a purulent pleural fluid that has a pH below 7.20 or a glucose below 60, or has a lactic acid dehydrogenase level of more than three times the upper normal limit for serum. Patients with pneumonia and an effusion of more than minimal size should have a therapeutic thoracentesis. If the fluid cannot be removed with a therapeutic thoracentesis, a chest tube should be inserted and consideration be given to the intrapleural instillation of fibrinolytics. If the loculated effusion persists, the patient should be subjected to video-assisted thoracoscopic surgery, and if the lung cannot be expanded with this procedure, a full thoracotomy with decortication should be performed. The definitive procedure should be performed within 14 d.

**Keywords:** decortication; fibrinolytics; pleural effusion; thoracoscopy

Parapneumonic effusion is any pleural effusion secondary to pneumonia (bacterial or viral) or lung abscess. Empyema is, by definition, pus in the pleural space. Pus is thick, viscid fluid that appears to be purulent. A complicated parapneumonic effusion is a parapneumonic pleural effusion for which an invasive procedure, such as tube thoracostomy, is necessary for its resolution, or a parapneumonic effusion on which the bacterial cultures are positive (1). The reason for the latter part of this definition is that if it were known that the cultures were going to be positive, then an invasive procedure would be indicated.

The evolution of a parapneumonic effusion can be divided into three stages that represent a continuous spectrum (2). The first stage is the exudative stage in which, in a patient with a parapneumonic effusion, there is rapid outpouring of fluid into the pleural space. Most of the fluid is due to increased pulmonary interstitial fluid traversing the pleura to enter the pleural space but some of this is due to increased permeability of the capillaries in the pleural space. The pleural fluid in this stage is characterized by negative bacterial studies, a glucose level above 60 mg/dl, a pH above 7.20, and a lactic acid dehydrogenase (LDH) level of less than three times the upper normal limit of serum. If the patient does not see a physician or receives the wrong antibiotic, the effusion may proceed to the second stage, which is the fibropurulent stage. The pleural fluid in this stage is characterized by positive bacterial studies, a glucose level below 60 mg/dl, a pH below 7.20, and a pleural fluid LDH more than three times

the upper normal limit for serum. In this stage, the pleural fluid becomes infected and progressively loculated. The pleural fluid needs to be drained in this stage and drainage becomes progressively difficult as more loculations form. If a stage 2 effusion is not drained, the effusion may progress to the third stage in which fibroblasts grow into the pleural fluid from both the visceral and parietal pleurae, producing a thick pleural peel. The peel over the visceral pleura prevents the lung from expanding. Because the pleural space must be eradicated if a pleural infection is going to be eliminated, this peel must be removed if the infection is going to be cured.

There are approximately one million patients hospitalized in the United States each year with pneumonia. Of those hospitalized, 20 to 40% have a parapneumonic effusion. The mortality is higher in patients with pneumonia who have a pleural effusion. In one study, the mortality risk was 6.5 times higher if the effusions were bilateral, whereas the mortality risk was 3.7 times higher if the effusion was unilateral (3). Although some of the increased mortality is due to comorbid conditions, some of it is due to mismanagement of the pleural effusion. In assessing whether patients with community-acquired pneumonia require hospitalization, the presence of a pleural effusion is given the same weight as a  $Po_2$  level of less than 60 mm Hg (4).

The symptoms with a parapneumonic effusion can be either acute or chronic. Anaerobic pulmonary infections frequently have an associated pleural effusion and are characterized by a more chronic course (5). Weight loss and anemia are common with anaerobic infections. In one earlier study of patient with anaerobic pleural infections, 60% of the patients had substantial weight loss (mean, 29 lb) (5). In patients with pneumonia, the clinical picture, such as the degree of leukocytosis or the incidence of chest pain, is very similar whether or not they have a parapneumonic effusion (6). Similarly, if the patient has a parapneumonic effusion, the clinical picture is similar whether or not the effusion is complicated (6).

The pleural fluid with a parapneumonic effusion is an exudate with a predominance of neutrophils. If the presumptive diagnosis is a parapneumonic effusion and the pleural fluid has predominantly mononuclear cells, an alternative diagnosis should be sought. The pleural fluid changes as a parapneumonic effusion moves to progressively higher stages. Initially, the fluid is smear- and culture-negative, but early in stage 2, the bacteriology becomes positive. As a parapneumonic effusion progresses, the pH and glucose levels become progressively lower, whereas the pleural fluid LDH becomes progressively higher. The most sensitive pleural fluid measurement that indicates a parapneumonic effusion is complicated is the pleural fluid pH, which drops to below 7.20 before the glucose drops below 60 mg/dl or the LDH becomes more than three times the upper limit of serum (7). If the pleural pH is used to assess the prognosis of a parapneumonic effusion, it must be measured with a blood gas machine. Measurement with a pH meter or a pH indicator strip is not sufficiently accurate and gives readings that are falsely high (8).

When a patient with a parapneumonic effusion is first seen, it is important to classify that patient's prognosis with respect to the parapneumonic effusion. In 2000, the American College of Chest Physicians developed a classification of parapneumonic

(Received in original form October 21, 2005; accepted in final form October 23, 2005)

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Proc Am Thorac Soc Vol 3, pp 75–80, 2006

DOI: 10.1513/pats.200510-113JH

Internet address: www.atsjournals.org

effusions on the basis of the anatomic characteristics of the fluid (A), the bacteriology of the pleural fluid (B), and the chemistry of the pleural fluid (C). This classification is somewhat analogous to the TMN (tumor-node-metastasis) classification used to classify tumors (9). The classifications are shown in Table 1.

The anatomy (A) of the pleural effusion is based on the size of the effusion, whether it is free flowing, and whether the parietal pleura is thickened. A<sub>2</sub> effusions (those with a poor prognosis) occupy more than 50% of the hemithorax, are loculated, and/or are associated with thickening of the parietal pleura. The bacteriology (B) of the effusion is based on whether smears or cultures are positive. If either is positive, the bacteriology is B<sub>1</sub>, which indicates that invasive procedures are indicated. If the pleural fluid consists of pus, the bacteriologic category is B<sub>2</sub>, which is also an indication for drainage. The chemistry (C) of the effusion is based on the pH of the pleural fluid, and a pH that is less than 7.20 indicates that invasive procedures are indicated. If a pleural fluid pH measurement with a blood gas machine is not available, an alternative measurement is a pleural fluid glucose level with a cutoff level of 60 mg/dl.

On the basis of the A, B, and C classification, the effusion is categorized. The category 1 effusion is a small (< 10-mm thickness on decubitus, computed tomography [CT], or ultrasound studies) free-flowing effusion. Because the effusion is small, no thoracentesis is performed and the bacteriology and chemistry of the fluid are unknown. The risk of a poor outcome with a category 1 effusion is very low.

The category 2 effusion is small to moderate in size (> 10-mm thickness and < one-half the hemithorax) and is free flowing. The Gram stain and culture of the pleural fluid are negative and the pleural fluid pH is more than 7.20. It is important to emphasize that the pleural fluid pH must be measured with a blood gas machine. Neither a pH meter nor an indicator strip is sufficiently accurate (8). If the pleural fluid pH is unavailable, the pleural fluid glucose level must be more than 60 mg/dl. The risk of a poor outcome with a category 2 effusion is low.

The category 3 effusion meets at least one of the following criteria: (1) the effusion occupies more than one-half the hemithorax, is loculated, or is associated with a thickened parietal pleura; (2) the Gram stain or culture is positive; or (3) the pleural fluid pH is less than 7.20 or the pleural fluid glucose is less than 60 mg/dl. The risk of a poor outcome with a category 3 effusion is moderate.

The category 4 effusion is characterized by pleural fluid that consists of pus. The risk of a poor outcome with a category 4 effusion is high.

## OPTIONS FOR MANAGEMENT OF PLEURAL FLUID

There are several options available for the management of the pleural fluid in patients with parapneumonic effusion: these include observation, therapeutic thoracentesis, tube thoracostomy, intrapleural instillation of fibrinolytics, thoracoscopy with the breakdown of adhesions or decortication, thoracotomy with the breakdown of adhesions and decortication, and open drainage procedures.

### Observation

Observation is an acceptable option for category 1 pleural effusions because the risk of a poor outcome without drainage is very low (6).

In patients with other categories of parapneumonic effusion, observation without examination of the pleural fluid is not acceptable because examination of the pleural fluid is necessary to properly categorize the effusion (9).

Although only about 10% of patients with parapneumonic effusions require drainage of their effusion, it is important not to delay drainage in those who require it because an effusion that is free-flowing and easy to drain can become loculated and difficult to drain over a period of 12 to 24 h (5, 10).

### Therapeutic Thoracentesis

Therapeutic thoracentesis was used for the treatment of parapneumonic effusions as early as the middle of the 19th century (11). Subsequently, in 1962, the American Thoracic Society recommended repeated thoracentesis for nontuberculous empyemas that were in the early exudative phase (2). Then, in 1968, Snider and Salleh recommended that patients with empyema be managed with two therapeutic thoracenteses, but if fluid accumulated after that time, then tube thoracostomy should be performed (12). However, therapeutic thoracentesis for parapneumonic effusion has been an outdated treatment for the past couple of decades.

Recent studies in a rabbit model of empyema have shown that daily therapeutic thoracentesis starting 48 h after empyema induction is at least as effective as tube thoracostomy initiated

**TABLE 1. CATEGORIZING RISK FOR POOR OUTCOME IN PATIENTS WITH PARAPNEUMONIC EFFUSIONS AND EMPYEMA**

Pleural Space Anatomy		Pleural Fluid Bacteriology		Pleural Fluid Chemistry	Category	Risk of Poor Outcome	Drainage
A <sub>0</sub> : Minimal, free-flowing effusion (< 10 mm on lateral decubitus)	and	B <sub>x</sub> : culture and Gram stain results unknown	and	C <sub>x</sub> : pH unknown	1	Very low	No
A <sub>1</sub> : Small to moderate free-flowing effusion (> 10 mm and < one-half hemithorax)	and	B <sub>0</sub> : negative culture and Gram stain	and	C <sub>0</sub> : pH ≥ 7.20	2	Low	No
A <sub>2</sub> : Large, free-flowing effusion (≥ one-half hemithorax) loculated effusion, or effusion with thickened parietal pleura	or	B <sub>1</sub> : positive culture and Gram stain	or	C <sub>1</sub> : pH < 7.20	3	Moderate	Yes
		B <sub>2</sub> : pus			4	High	Yes

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at the same time (13). Moreover, Storm and coworkers (14) reported daily thoracentesis effected the resolution of empyema (purulent pleural fluid or positive microbiological studies on the pleural fluid) in 48 of 51 patients (94%). Simmers and associates treated 29 patients with parapneumonic effusions that consisted of pus, had positive bacteriology, or had positive chemistries with alternate-day ultrasound-guided thoracenteses and reported that 24 patients (86%) were successfully treated (15). The drawback to this study was that the patients underwent an average of  $7.7 \pm 3.5$  thoracenteses and the average hospitalization was 31 d (15). There have been no controlled studies comparing therapeutic thoracentesis with small-tube thoracostomy in the treatment of patients with complicated nonloculated parapneumonic effusions.

### Tube Thoracostomy

The most common method by which parapneumonic effusions have been initially drained for the past several decades has been tube thoracostomy. The chest tube should be positioned in a dependent part of the pleural effusion. Although relatively large (28–36 F) chest tubes have been recommended by most due to the belief that smaller tubes would become obstructed with the thick fluid, such large tubes are probably not necessary. In one study, 103 patients with empyema were treated with 8- to 12-F pigtail or 10- to 14-F Malecot catheters inserted with the Seldinger technique under either ultrasound or CT scan (16). These small catheters served as the definitive treatment in 80 of the 103 patients (78%) (16). These results are at least as good as those reported in surgical series in which much larger tubes were used (17, 18). It is likely that the correct positioning of the chest tube is more important than its size (1). The small catheters were placed using either ultrasound or CT scans, whereas no imaging was used to place the large catheters. The advantages of the smaller tube are that it is less painful to the patient and is easier to insert.

Successful closed-tube drainage of complicated parapneumonic effusions is evidenced by improvement in the clinical and radiologic status within 24 h. If the patient has not demonstrated significant improvement within 24 h of initiating tube thoracostomy, either the pleural drainage is unsatisfactory or the patient is receiving the wrong antibiotic. Unsatisfactory pleural drainage can be due to the tube being in the wrong location, loculation of the pleural fluid, or a fibrinous coating of the visceral pleura, which prevents the underlying lung from expanding. If drainage is inadequate, ultrasonography or a CT scan should be obtained to delineate which of the above factors is responsible.

### Intrapleural Fibrinolytics

If the pleural fluid becomes loculated, drainage of a parapneumonic effusion is difficult. More than 50 y ago, Tillet and associates (19) reported that the intrapleural injection of streptokinase (a fibrinolytic) and streptodornase (a DNase) facilitated pleural drainage in patients with empyemas. However, the use of intrapleural streptokinase and streptodornase was subsequently largely abandoned because their intrapleural injection was associated with systemic side effects, including febrile reactions, general malaise, and leukocytosis (20). However, starting with the report of Bergh and colleagues in the late 1970s (21), there have been several uncontrolled studies (22–26), each with more than 20 patients, that concluded that fibrinolytics are useful in the management of patients with loculated parapneumonic effusions. Both streptokinase (22–25) and urokinase (22, 25, 26) have been reported to be effective. Both agents are administered intrapleurally in a total volume of 50 to 100 ml. The usual dose of urokinase is 100,000 IU and the cost of one vial of urokinase that contains 250,000 IU is \$490 (1). The usual dose for streptokinase is 150,000 IU, but it is no longer available in the United States.

Recently, there have been several reports (27–30) on the intrapleural use of tissue plasminogen activator (tPA) for loculated parapneumonic effusions. All of these have reported positive results but none have been controlled. The doses used have had a wide range, but a reasonable dose is 10 mg. The cost of a vial containing 50 mg tPA is \$1,042.

There have now been several controlled studies on the use of fibrinolytics for complicated parapneumonic effusions (31–36). The first study was not randomized or blinded in that the patients received no fibrinolytics for the first part of the study and then received streptokinase for the latter part of the study (31). This study, which included 52 patients, concluded that there was no significant difference in the need for more invasive surgery or in the mortality rate in the two groups (31). In a second study, 24 patients were randomized to receive streptokinase 250,000 IU/d, or saline flushes as controls, for up to 3 d (32). The streptokinase group had a significantly greater reduction in the size of the pleural fluid collection and greater improvement in the chest radiograph (32). In a third study, 31 patients were randomly assigned to receive either intrapleural urokinase or normal saline for 3 d (33). Pleural fluid drainage was complete in 13 (86.5%) patients in the urokinase group but in only four (25%) in the control group. However, when urokinase was subsequently administered to the 12 with incomplete drainage in the saline control group, complete drainage of the effusion was observed in only six patients (50%) (33). In a fourth study Tuncozgun and associates (34) randomly assigned 49 patients with parapneumonic empyema to receive intrapleural urokinase or normal saline daily for 5 consecutive days. Patients who received urokinase in this study had a shorter time for defervescence ( $7 \pm 3$  vs.  $13 \pm 5$  d,  $p < 0.01$ ), a lower need for decortication (60 vs. 29%,  $p < 0.01$ ), and a shorter hospitalization ( $14 \pm 4$  vs.  $21 \pm 4$  d,  $p < 0.01$ ) (34). In a fifth study, Diacon and associates (35), in a single-center, randomized, double-blind study, assigned 44 patients to receive daily pleural washes with streptokinase or saline. After 3 d, there was no significant differences in the groups, but after 7 d, streptokinase-treated patients had a higher clinical success rate (82 vs. 48%,  $p = 0.01$ ) and fewer referrals for surgery (43 vs. 9%,  $p = 0.02$ ).

However, the most recently published study on the use of intrapleural fibrinolytics for the treatment of complicated parapneumonic effusions, which was the largest and best study ever performed, was negative (36). In this multicenter, randomized, double-blind study, 427 patients were randomized to receive intrapleural streptokinase or placebo. In this study, there were no significant differences between the groups in the proportion of patients who died or needed surgery (with streptokinase: 64 of 206 patients [31%]; with placebo: 60 of 221 [27%]; relative risk, 1.14 [95% confidence interval, 0.85–1.54];  $p = 0.43$ ), a result that excluded a clinically significant benefit of streptokinase. Moreover, there was no benefit to streptokinase in terms of mortality, rate of surgery, radiographic outcomes, or length of the hospital stay (36).

The results of this recently published multicenter study cast doubt on the effectiveness of intrapleural fibrinolytics for the therapy of complicated parapneumonic effusions. Although the previous controlled studies supported their use, only the studies of Diacon and coworkers (35) and the multicenter study from the United Kingdom (36) were double blind. It should be noted that the pleural disease in the study of Diacon and coworkers (35) was probably more advanced as indicated by a lower pleural fluid pH and a higher incidence of surgery in the control group. It is also possible that the administration of newer fibrinolytics alone or in conjunction with DNase may facilitate the drainage of complicated parapneumonic effusions. Indeed, at the present time, there is another multicenter trial underway in the United

Kingdom in which patients with complicated parapneumonic effusions are randomized to saline, 10 mg tPA, 1 mg recombinant DNase, or the combination of tPA and DNase twice a day. Until the results of this trial are available, the use of intrapleural fibrinolytics should be reserved for patients in centers without access to video-assisted thoracic surgery and for patients who are not surgical candidates.

The original articles on enzymatic debridement for loculated parapneumonic effusions used Varidase, which consists of a fibrinolytic (streptokinase) and a DNase (streptodornase). It is unclear how much the DNase contributed to the efficacy of the preparation. We have shown that when thick empyemic material from rabbits is incubated with either streptokinase or urokinase, there is no significant liquefaction of the fluid (20). In contrast, when the fluid is incubated with Varidase, the fluid becomes completely liquefied over 4 h. Although Varidase is presently not available in the United States, recombinant human DNase (Pulmozyme; Genentech, San Francisco, CA) is available. Simpson and coworkers have recently demonstrated that recombinant DNase by itself is very effective at reducing the viscosity of human empyema fluid (37). The usefulness of DNase with or without a fibrinolytic in the treatment of complicated parapneumonic effusions or empyema is being evaluated in a multicenter study as outlined in the previous paragraph.

### Thoracoscopy with Lysis of Adhesions

One option for the patient with an incompletely drained parapneumonic effusion is thoracoscopy. A chest CT scan should be obtained before thoracoscopy to provide anatomic information about the size and extent of the empyema cavity (38). With thoracoscopy, the loculations in the pleural space can be disrupted, the pleural space can be completely drained, and the chest tube can be optimally placed (38). In addition, the pleural surfaces can be inspected to determine the necessity for further intervention, such as decortication. If at the time of thoracoscopy, the patient is found to have a very thick pleural peel with a large amount of debris and entrapment of the lung, the thoracoscopy incision can be enlarged to allow for decortication if the procedure cannot be accomplished via thoracoscopy (38).

Thoracoscopy is very effective at treating incompletely drained parapneumonic effusions. When four recent studies with a total of 232 patients are combined, thoracoscopy was the definitive procedure in 178 of the patients (77%) (39–42). The overall mortality was 3%, and the median time for chest tube drainage post-procedure ranged from 3.3 to 7.1 d. The median hospital stay post-thoracoscopy ranged from 5.3 to 12.3 d (39–42). There was one small study that randomized 20 patients with either a loculated pleural effusion or a pleural fluid pH of less than 7.20 to receive either chest tube drainage plus streptokinase or thoracoscopy (43). In this study, thoracoscopy was the definitive procedure in 10 of 11 patients (91%), whereas streptokinase was definitive in four of nine patients (44%) (43). The authors of this study concluded that, in patients with loculated parapneumonic effusions, a primary treatment strategy of video-assisted thoracoscopic surgery is associated with a higher efficacy, shorter hospital duration, and less cost than a treatment strategy that uses catheter-directed fibrinolytic therapy (43). However, it should be noted that there were a small number of patients in this study and the study was not blinded.

### Decortication

Decortication involves the removal of all fibrous tissue from the visceral pleura and parietal pleura, and the evacuation of all pus and debris from the pleural space (44). Decortication eliminates the pleural sepsis and allows the underlying lung to expand. Decortication is a major thoracic operation, usually requiring a

full thoracotomy incision and should therefore not be performed on patients who are markedly debilitated.

Even though decortication is a major procedure, the post-procedure hospitalization is not long. The median postoperative stay reported in one study of 71 patients was only 7 d (45). The mortality rate in this series was 10%, but all the patients who died had other serious medical problems (45). The times for chest tube drainage and for hospitalization are shorter after thoracoscopy than after thoracotomy with decortication (46).

When managing patients with pleural infections in the acute stages, decortication should only be considered for the control of pleural infection. Decortication should not be performed just to remove thickened pleura because such thickening usually resolves spontaneously over several months (47). If, after 6 mo, the pleura remains thickened and the patient's pulmonary function is sufficiently reduced to limit activities, decortication should be considered. The pulmonary function of patients who undergo decortication can increase significantly (48).

### Open Drainage

Chronic drainage of the pleural space can be achieved with open-drainage procedures. Two different types of procedures can be performed. With the simplest procedure, segments of one to three ribs overlying the lower part of the empyema cavity are removed and one or more short, large-bore tubes are inserted into the empyema cavity. The tubes are subsequently irrigated daily with a mild antiseptic solution. The drainage from the tubes can be collected in a colostomy bag placed over the tubes. Alternatively, the empyema cavity can be packed with gauze. This procedure allows the patient to be freed from his attachment to the suction system and provides more complete drainage (1).

A similar but more complicated procedure lines the tract between the pleural space and the surface of the chest with a skin and muscle flap after two or more overlying ribs are resected. The advantage of this open-flap (Eloesser flap) procedure is that it creates a skin-lined fistula that provides drainage without tubes. It can therefore be more easily managed by the patient at home and permits gradual obliteration of the empyema space (49).

It is important to not perform an open-drainage procedure too early in the course of a complicated parapneumonic effusion. If the visceral and parietal pleura adjacent to the empyema cavity have not been fused by the inflammatory process, exposure of the pleural space to atmospheric pressure will result in a pneumothorax. Before open-drainage procedures, this possibility can be evaluated by leaving the chest tube exposed to atmospheric pressure for a short period and determining radiologically whether the lung has collapsed. The high mortality with parapneumonic effusions during World War I has been attributed to performing open-drainage procedures too early (50).

Patients treated with open-drainage procedures can expect to have an open chest wound for a prolonged period. In one older series of 33 patients treated by open-drainage procedures, the median time for healing the drainage site was 142 d (5). With decortication, the period of convalescence is much shorter (45), but decortication is a major surgical procedure that cannot be tolerated by markedly debilitated patients.

## RECOMMENDED MANAGEMENT OF PARAPNEUMONIC EFFUSIONS

It is recommended that a stepwise approach be taken with patients with parapneumonic effusions. The treatment options are therapeutic thoracentesis, tube thoracostomy, tube thoracostomy with intrapleural fibrinolytics, thoracoscopy, and thoracotomy.

The definitive treatment should be performed within the first 10 d of hospitalization.

When a patient with pneumonia is initially evaluated, one should ask if the patient has a parapneumonic effusion. This possibility should be evaluated with decubitus radiographs or ultrasound if the diaphragms are not visible throughout their entire length on the lateral radiographs or if it appears there is loculated pleural fluid. If pleural fluid is present and its thickness between the inside of the chest wall and the outside of the lung is more than 10 mm, the fluid should be analyzed within a short time period. The reason for sampling the pleural fluid in these situations is to determine whether any poor prognostic factors are present (Table 2). The presence of poor prognostic factors indicates a higher likelihood for the need of aggressive drainage. If there is doubt as to how much of the density in a hemithorax is parenchymal and how much is pleural, a CT scan of the chest should be obtained.

If a patient has sufficient pleural fluid to warrant a thoracentesis, a therapeutic rather than a diagnostic thoracentesis is recommended (1). The reasoning behind this recommendation is as follows. If no fluid reaccumulates after the initial therapeutic thoracentesis, one need not worry about the parapneumonic effusion. If the pleural fluid reaccumulates and there were no poor prognostic factors at the time of the initial thoracentesis, no additional therapy is indicated as long as the patient is doing well. If the fluid reaccumulates and there were poor prognostic factors present at the time of the initial thoracentesis, a second therapeutic thoracentesis should be performed. If the fluid reaccumulates a second time, a tube thoracostomy should be performed if any of the poor prognostic factors were present at the time of the second therapeutic thoracentesis (1).

Performance of the therapeutic thoracentesis will also delineate whether the pleural fluid is loculated. If the pleural fluid is loculated, and if any of the other poor prognostic factors listed in Table 2 are present, then more aggressive therapy is indicated. The two primary options at this time are tube thoracostomy with the instillation of fibrinolytics or thoracoscopy with the lysis of adhesions and an attempt at decortication if the lung does not expand. The choice between these two is dictated somewhat by local circumstances. If thoracoscopy is unavailable, the obvious choice is fibrinolytics. If both are available, one may want to try tube thoracostomy with fibrinolytics initially. However, if complete drainage is not obtained with one or two administrations of the fibrinolytics, one should move to thoracoscopy.

If, with thoracoscopy, the lung does not reexpand completely, then decortication should be performed without delay. It should be noted, however, as surgeons become more adept at thoracoscopy, a smaller fraction of patients subjected to thoracoscopy require decortication. In a recent study from the United Kingdom, Waller and Rengarajan reported that they successfully performed decortication via thoracoscopy in 21 of 36 patients (58%)

**TABLE 2. FACTORS ASSOCIATED WITH POOR PROGNOSIS IN PATIENTS WITH PARAPNEUMONIC EFFUSION**

Pleural fluid is pus
Pleural fluid bacterial smears are positive
Pleural fluid glucose is less than 60 ml/dl
Pleural fluid bacterial cultures are positive
Pleural fluid pH is less than 7.20
Pleural fluid LDH is more than three times the upper limit of normal
Pleural fluid is loculated

*Definition of abbreviation:* LDH = lactic acid dehydrogenase.  
Factors are listed in decreasing order of importance.

(51). Open-drainage procedures are reserved for those patients who are too ill to undergo thoracoscopy or thoracotomy.

**Conflict of Interest Statement:** R.W.L. does not have a financial relationship with a commercial entity that has an interest in the subject of this manuscript.

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