

Management of empyema – Role of a surgeon

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ABSTRACT

Postpneumonic empyema still remains quite common in developing countries, especially during the hot and humid months. While most cases would respond to antibiotic therapy, needle aspiration and intercostal drainage, few cases require further surgical management.

The most common nontubercular etiological agent is *Staphylococcus*. Tubercular etiology is not uncommon in India, especially due to delayed presentation, multiresistant strains, mismanaged cases, and noncompliance with antitubercular treatment amidst malnutrition and anemia. Clinical symptoms, a skiagram chest followed by thoracentesis are enough for diagnosis. Pleural fluid is usually diagnostic and helps in choosing the appropriate antibiotics. Further investigations and management depends on the stage of the disease. Thoracentesis alone may be sufficient for the exudative phase. In fibrinopurulent stage, a properly sized and well-placed tube thoracostomy with underwater seal is curative in most cases. Interventional radiologists have placed small-bore catheters, specifically directed to the loculated collection and have used fibrinolytics like urokinase, streptokinase, and tissue plasminogen activator (TPA) to break loculations, ameliorate fibrous peel formation, and fibrin deposition.

Thoracoscopic debridement and thoracoscopic decortication is an alternative with distinct advantages over thoracotomy and are indicated if there was no response with intercostal drainage procedure. In the organizing stage, a thoracotomy (for decortication) would be required if there is a loculated empyema, underlying lung disease or persistently symptomatic effusions. Timely institution of proper management prevents the need for any surgical intervention and avoids long-term morbid complications.

KEY WORDS: Children, Empyema, Surgery

Empyema thoracis constitutes approximately 5–10% cases seen by a pediatrician in India. Culture positivity has decreased significantly over the years as the patients receive antibiotics before presentation.

Tube drainage is used in 80–90% of fibro-purulent cases, and is successful in 70–80% cases. At a tertiary center, approximately 10% of cases need limited thoracotomy, and 3–5% require decortication. Surgery is mainly required by children with persistent pleural sepsis after 10 days of tube drainage. Delaying surgery has a significantly higher potential of requiring decortication.

Definition

Empyema is a localized or free collection of purulent material in the pleural space as a result of combination of pleural dead space, culture medium of pleural fluid, and inoculation of bacteria. It is an advanced parapneumonic effusion.

ETIOLOGY

The etiological factors include: pneumonia – viral, bacterial, tubercular, mycotic; postoperative infection; lung abscess; trauma; subphrenic abscess; generalized sepsis; adjacent infections – retropharyngeal or mediastinal abscess; Esophageal perforation; foreign body; cystic fibrosis; endotracheal tumor; instrumentation.

Parapneumonic effusions are predominantly exudative and occur in 50–70% of patients admitted with a complicated pneumonia. Host factors that contribute to alterations in pleural permeability, such as noninfectious inflammatory diseases, infection, trauma, or malignancy, may allow accumulation of fluid in the pleural space, which becomes secondarily infected.^[1]

BACTERIOLOGY

The most common bacteria implicated for

postpneumonic, nontubercular empyema are *Staphylococcus aureus*, *Pneumococci*, *E. coli*, *Pseudomonas*, *Klebsiella*, and anaerobes.

The cultures are sterile in 30–50% of the cases due to antibiotics. *Staphylococcus aureus* is now the most commonly retrieved organism.^{[2]–[4]} The increasing incidence of methicillin-resistant *Staphylococci* reported from the developed countries has also been recognized in the Indian scenario.^{[5],[6]} Postoperative and post-traumatic empyemas may contain *Bacteroides* or *Pseudomonas aeruginosa*.^[1] Anaerobes have also been recognized as important cause of childhood and adolescent empyema.^[7] Tubercular empyema is common in India and usually associated with lung disease. Tuberculosis being rampant in India may present as acute empyema. In cases of late diagnosis, noncompliance with antitubercular treatment, and resistant strains of mycobacterium, it is usually a chronic disease with underlying parenchymal involvement.

PATHOPHYSIOLOGY

In 1962, the American Thoracic Society described three stages of empyema, which continue to be applied in the classification of the disease.

The progression of pleural fluid collection evolves gradually from stages 1–3 [Table 1].^[8]

1. *Exudative (acute) stage*. The pleural inflammation results in increased permeability and a small fluid collection. The fluid is thin, contains few cellular elements mostly neutrophils, and is often sterile and amenable to thoracentesis. This stage lasts only 24–72 h and then progresses to the fibrinopurulent stage.
2. *Fibrinopurulent (transitional) stage*. It is characterized by the invasion of the organism into the pleural space, progressive inflammation, and polymorphonuclear (PMN) leukocyte invasion. There is an accumulation of protein and fibrinous material with formation of fibrin membranes, which forms partitions or loculations within the pleural space. This stage lasts for 7–10 days and often requires more aggressive treat-

ment such as tube thoracostomy.

3. *Organizing (chronic) stage*. A thick pleural peel is formed by resorption of fluid and as a result of fibroblast proliferation. The lung parenchyma becomes entrapped, forming a fibrothorax. This stage usually occurs within 2–4 weeks after the initial presentation.

The pleural inflammatory response leads to an increased procoagulant activity and depressed fibrinolytic activity, causing fibrin deposition. Loculations are thus formed with fibrin strands covered by fibroblasts that proliferate and deposit basement membrane proteins over the pleura. These proteins prevent the separation of the visceral and parietal pleura and lead to the formation of a pleural peel. Following timely initiation of proper antibiotic therapy, the inflammatory process resolves. Re-epithelialization of the pleura occurs with the migration of pleural mesothelial cells into areas of denudation. However, inappropriate or delayed treatment leads to exuberant pleural inflammation resulting in pleural fibrosis, and restrictive lung disease.

The fluid is turbid and contains > 15 000/dl white blood cells. The aspirated pleural fluid may be investigated for cell count, differential count, Gram stain, glucose, LDH, pH, protein, amylase, lipid stain or triglycerides, and serologic studies. Bacterial, mycobacterial, and fungal cultures of the fluid may be sent, but the treatment should be initiated on the basis of the clinical course. Pleural fluid latex agglutination [or counter immunoelectrophoresis (CIE) for specific bacteria] may be helpful if the cause of the infection cannot be ascertained from culture results.

TREATMENT

The objectives of treatment are to

- control infection,
- drainage of the purulent fluid, and
- eradication of the sac to prevent chronicity and allow re-expansion of the affected lung to restore function.

The therapy instituted depends on the causative factor, stage of empyema, state of the underlying lung, presence of bronchopleural fistula (BPF) if any, ability to obliterate the space, and the condition of the patient. The treatment needs to be individualized and it depends on the available clinical, radiological, and laboratory evidence. General measures include increase in the protein and fluid intake. Physiotherapy and breathing exercises will help

Table 1: Features of three stages of empyema

	Transitional	Acute	Chronic
Viscosity	+	++	+++
WBC	+	++	+++
LDH	+	++	+++
PH	+++	++	+
Glucose	+++	++	+
Lung expansion	+++	++	+

in early re-expansion of the lung following evacuation of the fluid.

Thoracentesis

Thoracentesis may provide, both significant diagnostic information and therapeutic relief for parapneumonic effusions. In cases of streptococcal infection, the pus is very thin and the volume is also small, with fluid pH above 7.2, glucose above 40 mg/dl and with LDH levels below 1000 IU/l. In such cases, only a diagnostic needle aspiration suffices. Performing thoracentesis before the initiation of antibiotics increases the diagnostic yield of the fluid cultures and allows more specific antimicrobial therapy. In cases of tubercular etiology, the antitubercular chemotherapy should be started immediately, and the pus in the pleural space aspirated through a wide-bore needle. Occasionally a repeat aspiration may be required. In many cases, no other treatment is necessary.

The patient receives intravenous antibiotics for 10–14 days followed by oral antibiotics for 1–3 weeks. Antitubercular treatment is mandatory for tubercular empyema. A 6-month course with 4+2 drugs or a 9-month course with 3 drugs is recommended. The treatment may be required for a longer time in cases with associated Pott's spine.

The most controversial area in the management of parapneumonic effusions is the identification of patients, who would benefit from pleural drainage and the choice of the appropriate drainage.^[9] However, long-term follow-up studies show no differences in pulmonary function or exercise capacity between groups managed by antibiotics and antibiotics and drainage alone and these alone and those who underwent drainage procedures in the early stages of empyema.

Tube thoracostomy

Chest tube drainage with an underwater seal is done for cases in stage 2. Diagnostic thoracentesis and chest tube drainage are effective therapy in more than 50% of patients. Prompt drainage of a free-flowing effusion prevents the development of loculations and a fibrous peel. Most children with nontubercular empyema heal well in the long run, even without immediate surgical intervention. When inserted in early stages of empyema, ICD may be sufficient if kept for 5–6 days. If the fluid is not free flowing, further radiological imaging may be required.

Interventional radiology

The placement of small-bore catheters, specifically di-

rected to the loculated pleural fluid collections, has helped to facilitate drainage. Radiologists can lyse adhesions directly using imaging during the tube placement. Interventional radiologists have used fibrinolytics such as urokinase, streptokinase, and tissue plasminogen activator (TPA) in complicated empyemas with loculations and ameliorated fibrous peel formation and fibrin deposition.^{[10]–[12]}

Surgical treatment

Surgical treatment is required for chronic empyema, that may be caused by delayed medical attention, inadequate antibiotic therapy, inadequate drainage, presence of foreign body, inflexion of postresectional space, and chronic pulmonary infection such as mismanaged tuberculosis. Other causes of ICD failure include improper positioning of tube, improper selection of tube size, inadequate physiotherapy, and presence of BPF. Multiloculated empyema or persistently symptomatic effusion is likely to require surgical intervention.

Rib resection

Although the incidence for resorting to rib resection has gone down in the past decade or so, still rib resection becomes mandatory to gain adequate access while dealing with the chronic cases. Rib resection becomes necessary if the pus is thick and loculated, or if the patient remains toxic after intercostal tube drainage. This not only provides adequate exposure but also allows one to evacuate the pus, break up loculations and adhesions, and assess the need for decortication. After cleaning the cavity thoroughly, a tube may be placed in its most dependent portion and attached to underwater seal drainage. A properly placed intercostal tube would be as effective as two or three tubes.

Open drainage

In chronic cases with a regular discharge of thick pus, a wide bore tube may be left in place, open to atmospheric pressure. This is helpful in adolescents with chronic tubercular empyema, in whom the daily output has reduced to approximately 25 ml or so after a prolonged (3–5 weeks) chest tube drainage.

Decortication

Thoracotomy is done to remove the pleural peel and lyse the adhesions if the patient does not respond promptly to the treatment as mentioned above. Decortication comprises removal of the organized inflammatory membrane. It comprises of two types of procedures:

1. removal of the visceral peel alone, and
2. empyemectomy comprising of extrapleural dissection outside the parietal pleura and removal of the com-

plete cavity.

Length of hospital stay, duration of antibiotics, and long-term morbidity are reduced by this more aggressive approach with rapid resolution of symptoms, but it is a major operative procedure with increased cost and short-term morbidity.^[13] Thoracotomy and decortication is very effective, with a reported 95% success rate for patients with fibrinopurulent effusions, and is likely to remain a treatment of choice for advanced empyema.

Video-assisted thoracoscopic surgery

Preoperative CT scan will help to assess the location and thickness of pleural peels and enable to site thoracoscopic ports more effectively.

Although video-assisted thoracoscopic surgery (VATS) is a new and useful dimension added in the management of empyemas, the facilities and the expertise remain limited to the masses, especially in the developing countries. Thoracoscopic debridement closely imitates open thoracotomy and drainage. However, it is usually inadequate and not suitable in late stages of empyema where the encasing thick pleura needs to be removed.

Thoracoscopic decortication has also been done by a few enthusiastic and experienced surgeons. The VATS has proved to be an effective and less invasive replacement for the limited decortication procedure.^{[14]-[16]} However, the drawbacks may include suboptimal decortication of the parietal pleura in the event of bleeding and inadvertent lung injury. It may, thus, not be beneficial for cases with very thick pleura (stage 3).

Lobectomy and pneumonectomy

Surgical excision of a lobe or the whole lung, though not described frequently in the Western literature, remains an important component of the management in our country, where tuberculosis is rampant and neglected cases of empyema are not uncommon. In a few patients, even after adequate decortication, the lung does not expand owing to underlying necrosis. In such cases, resection of the affected lung segment will be prudent. The institutional experience would show that the lung excision (complete or in part) is frequently required not only to excise the diseased lung but also to prevent the other lung from being flooded with the secretions from the infected lung. Also, rib excision may sometimes be required to have a good access to thorax in the advanced cases of empyema with crowding of the ribs. Rarely, the cases may be so difficult that even a second look thoracotomy is required before a lobectomy could be performed successfully.

Indications for pulmonary resection in cases of tubercular empyema.

1. Persistently positive sputum cultures with cavitation after 6 months of continuous optimal chemotherapy with two or more drugs. Resistant tuberculosis should be ruled out. Relative indications for surgical intervention such as severe cavitation, bronchiectasis, or bronchial stenosis may contribute to the failure of chemotherapy in some patients.^[17]
2. Localized pulmonary disease caused by atypical *Mycobacterium* or *Mycobacterium tuberculosis* with broad resistance to chemotherapy (localized disease is defined as that encompassing 1–2 segments of the lung).
3. A mass lesion of the lung in an area of tubercular involvement. This helps for simultaneous diagnosis of the mass lesion and treatment of tuberculosis.^[18]
4. Massive life-threatening hemoptysis or recurrent severe hemoptysis.^[19]
5. A broncho-pleural fistula that does not respond to tube thoracostomy.

COMPLICATIONS

Empyema necessitans

A swelling appears over the chest wall, which is in communication with the underlying empyema. It has a positive cough impulse. It usually does not require any additional treatment and heals spontaneously with adequate treatment of the underlying empyema.

Fibrothorax, is a rare complication seen in adolescents who have presented very late.

Broncho-pleural fistula (BPF) already covered in JIAPS discussion.

Long-term effects

Despite the variability in presentation, most patients recover without sequelae. A number of studies have demonstrated resolution of the radiographic abnormalities in 3–6 months following therapy, with little to no symptoms reported at follow-up examination.

Pulmonary function testing performed following hospitalization has not shown marked abnormalities, irrespective of the clinical course. The only abnormality observed may be slight expiratory flow limitation. Mild obstructive abnormalities were the only findings observed in patients evaluated 12 years (± 5) following recovery from empyema. In advanced stages of empyema, few patients silently suffer restrictive lung disease and abnormal spirometry. Some increased bronchial reactivity has been

reported at later follow-up examinations; however, lung function, and exercise response return to normal for most patients.

Early recognition of pneumonia with parapneumonic effusion, effective intervention to identify the causative organism, and initiation of definitive therapy would reduce morbidity and complications associated with this process.

The success of any intervention depends on the status of the underlying lung pathology and the proper usage of antibiotics. A properly sited intercostal tube drainage during the early stage of pathology could avoid surgery. Tuberculosis should be ruled out in developing countries, at an initial stage to avoid morbid complications. A properly managed case of empyema would prevent serious complications that may later require major surgical resections.

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